

SECTION 22000 – GENERAL PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

- A. These specifications govern the furnishing of all materials and the installation of the same under the subject of plumbing work.
- B. The plumbing contractor is directed to read Special Conditions Turnkey and shall be required to conform to any and all provisions therein.
- C. The plumbing contractor is responsible for the work under all Division 22 headings and shall hereinafter in Division 22 of these specifications be referred to as the “Contractor”. Plumbing plans, and by reference general and electrical plans, are a part of this specification.
- D. The Plumbing plans indicated the extent and general arrangements of the various plumbing systems. Changes in locations or arrangement required by job conditions shall be made by approved Change Order.

1.2 MATERIALS AND EQUIPMENT

- A. All work and materials specified are to be new and of the quality described and essentially the standard product of the manufacturer. The use of manufacturers’ names in specifying equipment or material herein determines the material or equipment to be used.
- B. Unless otherwise specified, where two or more units of the same class equipment or material are to be used for similar purposes, they shall be the products of the same manufacturer. All equipment shall be installed in accordance with the manufacturer’s recommendations.

1.3 CLEANING

- A. All dirt, rubbish, grease, or stains due to the operations of the Contractor shall be removed from all floors, walls, fixtures, etc., with the premises left in perfect condition. All plumbing equipment under this contract shall be set and connected, ready for operation.

1.4 PERMITS AND FEES

- A. Contractor shall secure all necessary permits or licenses to carry work, and shall pay all lawful fees, taxes, etc., in connection with the work. Contractor shall arrange for all tests and inspections on any or all parts of work, required by authorities and organizations having jurisdiction, and shall pay all charges for the same.

1.5 LAW AND ORDINANCES

- A. Work performed shall be in accordance with all local and state or national codes, laws and ordinances pertinent to such work. In case of any conflict wherein methods or standards on installation of materials specified do not equal or exceed requirements of laws of ordinances but not specified or shown on the drawings shall be furnished without extra charge as if shown or specified.

1.6 JOB FORMAN

- A. The Contractor shall have a competent representative available at all times while the project is under construction who will be responsible for coordination of the trades and installation of the work according to plans and specifications.

1.7 WORK TO BE PERFORMED BY OTHER TRADES

- A. Electrical Subcontractor is responsible for all wiring, including interconnecting wiring between controls and any electrical temperature control wiring.
- B. The Developer will perform the following work in connection with the mechanical contract.
 1. Build into building construction all pipe sleeves, bolts and inserts necessary for supporting mechanical equipment. These items will be furnished by the Contractor and will be set in place by him.
 2. Provide all chases, shafts and recesses necessary for installation of all mechanical equipment and furring necessary to conceal piping, ductwork, etc. The Contractor shall provide all necessary information as to size, exact location of chases, recesses, furring, etc., required.
 3. Provide wall, floor, and roof openings necessary for the installation of the mechanical systems. Contractor shall provide exact size and location of such openings, and shall be responsible for completed installations being watertight and waterproof.
 4. Provide bases and supports for principle items of mechanical equipment. He Contractor shall provide exact size and location and shall be responsible for all bases and supports other than these specified above.

1.8 OPERATION AND MAINTENANCE INSTRUCTIONS (O&M)

- A. The Developer shall furnish the Indian Housing Authority (IHA) two bound sets of operating and maintenance instructions covering all equipment furnished under specifications for each total contract. The instructions shall be assembled in an indexed brochure. Separate equipment brochures will not be acceptable. NOTE: These manuals must be delivered to the above before final payment.
- B. A competent supervisor shall instruct the IHA representative in the care, operation, and maintenance of the equipment.

1.9 PROTECTION OF MATERIAL AND WORK

- A. Protect and preserve all materials, supplies and equipment and all work performed.

1.10 FINAL AND GUARANTEE

- A. Nothing herein contained may be construed to relieve the Developer and Contractor from making good and perfect work in all details of construction of installation, and they will be held responsible to provide and furnish necessary material, and to perform all necessary labor, and to bear all expenses incidental to the satisfactory completion of the work embraces herein.
- B. At final inspection, prior to purchase by the Indian Housing Authority, the Developer and Contractor shall demonstrate completely the system and equipment performance. Developer and Contractor shall guarantee all labor, material, and equipment furnished under this contract against any defects developing from faulty or poor workmanship or material for a period of one (1) year from the date of final acceptance by the Indian Housing Authority. The Developer or Contractor shall remedy any defect appearing within that time without extra charge to the Indian Housing Authority within a reasonable time after notice. The term “defect” excludes occurrences, as would normally follow improper treatment, accident, or wear and tear of normal use.
- C. Furnish written guarantees for each piece of equipment so covered by manufacturer’s warranties. These shall be furnished for each dwelling unit and shall be bound, indexed and labeled for the appropriate dwelling.

1.11 SINGULAR NUMBER

- A. Where any device or part of equipment is herein referred to in the singular number (such as “the pump”), such reference shall be deemed to apply to as many devices as are required to complete the installation as shown on the drawings.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 SCOPE

- A. The work performed under this heading includes all labor, materials, and equipment to complete the various piping systems for plumbing, drainage and heating, including all pipe fittings, insulation, and valves as shown on the plans and specifications. Contractor shall keep a competent foreman on the premises while his work is in progress.
- B. All piping shall be run substantially as shown on the plans and shall be run in the most direct manner, make the piping conform to the building construction and shall be made without extra charge. Each section of pipe and all fittings, valves, etc., shall be inspected and thoroughly cleaned inside before being installed. All piping and fittings shall have working pressure

ratings suitable for the operating pressures to which they will be subject. All defective pipe, fittings, valves, and other material installed shall be removed and replaced with new and good material. Pipe shall be cut accurately to measurements established at the site and worked into place without springing or forcing. Ream ends of all cut pipe.

- C. The plumber shall furnish material, labor, and transportation required for performance of the work herein described. He shall keep a competent foreman on the premises while work is in progress.
- D. Contractor shall obtain necessary permits and pay all fees therefore. He shall be responsible for damage to property caused by him or his employees. He shall protect his work from damage and work in harmony with other trades.
- E. From time to time as the work progresses, he shall remove all rubbish and accumulation resulting from his work. Plumbing work shall comply with all laws having jurisdiction of the work including the Local Code, State Health Department and the BOCA Plumbing Code.
- F. The Plumber shall examine the general plans and specifications, and make sure he understands the conditions under which he must work. He must visit the building site and secure firsthand information regarding the location and depth of water, gas and sewer lines.
- G. Refer to foundation plan and notice the depth and location of grade beams. If necessary to run lines through concrete beam, provide sleeves in concrete.
- H. Piping shall be installed in a manner to insure absence of vibration, rubbing or other objectionable noises. All necessary expansion requirements must be provided.
- I. Pipe sizes shown on the plans are nominal, (not including insulation).

3.2 SITE VISIT

- A. Contractor shall visit the site of the project and thoroughly familiarize himself with the existing conditions prior to submitting a proposal. Additional payment will not be authorized for extra work for reason of unforeseen conditions due to failure to make site visit.

3.3 FOUNDATIONS, BASES AND SUPPORTS

- A. Contractor shall furnish all special foundations, bases, and supports required for the proper installation and operation of any equipment furnished under this Division. Equipment with moving parts shall have special cork or rubber-and-metal isolation bases for prevention of noise and vibration.

3.4 MOTORS AND CONTROL (S)

- A. Contractor shall furnish all motors and integral motor starters for mechanical equipment.
- B. Unless otherwise specified or noted, all motors less than ½ HP shall be wound for single phase, 6—cycle, 120-volt current.

- C. Motors shall be constructed in accordance with NEMA standards, shall be applied to operate at not more than 100% of their rating, and shall have ball or roller bearings.
- D. Where motor sizes are increased above those shown on plans, due to variations in manufacturer's equipment, the Developer and Subcontractor will ascertain the requirements and make due allowances for increased service thereto. Any additional cost in electrical work caused by variation in manufacturers' equipment shall be the responsibility of the Developer and Subcontractor.

3.5 WASTE, VENT PIPE AND FITTINGS

- A. Refer to appropriate Division 22 specifications for allowable materials. All joints and connections in plastic pipe shall be made watertight with joint cement as recommended by manufacturer.
- B. Cleanouts: Accessible cleanouts shall be installed in all waste lines and shall not be greater than 100 feet apart in horizontal lines and elsewhere as shown or required by Code. All cleanouts shall have removable plugs.
- C. Roof Flashing: Vent through roof shall be flashed with 4 pound sheet lead with lead extending 8" away on all sides, turned-in at top and made watertight. The Contractor may use galvanized roof flashing with neoprene seal sized to fit vent stack.
- D. Floor Drains: Shall be 2" discharge and located in showers and water heater closets, as shown on plan. Strainers shall be 4" diameter brass, with chrome finish, adjustable to the finished floor surface of shower or closet.
- E. Standing Drains: The contractor will furnish and install 1-1/2" standing drains with trap and 1-1/2" drain lines for washer box as shown and located on the plans.

3.6 WATER PIPE AND FITTINGS

- A. Refer to appropriate Division 22 specifications for allowable materials.
 - 1. Water pipe above grade within the building area shall be Type L hard copper. Under floor water pipe shall be Type K soft copper without joints and shall comply with ASTM C425-64.
 - 2. All fittings shall be seat joint type using 95-5 solder. The ends of the pipe shall be reamed to full diameter and cleaned with garnet paper. Water lines to 5'-0" outside of building shall be Type K soft copper with sweated terminal fittings. Beyond 5'-0" shall be PVC Schedule 40 pipe.
 - 3. Air Chambers: 12" copper pipe shall be installed in water supply of each fixture. The diameter of the air chamber shall be not less than the size of the supply.
 - 4. Plates: Exposed pipe passing through floors and walls shall be fitted with chromium plated split ring escutcheons.
 - 5. Fittings on water heater shall be brass (no galvanized). Provide electrically insulated non-metallic fittings for dielectric break in water lines at water heater. All water pipes shall be neatly arranged and securely anchored to avoid vibration.
 - 6. Solder: "Lead Free Solder" tin/copper/nickel/silver low melting temperature.

3.7 PIPE INSULATION AND SLEEVES

- A. Refer to appropriate Division 22 specifications for allowable materials.
- B. The full length of all hot water pipes and all cold water pipes shall be insulated per section 220700 Insulation.
- C. Where piping penetrates the slab, insulation must be properly sized to fit pipe and cover all fittings. All water supply lines under slab shall be sleeved with 80 pound black poly pipe throughout, and extending through slab to connection with sweeps.
- D. Where vents or other piping (except gas) penetrate tope plate, seal voids around piping with liquid polyurethane foam. **DO NOT SEAL GAS LINE PENETRATIONS.**

3.8 GAS SERVICE

- A. Refer to appropriate Division 22 specifications for allowable materials.
- B. The entire installation shall conform to the rules and regulations of the Local Gas Company. Verify location of existing gas service and install gas service of 1-1/4" diameter, with cut-off at each entrance into building. Cut-off to be cast iron body with brass working parts, as approved by Indian Housing Authority.
- C. Distribution: Gas shall enter the building above the floor line and distribute overhead above ceilings and drop in partitions. There shall be no connections within the partitions. Top plate shall be vented to the attic space where gas lines penetrate them. Provide gas to each gas-burning device, provide cut-offs and connect.
- D. Regardless of anything herein to the contrary, where L.P gas is used the entire installation and distribution shall be in strict accordance with the state requirements for liquid petroleum piping.
- E. Furnish and install 3/4" gas line, with cut-off, to each water heater, central furnace, range space, and clothes dryer space. (Cap end of lines that are optional use, in addition to cut-off, at range and dryer spaces.
- F. *LP Gas (where applicable) – 250 gallon tank will be provided and filled to a minimum 70% capacity at time of acceptance by the Indian Housing Authority.

3.9 PLUMBING FIXTURES

- A. Furnish and install plumbing fixtures where so indicated on plans. Protect fixtures from damage during construction and replace any damaged material without cost to the Indian Housing Authority (IHA).
- B. Refer to appropriate Division 22 specifications for allowable materials.
- C. NOTE: No plastic valves of stops shall be used. All fixture fittings shall be washer less valves. All exposed trim (not in cabinet work) shall be chromed.

- D. Water Well Pump: Where required, furnish GOLD-JACUZZI submersible 1/3 to 1-1/2 HP per O.E.H. recommendation, complete with pump, pump ends, motor, tank and all accessories. Provide 5-year protection plan “Sub-Shield” or equal. The contractor shall furnish this warranty to IHA complete with serial number, name of participant and location of pump.

3.10 PROTECTION OF WORK

- A. At all times, take precautions necessary to properly protect the plumbing equipment and accessories from damage. Protect work from possible damage from freezing and stoppage of the pipes, traps, floor drains, and waste lines by building materials. The Contractor shall repair any damage without additional charge. Protect all plumbing fixtures from use or damage until completion of building.

3.11 LEAK DAMAGE

- A. The General Contractor shall be responsible for damages to the building, or its contents, etc., caused by leaks in any of the equipment installed by him or his Subcontractors, through equipment or material failures, disconnected pipes, and fittings or by overflows caused by improper installation and/or protection. The Contractor shall be responsible for all repairs to merchandise, fixtures and equipment damaged.

3.12 REMOVL OF RUBBISH

- A. The Contractor shall keep the premises free from accumulations of waste material or rubbish caused by this work during construction period. At the completion of the work, remove all rubbish from the building site. Leave the building “Broom Clean”.

3.13 EXCAVATING AND BACKFILLING

- A. Furnish all excavating and backfilling required, both inside and outside building, for the installation of all underground piping in connection with this contract.
- B. The bottom of all trench excavation shall be firm, stable and of uniform density as nearly as practicable; and unless necessary, materials shall not be disturbed below grade. All soft, wet, disintegrated, or other unsuitable materials shall be removed and any rock materials shall be removed to a depth of a least 6” below grade. Such removed materials shall be replaced with suitable material thoroughly compacted in place to finish the grade elevation in a satisfactory manner. Bell holes shall be provided under all bells to a minimum depth of 3”. Water, gas and sewer lines in yard shall have a minimum coverage of 24”. Keep trenches dry and furnish necessary pumps and power.
- C. After inspection and approval, backfill trenches with approved backfill material and solidly tamped about pipes. This material shall be carefully deposited and compacted in uniform layers as specified in Item “N”. Puddling or water flooding for consolidation of materials is approved for sand only.

- D. Earth backfilling shall be hand placed alongside and 12” above the pipe, on both sides simultaneously, in layers not exceeding 4” depth, loose measurements. Each layer shall be thoroughly compacted. Compactions shall be not less than 90% Standard Proctor Density.
- E. Submission of bid shall constitute acceptance by the Bidder of existing site conditions as a part of the requirements for this work.
- F. General: Lay all pipes in open trench except when the Local Authority Having Jurisdiction gives written permission for tunneling. Open the trench sufficiently ahead of pipe laying to reveal obstructions. Maintain easy access to fire hydrants by firefighting apparatus. Provide trench crossings as necessary to accommodate public travel.
- G. Width of Trench: Excavate trenches of sufficient width for proper installation of the work. When the depth of backfill over sewer pipe exceeds 10 feet, keep the trench at the level of the top of pipe as narrow as practicable.
- H. Sheeting and Bracing: As necessary to protect workmen and adjacent structures, comply with OSHA regulations. Do not remove sheeting until trench is backfilled sufficiently to protect pipe and prevent injurious caving. Cut off such sheet not to be removed at least 3 feet below finished grade.
- I. Water Removal: Pump or bail water from trenches and bell holes to permit proper joining of pipes. Conduct the discharge from trench dewatering to drains or natural drainage channels.
- J. Disposition of Utilities: Rules and regulations governing the respective utilities shall be observed in executing all work under this heading. Active utilities shall be protected. Relocation, if required, shall be in accordance with the written instructions of the Local Authority. Inactive and abandoned utilities encountered in trenching operations shall be removed, plugged or capped. In absence of specified requirements, plug or cap such utility lines at least 3 feet from utility line to be installed or as required by the local regulations.
- K. Grading Trench Bottom: Carry machine excavation only to such depth that soil bearing for pipes will not be disturbed. Grade bottom of trenches evenly to insure uniform bearing for all pipes. Cut holes as necessary for joints and joint making.
 - 1. As an alternative method, optional with the Contractor, excavate trenches to insure uniform bearing for all pipes. Cut holes as necessary for joints and joint making.
 - 2. In rock, cemented gravel, old masonry or other hard material, excavate at least 4” below the pipe at all points and refill to grade with sand or gravel firmly compacted.
- L. Special Supports: Wherever the soil, at or below the requisite pipe grade, is unsuitable for supporting sewer or other such piping and appurtenances specified in this Division, such special supports, in addition to those shown or specified, shall be provided as the Local Authority may direct.
- M. Tree Protection: Protect the roots of trees to remain. Within the branch spread of such trees, perform all trenching by hand. Open the trench only with the utility can be installed immediately; prune injured roots cleanly; and backfill as soon as possible.
- N. Backfilling: Backfill trenches only after piping has been inspected, tested and locations of pipelines and appurtenances have been recorded.

1. For a depth of at least 12" above the top of the pipe, backfill by hand with earth or granular material free from large stones, rock fragments, roots and sod; excluded cinders, junk, refuse, scrap iron, and unused portions of welding rods from trenches in which metal pipes are to be laid; tamp this backfill thoroughly in layers 4 inches in thickness, taking care not to disturb the pipe or injure the pipe coating.
2. For the remaining trench depth, backfill in 6" to 10" lifts with material as specified in the preceding subparagraph, except that the material may contain stones, rocks, concrete or masonry materials with a maximum dimension of 4 inches, providing the voids in such coarse material are completely filled with earth or granular material. IN the event that sufficient suitable material, as herein specified for the trench backfill, is not available from the trenching or other excavation for the project, supply and place the required additional material. Compact thoroughly to backfill to 90% Standard Proctor Density. If the granular material is sand, the top 6 inches of the trench must be soil similar to the existing finish material or soil.
3. NOTE: Where sand is used to fill trenches, 5' entering of leaving a building shall be clay type soil, which will prohibit the flow of water.

3.14 SERVICES

- A. Where an approved public water and/or sewer system is available to the house, this Contractor shall connect complete to the public systems. Where there is not public water or sewer system available, this Contractor shall provide a complete well and water system and septic system in accordance with the Indian Housing Authority Bidder's Packet, the State Health Department, and the Indian Health Service.
- B. Sewer Connection: Where applicable, make a proper connection to existing city sewer and pay all costs incident thereto. Verify sewer location and depth before installing waste lines and provide a uniform grade from all fixtures to the point of discharge.

3.15 TESTING AND ADJUSTING

- A. Plumbing contractor shall test and adjust the various plumbing systems on this job to give the required performance.
- B. Pipe work must be properly tested by the Plumbing Contractor and approved by the Indian Housing Authority before being covered up or enclosed by building construction. The Contractor will be held responsible, and be required to pay for any damage or expense due to leaks or broken connections that may prove to exist before and after such work is concealed.
- C. Waste and Vent Piping: Plug all necessary openings to allow entire system to be filled with water to level of highest vent stack above roof. System shall hold water 30 minutes without a drop in level, 24 hours without leakages. Portion of systems may be tested as above, except that a vertical stack 10 feet above highest horizontal point to be tested may be installed and filled with water to maintain pressure. A pump may be used to attain pressure; pressure must hold for 30 minutes without pumping.
- D. Hot and cold water lines shall be made tight without dope or caulking. Test by air to 125psi. System must hold pressure for twelve (12) hours without pumping. Test to be performed after rough-in has been completed.

- E. Gas piping to be tested with 50 pounds air pressure; test to remain on piping for 24 hours without a drop in pressure. Final test on all piping connections to be made with soap solution.
- F. A final test shall be made upon completion of all piping systems. The test pressure being the maximum operating pressure of the system, without leaking.

END OF SECTION 220000

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for solder-joint connections.

B. NSF Compliance: NSF 61 for valve materials for potable-water service.

2.2 GENERAL-DUTY VALVES

A. Valve Sizes: Same as upstream piping unless otherwise indicated.

B. Valves in Insulated Piping: With 2-inch stem extensions.

C. Class 125, NRS, Bronze Gate Valves:

1. Description:

- a. Standard: MSS SP-80, Type 1.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Material: Bronze with integral seat and screw-in bonnet.
- d. Ends: Threaded or solder joint.
- e. Stem: Bronze.
- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Use gate valves for shutoff duty.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves for each fixture and item of equipment.
- D. Install valves in horizontal piping with stem at or above center of pipe.
- E. Install valves in a position to allow full stem movement.
- F. Provide interior cut-off 1" diameter gate valve in interior wall at exterior hose bibb location. Install valve minimum 12" into interior wall. Provide with 16"x18" "Cover Up" access panel by Diversified Plastics Industries, Sand Springs, OK, or equal.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

2.2 HANGERS AND SUPPORTS FOR PLUMBING PIPING EQUIPMENT

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.

B. Miscellaneous Materials:

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

PART 3 - EXECUTION

3.1 GENERAL PIPING INSTALLATIONS

- A. Install piping free of sags and bends.

- B. Install fittings for changes in direction and branch connections.

3.2 HANGERS AND SUPPORTS

- A. Comply with MSS SP-69 and MSS SP-89. Install building attachments within concrete or to structural steel.
- B. Install hangers and supports to allow controlled thermal movement of piping systems.
- C. Load Distribution: Install hangers and supports so piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- D. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 - 1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 4.
 - 2. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 3. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
- E. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 4.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 4, if longer ends are required for riser clamps.

END OF SECTION 220529

SECTION 220533 - HEAT TRACING FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: For each type of product indicated.

- a. Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.
- b. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.
- c. Shop Drawings: For electric heating cable. Include plans, sections, details, and attachments to other work.
- d. Wiring Diagrams: Power, signal, and control wiring.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
- B. Comply with IEEE 515.1.

2.2 PLASTIC-INSULATED, SERIES-RESISTANCE HEATING CABLES

- A. Heating Element: Single- or dual-stranded resistor wire. Terminate with waterproof, factory-assembled nonheating leads with connectors at both ends.
- B. Electrical Insulating Jacket: Minimum 4.0-mil Kapton with silicone jacket or Tefzel.
- C. Cable Cover: Aluminum braid and silicone or Hylar outer jacket.
- D. Maximum Operating Temperature: 300 deg F.
- E. Capacities and Characteristics:
 1. Maximum Heat Output: 6 W/ft..

2.3 CONTROLS

A. Pipe-Mounting Thermostats for Freeze Protection:

1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
4. Corrosion-resistant, waterproof control enclosure.

2.4 ACCESSORIES

- A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.
- B. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Electric Heating Cable Installation for Freeze Protection for Piping:

1. Install electric heating cables after piping has been tested and before insulation is installed.
 2. Install electric heating cables according to IEEE 515.1.
 3. Install insulation over piping with electric cables according to Section 220700 "Plumbing Insulation."
 4. Install warning tape on piping insulation where piping is equipped with electric heating cables.
- B. Set field-adjustable switches and circuit-breaker trip ranges.
- C. Protect installed heating cables, including nonheating leads, from damage.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- F. Testing: Perform tests after cable installation but before application of coverings.
- G. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounting cables.

- H. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 220533

SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: For each type of product.
2. For adhesives and sealants, documentation including printed statement of VOC content and chemical components.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- ##### A. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less according to ASTM E 84.

2.2 INSULATION MATERIALS

- ##### A. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- ##### B. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

2.3 ADHESIVES

- ##### A. Flexible Elastomeric and Polyolefin 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.

2.4 SEALANTS

A. Joint Sealants for Cellular-Glass Products:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F (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.

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. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

PART 3 - EXECUTION

3.1 PIPE INSULATION INSTALLATION

- A. Comply with requirements of the Midwest Insulation Contractors Association's "National Commercial & Industrial Insulation Standards" for insulation installation on pipes and equipment.
- 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, Partition, and Floor Penetrations: Install insulation continuously through penetrations. Seal penetrations. Comply with requirements in Section 078413 "Penetration Firestopping."
- D. Flexible Elastomeric Insulation Installation:
1. Seal longitudinal seams and end joints with adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 2. Insulation Installation on Pipe Fittings and Elbows: Install mitered sections of pipe insulation. Secure insulation materials and seal seams with adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- E. Interior Piping System Applications: Insulate the following piping systems:
1. Domestic hot water.
 2. Recirculated domestic hot water.
 3. Domestic cold water.
 4. Exposed water supplies and sanitary drains of fixtures for people with disabilities.
- F. Do not apply insulation to the following systems, materials, and equipment:
1. Flexible connectors.
 2. Sanitary drainage and vent piping.
 3. Drainage piping located in crawlspaces unless otherwise indicated.
 4. Chrome-plated pipes and fittings, except for plumbing fixtures for people with disabilities.

5. Piping specialties, including air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.2 INDOOR PIPING INSULATION SCHEDULE

- A. Unless otherwise indicated, do not install insulation on the following:
 1. Drainage piping located in crawlspaces.
 2. Underground piping.
 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
- B. Domestic Cold Water:
 1. NPS 1 and Smaller: Insulation shall be the following:
 - a. Flexible Elastomeric: 1/2 inch thick.
- C. Domestic Hot and Recirculated Hot Water:
 1. NPS 1 and Smaller: Insulation shall be the following:
 - a. Flexible Elastomeric: 1/2 inch thick.
- D. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1/2 inch thick.

END OF SECTION 220700

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: For transition fittings and dielectric fittings.
2. Product for solvent cements and adhesive primers, documentation including printed statement of VOC content.

PART 2 - PRODUCTS

2.1 PREFORMANCE REQUIREMENTS

- ##### A. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

2.2 PIPE AND FITTINGS

- ##### A. Hard Copper Tubing: ASTM B 88, Types L, water tube, drawn temper with wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

1. Copper Unions: Cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
2. Joining Materials: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, 95-5 lead-free-alloy solder.

- ##### B. Soft Copper Tubing: ASTM B 88, Types K, water tube, annealed temper with copper pressure fittings, cast-copper-alloy or wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

1. Joining Materials: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, 95-5 lead-free-alloy solder.

- ##### C. PEX Tube and Fittings: ASTM F 877, SDR 9 PEX tubing and ASTM F 1807, metal insert-type fittings with copper or stainless-steel crimp rings.

1. Manifold: ASTM F 877 plastic or corrosion-resistant-metal assembly, with a plastic or corrosion-resistant-metal valve for each outlet.

- ##### D. Special-Duty Valves:

1. Comply with requirements in Section 220523 "General-Duty Valves for Plumbing Piping" for general-duty metal valves.

- E. Flexible Connectors: Stainless-steel, corrugated-metal tubing with wire-braid covering. Working-pressure rating a minimum of 200 psig.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install piping free of sags and bends.
- B. Install fittings for changes in direction and branch connections.
- C. Install unions at final connection to each piece of equipment.
- D. Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals in water piping.
- E. Soldered Joints: Comply with procedures in ASTM B 828 unless otherwise indicated.
- F. Install shutoff valve, inside the building at each domestic water service entrance.
- G. Install domestic water piping without pitch for horizontal piping and plumb for vertical piping.
- H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- I. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
 - 1. Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters:
 - a. NPS 1 (DN 25) and Smaller: 32 inches (815 mm) with 3/8-inch (10-mm) rod.
 - b. Install hangers for vertical PEX piping every 48 inches (1200 mm).

3.2 INSPECTING AND CLEANING

- A. Inspect and test piping systems as follows:
 - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
- B. Clean and disinfect potable domestic water piping by filling system with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.

3.3 PIPING SCHEDULE

- A. Underground, Service Entrance Piping: Soft copper tubing.
- B. Aboveground Distribution Piping: Type L, hard copper tubing or PEX piping.

3.4 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use bronze gate valves for piping NPS 2 and smaller.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: For each type of product.
2. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- ##### A. Potable-water piping and components shall comply with NSF 61.

2.2 PERFORMANCE REQUIREMENTS

- ##### A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 MANUFACTURED UNITS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Standard: ASSE 1001.
2. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), as required to match connected piping.
3. Body: Bronze.
4. Inlet and Outlet Connections: Threaded.
5. Finish: Chrome plated.

B. Hose-Connection Vacuum Breakers:

1. Standard: ASSE 1011.
2. Body: Bronze, nonremovable, with manual drain.
3. Outlet Connection: Garden-hose threaded, complying with ASME B1.20.7.
4. Finish: Chrome- or nickel-plated bronze.

C. Reduced-Pressure-Principle Backflow Preventers:

1. Standard: ASSE 1013.
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 12 psig maximum, through middle third of flow range.
4. Body: Bronze for NPS 2 (DN 50) and smaller.

5. End Connections: Threaded for NPS 2 (DN 50) and smaller.
6. Accessories:
 - a. Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

D. Water Regulators:

1. Standard: ASSE 1003.
2. Pressure Rating: Initial working pressure of 150 psig (1035 kPa).
3. Body: Bronze for NPS 2 (DN 50) and smaller.
4. End Connections: Threaded for NPS 2 (DN 50) and smaller.

E. Clothes Washer Outlet Boxes:

1. Mounting: Recessed.
2. Material and Finish: Plastic box and faceplate.
3. Faucet: Combination valved fitting or separate hot- and cold-water valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
4. Supply Shutoff Fittings: NPS 1/2 (DN 15) gate, globe, or ball valves and NPS 1/2 (DN 15) copper, water tubing.
5. Drain: NPS 2 standpipe and P-trap for direct waste connection to drainage piping.
6. Inlet Hoses: Two 60-inch-long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
7. Drain Hose: One 48-inch-long, rubber household clothes washer drain hose with hooked end.

F. Nonfreeze Wall Hydrants:

1. Standard: ASME A112.21.3M for exposed-outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig (860 kPa).
3. Operation: hand wheel.
4. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
5. Inlet: NPS 3/4.
6. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
7. Nozzle and Wall-Plate Finish: Rough bronze.

G. Water-Hammer Arresters:

1. Standard: ASSE 1010 or PDI-WH 201.
2. Type: Copper tube with piston.
3. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install water-hammer arresters in water piping according to PDI-WH 201.

END OF SECTION 221119

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: For each type of product.
2. For solvent cements and adhesive primers, documentation including printed statement of VOC content.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
1. Soil, Waste, and Vent Piping: 10-foot head of water.
 2. Waste, Force-Main Piping: 50 psig.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components.

2.2 PIPES AND FITTINGS

- A. PVC Plastic, DWV Pipe and Fittings: ASTM D 2665, Schedule 40, plain ends with PVC socket-type, DWV pipe fittings.
1. Adhesive Primer: ASTM F 656.
 - a. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Solvent Cement: ASTM D 2564.
 - a. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Install wall penetration system at each pipe penetration through foundation wall.
 - 1. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- B. 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.
- C. 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.
- D. 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 and smaller; 1 percent downward in direction of flow for piping NPS 4 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.
- E. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- F. Install underground PVC soil and waste drainage piping according to ASTM D 2321.
- G. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- H. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

3.2 PIPE SCHEDULE

- A. Aboveground Applications: PVC plastic, DWV pipe and fittings with solvent-cemented joints.
- B. Belowground Applications: PVC plastic, DWV pipe and drainage-pattern fittings with cemented joints.

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221316-SANITARY WASTE AND VENT PIPING

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END OF SECTION 221316

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- ##### A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

2.2 CLEANOUTS

A. Plastic Cleanouts:

1. Size: Same as connected branch.
2. Body: PVC.
3. Closure Plug: PVC.
4. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.3 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Standard: ASME A112.6.3.
2. Pattern: Floor drain.
3. Body Material: Gray iron.
4. Seepage Flange: Required
5. Clamping Device: Required.
6. Outlet: Bottom.
7. Coating on Interior and Exposed Exterior Surfaces: Not required.
8. Sediment Bucket: Not required.
9. Top or Strainer Material: Nickel bronze.
10. Top of Body and Strainer Finish: Nickel bronze.
11. Top Shape: Round.

2.4 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

1. Description: Manufactured assembly made of 4.0-lb/sq. ft. thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
 - a. Open-Top Vent Cap: Without cap.
 - b. Low-Silhouette Vent Cap: With vandal-proof vent cap.
 - c. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Air-Gap Fittings: ASME A112.1.2, chrome-plated brass cover.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- B. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor unless otherwise indicated.
 1. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 2. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- C. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- D. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

END OF SECTION 221319

SECTION 223100 - DOMESTIC WATER SOFTENERS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: For each type of product.
 - a. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Operation and Maintenance Data:

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water softener that fail in materials or workmanship within five years from date of Substantial Completion.

C. Maintenance: Submit manufacturer's "Agreement for Continued Service and Maintenance," before Substantial Completion, for Owner's acceptance.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. UL Compliance: Fabricate and label water softeners to comply with UL 979, "Water Treatment Appliances."

2.2 RESIDENTIAL WATER SOFTENERS

A. Description: Factory-assembled, fully automatic, pressure-type water softener with one mineral tank and one brine tank or cabinet-style, combination mineral and brine tank unit with equivalent characteristics.

1. Mineral Tank: Steel or FRP, with coating or liner suitable for potable-water service and 125-psig minimum pressure rating. Fabricate and label mineral tanks to comply with ASME Boiler and Pressure Vessel Code.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects."
3. Controls: For fully automatic operation.
4. Brine Tank: Combination measuring and wet-salt storing system.
 - a. Tank and Cover Material: FRP or molded PE.

- b. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
 - c. Size: Large enough for at least two regenerations at full salting.
5. Factory-Installed Accessories:
- a. Piping, valves, tubing, and drains.
 - b. Sampling cock.
 - c. Main-operating-valve position indicator.

2.3 CHEMICALS

- A. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock.
 - 1. Exchange Capacity: 30,000 grains/cu. ft. of calcium carbonate of resin when regenerated with 15 lb of salt.
- B. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are not acceptable.
 - 1. Form: Processed, food-grade salt pellets.

2.4 WATER TESTING SETS

- A. Description: Manufacturer's standard water-hardness testing apparatus and chemicals with testing procedure instructions. Include metal container suitable for wall mounting.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install water softener on 4-inch-thick concrete base.
- B. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible.
- C. Anchor water softener and brine tanks to substrate.
- D. Install seismic restraints for tanks and floor-mounting accessories and anchor to building structure.
- E. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.
- F. Install piping adjacent to equipment to allow service and maintenance.

- G. Make piping connections between water-softener-unit headers and dissimilar-metal water piping with dielectric fittings. Provide shutoff valves on raw-water inlet and soft-water outlet piping.
- H. Add water to brine tanks and fill with salt.

END OF SECTION 223100

SECTION 223300 - ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: For each type and size of domestic-water heater.

B. Warranties: Submit a written warranty executed by manufacturer agreeing to repair or replace water heaters that fail in materials or workmanship within three years from date of Substantial Completion. Failures include, but are not limited to, tanks and elements.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with requirements of applicable NSF, AWWA, or FDA and EPA regulatory standards for tasteless and odorless, potable-water-tank linings.

B. Comply with performance efficiencies prescribed in ASHRAE 90.2, "Energy Efficient Design of New Low-Rise Residential Buildings."

2.2 WATER HEATERS, GENERAL

A. Insulation: Suitable for operating temperature and required insulating value. Include insulation material that surrounds entire tank except connections and controls.

B. Anode Rods: Factory installed, magnesium.

C. Combination Temperature and Pressure Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input and pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into tank.

D. Drain Valve: Factory or field installed.

2.3 ELECTRIC WATER HEATERS

A. Residential, Small-Capacity, Electric, Domestic-Water Heaters:

B. Standard UL 174, 40-gal. capacity; steel with 150-psig working-pressure rating. Two electric, screw-in, immersion-type heating elements with adjustable thermostat for each element and wiring arrangement for nonsimultaneous operation with maximum 30-A circuit.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install temperature and pressure relief valves and extend to closest floor drain.
- B. Install vacuum relief valves in cold-water-inlet piping.
- C. Install shutoff valves and unions at hot- and cold-water piping connections.
- D. Make piping connections with dielectric fittings where dissimilar piping materials are joined.
- E. Electrically ground units according to authorities having jurisdiction.

END OF SECTION 223300

SECTION 223400 - FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: For each type and size of domestic-water heater.
2. Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1, Section 7, "Service Water Heating."
3. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
4. Operation and maintenance data.

- ##### B. Warranties: Submit a written warranty executed by manufacturer agreeing to repair or replace water heaters that fail in materials or workmanship within five years from date of Substantial Completion. Failures include, but are not limited to, tanks and elements.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.
- C. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."
- D. Gas-Fired Water Heaters: Bear AGA certification label.
- E. Comply with requirements of applicable NSF, AWWA, or FDA and EPA regulatory standards for tasteless and odorless, potable-water-tank linings.
- F. Comply with performance efficiencies prescribed in ASHRAE 90.2, "Energy Efficient Design of New Low-Rise Residential Buildings."

2.2 WATER HEATERS, GENERAL

- A. Insulation: Suitable for operating temperature and required insulating value. ASHRAE/IESNA 90.1. Surround entire tank except connections and controls.
- B. Anode Rods: Factory installed, replaceable magnesium.

- C. Combination Temperature and Pressure Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input and pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into tank.
- D. Drain Valve: ASSE 1005. Factory or field installed.

2.3 GAS-FIRED WATER HEATERS

- A. Residential, Power-Vent, Gas-Fired, Storage, Domestic-Water Heaters:
 - 1. Standard ANSI Z21.10.1/CSA 4.1., 40-gal. capacity and 40 kBtu/h input burner; steel with 150-psig working-pressure rating; with adjustable thermostat; automatic gas-ignition system, draft hood; and power-vent system interlocked with burner. Energy Star rating and 40.4 GPH recovery.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install heaters on water-heater stand on floor.
 - 1. Maintain manufacturer's recommended clearances.
 - 2. Arrange units so controls and devices that require servicing are accessible.
- B. Install temperature and pressure relief valves and extend to closest floor drain.
- C. Install vacuum relief valves in cold-water-inlet piping.
- D. Install shutoff valves and unions at hot- and cold-water piping connections.
- E. Make piping connections with dielectric fittings where dissimilar piping materials are joined.
- F. Connect gas water heaters according to NFPA 54. Connect gas vent and draft hoods and diverters where required. Extend to outside and terminate in vent cap.
- G. Furnish and install 24 gauge galvanized metal pitch pan beneath water heaters installed over wood plenum framing and deck. Pan is to be same size as water heater closet. Sides are to extend up 2" with hemmed edge, abutting wall studs. Gypsum board wall to sit atop pan edge, in J-metal. Plumb and seal pitch pan into 2" floor drain, extending up through plenum base.

END OF SECTION 223400

SECTION 224100 - RESIDENTIAL PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bathtubs.
2. Faucets.
3. Bidets.
4. Lavatories.
5. Showers.
6. Kitchen sinks.
7. Dishwasher air-gap fittings.
8. Water closets.
9. Toilet seats.
10. Supply fittings.
11. Waste fittings.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- ##### A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted plumbing fixtures.

1.4 CLOSEOUT SUBMITTALS

- ##### A. Maintenance data.

PART 2 - PRODUCTS

2.1 BATHTUBS

A. Bathtubs FRP, with shower.

1. FRP Bathtubs:
2. Fixture:
 - a. Standard: ANSI Z124.1.2 for FRP bathtubs.
 - b. Bathing Surface: Slip resistant according to ASTM F 462.
 - c. Size: Refer to plans.
 - d. Color: White.

- e. Drain Location: Refer to plans.
 - f. Drain: NPS 1-1/2 (DN 40); chrome-plated-brass, pop-up waste and overflow.
- 3. Faucet: Pressure Balanced.
 - 4. Supply Fittings: Included in faucet.
 - 5. Tub Filler: Chrome-plated-brass diverter spout.
 - 6. Waste Fittings:
 - a. Standard: ASME A112.18.2/CSA B45.125.2.
 - b. Drain: Stainless steel or chrome-plated brass, removable strainer.
 - c. Overflow: Chrome-plated-brass escutcheon with toggle drain-plug device.
 - d. Drain Piping: NPS 1-1/2 cast-brass overflow, P-trap, and waste.

2.2 BATHTUB FAUCETS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.
- B. Bathtub Faucets: Single handle, pressure balance.
 - 1. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
 - 2. Faucet:
 - a. Body Material: Solid brass.
 - b. Finish: Polished chrome plate.
 - c. Maximum Flow Rate: 3 gpm unless otherwise indicated.
 - d. Mounting: Concealed.
 - e. Operation: Single handle, twist or rotate control, with hot- and cold-water indicators.
 - f. Antiscald Device: Integral with mixing valve.
 - g. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
 - h. Diverter: In-tub filler spout.
 - i. Supply Connections: NPS 1/2 (DN 15).
 - 3. Shower Head:
 - a. Standard: ASME A112.18.1/CSA B125.1.
 - b. Type: Ball joint with arm and flange.
 - c. Backflow-Prevention Device: ASSE 1014.
 - d. Shower Head Material: Metallic with chrome-plated finish.
 - e. Spray Pattern: Adjustable.
 - f. Integral Volume Control: Not required.
 - g. Shower-Arm, Flow-Control Fitting: Not required.
 - 4. Bathtub Filler Spout: Chrome-plated brass.

2.3 LAVATORIES

- A. Lavatories: Round, enameled cast iron or vitreous china, counter mounted.
 - 1. Enameled Cast-Iron Lavatories:
 - a. American Standard
 - b. Kohler
 - c. Eljer
 - 2. Vitreous-China Lavatories:
 - a. American Standard
 - b. Kohler
 - c. Eljer
 - 3. Fixture:
 - a. Standard: ASME A112.19.1/CSA B45.2 for enameled cast-iron lavatories.
 - b. Standard: ASME A112.19.2/CSA B45.1 for vitreous-china lavatories.
 - c. Type: Self-rimming.
 - d. Round Nominal Size: 18 inches in diameter.
 - e. Faucet-Hole Punching: Three holes, 4-inch centers.
 - f. Color: White.
 - 4. Faucet: Comply with requirements in "Lavatory Faucets" Article.
 - 5. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
 - 6. Waste Fittings: Comply with requirements in "Waste Fittings" Article.

2.4 LAVATORY FAUCETS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.
- B. Lavatory Faucets: Single-control mixing valve.
 - 1. General-Duty, Solid-Brass Faucets:
 - a. Delta
 - b. Moen
 - c. Valley
 - 2. Standard: ASME A112.18.1/CSA B125.1.
 - 3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
 - 4. Body Material: General-duty, solid brass.
 - 5. Finish: Polished chrome plate.
 - 6. Maximum Flow Rate: 2.2 gpm.
 - 7. Centers: 4 inches.
 - 8. Mounting: Deck, exposed.

9. Valve Handle(s): Lever.
10. Inlet(s): NPS 3/8 tubing, plain end.
11. Spout: Rigid.
12. Spout Outlet: Aerator.
13. Operation: Compression, manual.
14. Drain: Pop up.

2.5 SHOWERS

A. Showers: Standard FRP with base and faucet.

1. FRP Showers:
 - a. MUSTEE, INC
 2. Standard: ANSI Z124.1.2.
 3. Nominal Size: 36 by 36 inches.
 4. Surround: One piece.
 5. Bathing Surface: Slip resistant according to ASTM F 462.
 6. Color: White.
 7. Drain Location: Center.
 8. Shower Base.

2.6 SHOWER FAUCETS

A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.

B. Shower Faucets: Single handle, pressure-balance, mixing valve.

1. Single-Handle, Pressure-Balance Faucets:
 - a. Delta
 - b. Moen
 - c. Valley
2. Fixture:
 - a. Standard: ASME A112.18.1/CSA B125.1.
 - b. General: Include hot- and cold-water indicators; check stops; and fixed shower head, arm, and flange. Coordinate faucet inlets with supplies.
 - c. Body Material: Solid brass.
 - d. Finish: Polished chrome plate.
 - e. Maximum Flow Rate: 3 gpm unless otherwise indicated.
 - f. Mounting: Exposed.
 - g. Operation: Compression, manual.
 - h. Antiscald Device: Integral with mixing valve.
 - i. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.

3. Supply Connections: NPS 1/2.
4. Shower Head:
 - a. Type: Ball joint and head integral with mounting flange.
 - b. Shower Head Material: Combined, metallic and nonmetallic with chrome-plated finish.
 - c. Spray Pattern: Adjustable.
 - d. Integral Volume Control: Not required.

2.7 KITCHEN SINKS

- A. Kitchen Sinks: Two bowl, counter mounted, stainless steel.
 1. Stainless-Steel Kitchen Sinks:
 - a. American Standard
 - b. Kohler
 - c. Elkay
 2. Fixture:
 - a. Standard: ASME A112.19.3/CSA B45.4 for stainless-steel kitchen sinks.
 - b. Overall Dimensions: 32"x21".
 - c. Metal Thickness: 20 Gauge.
 - d. Bowl:
 - 1) Drain: 3-1/2-inch, crumb cup.
 - a) Location: Centered in bowl.
 3. Faucet: Comply with requirements in "Sink Faucets" Article.
 4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
 5. Waste Fittings: Comply with requirements in "Waste Fittings" Article, except include continuous waste for multibowl sinks.
 - a. Disposer: Not required.
 - b. Dishwasher Air-Gap Fitting: Comply with requirements in "Dishwasher Air-Gap Fittings" Article.

2.8 SINK FAUCETS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.
- B. Sink Faucets: kitchen sink.
 1. General-Duty, Solid-Brass Faucets:
 - a. Delta
 - b. Moen
 - c. Valley

2. Standard: ASME A112.18.1/CSA B125.1.
3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
4. Kitchen Sink Option: Separate hand spray complying with ASSE 1025.
5. Finish: Polished chrome plate.
6. Maximum Flow Rate: 2.5 gpm unless otherwise indicated.
7. Mixing Valve: Single control.
8. Backflow-Prevention Device for Hand Spray: Not required.
9. Centers: 4 inches.
10. Mounting: Deck.
11. Handle(s): Lever.
12. Spout Type: Swing, round tubular.
13. Spout Outlet: Aerator.
14. Drain: Stopper with chain.

2.9 DISHWASHER AIR-GAP FITTINGS

- A. Dishwasher Air-Gap Fittings:
1. Standard: ASSE 1021.
 2. Description: Device designed to prevent backflow of contaminated liquid into domestic dishwashers.
 3. Material: Plastic body with chrome-plated-brass cover.
 4. Hose Connections: 5/8-inch- (16-mm-) ID inlet and 7/8-inch- (22-mm-) ID outlet.
 5. Capacity: At least 5 gpm (0.32 L/s); at inlet pressure of at least 5 psig (35 kPa) and at temperature of at least 140 deg F (60 deg C).
 6. Mounting: Deck.
 7. Hoses: Rubber and suitable for temperature of at least 140 deg F (60 deg C).

2.10 WATER CLOSETS

- A. Water Closets: Floor mounted, floor outlet, close coupled (gravity tank), vitreous china.
1. Accepted Manufacturers
 - a. American Standard
 - b. Kohler
 - c. Eljer
 2. Bowl:
 - a. Standards: ASME A112.19.2/CSA B45.1, ASME A112.19.5, and ASSE 1037.
 - b. Bowl Type: Siphon jet.
 - c. Height: Refer to plans
 - d. Rim Contour: Round.
 - e. Water Consumption: Water saving.
 - f. Color: White.
 3. Toilet Seat: Comply with requirements in "Toilet Seats" Article.
 4. Supply Fittings:

- a. Standard: ASME A112.18.1/CSA B125.1.
- b. Supply Piping: Chrome-plated-brass pipe or chrome-plated-copper tube matching water-supply piping size. Include chrome-plated wall flange.
- c. Stop: Chrome-plated-brass, one-quarter-turn, ball-type or compression stop with inlet connection matching water-supply piping type and size.
 - 1) Operation: Wheel handle.
- d. Riser:
 - 1) Size: NPS 3/8.
 - 2) Material: ASME A112.18.6, braided- or corrugated-stainless-steel flexible hose riser.

2.11 TOILET SEATS

A. Toilet Seats:

1. Acceptable Manufacturers
 - a. Church
 - b. Olsonite
 - c. Beneke
2. Standard: IAPMO/ANSI Z124.5.
3. Material: Plastic.
4. Type: Residential.
5. Shape: Regular rim (Closed front).
6. Configuration: Closed front with cover.
7. Size: Regular.
8. Hinge Type: Check.
9. Hinge Material: Noncorroding metal.
10. Color: White.

2.12 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Lavatory and Kitchen Sink Supply Fittings:
 1. Supply Piping: Chrome-plated-brass pipe or chrome-plated-copper tube matching water-supply piping size. Include chrome-plated wall flange.
 2. Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression stop with inlet connection matching water-supply piping type and size.
 - a. Operation: Wheel handle.

3. Risers:
 - a. Size: NPS 3/8 (DN 10) for lavatories.
 - b. Size: NPS 1/2 (DN 15) for kitchen sinks.
 - c. Material: ASME A112.18.6, braided- or corrugated-stainless-steel flexible hose riser.

2.13 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/4 (DN 32) offset tailpiece for accessible lavatories.
- C. Drain: Pop-up type with NPS 1-1/4 (DN 32) straight tailpiece as part of faucet for standard lavatories.
- D. Drain: Grid type with NPS 1-1/2 (DN 40) offset tailpiece for accessible kitchen sinks.
- E. Trap:
 1. Size: NPS 1-1/4 (DN 32) for lavatories.
 2. Size: NPS 1-1/2 (DN 40) for kitchen sinks.
 3. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated-brass or -steel wall flange.

2.14 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 INSTALLATION

- A. Install plumbing fixtures level and plumb according to roughing-in drawings.
- B. Install floor-mounted water closets on closet flange attachments to drainage piping.
- C. Install counter-mounting fixtures in and attached to casework.

- D. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
- E. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.
- F. Install toilet seats on water closets.
- G. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- H. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes unless otherwise indicated.
- I. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Install in sink deck. Connect inlet hose to dishwasher and outlet hose to disposer.
- J. Set bathtubs and shower receptors in leveling bed of cement grout.
- K. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories and sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."
- L. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- M. Seal joints between plumbing fixtures, counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.2 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories and sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 ADJUSTING

- A. Operate and adjust plumbing fixtures and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

3.4 CLEANING AND PROTECTION

- A. After completing installation of plumbing fixtures, inspect and repair damaged finishes.
- B. Clean plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed plumbing fixtures and fittings.
- D. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224100

SECTION 230000 – GENERAL MECHANICAL

PART 1 - GENERAL

1.1 SUMMARY

- A. These specifications govern the furnishing of all materials and the installation of the same under the subject of mechanical work.
- B. The mechanical contractor is directed to read Special Conditions Turnkey and shall be required to conform to any and all provisions therein.
- C. The mechanical contractor is responsible for the work under all Division 23 headings and shall hereinafter in Division 23 of these specifications be referred to as the “Contractor”. Mechanical plans, and by reference general and electrical plans, are a part of this specification.
- D. The mechanical plans indicated the extent and general arrangements of the various mechanical systems. Changes in locations or arrangement required by job conditions shall be made by approved Change Order.

1.2 MATERIALS AND EQUIPMENT

- A. All work and materials specified are to be new and of the quality described and essentially the standard product of the manufacturer. The use of manufacturers’ names in specifying equipment or material herein determines the material or equipment to be used.
- B. Unless otherwise specified, where two or more units of the same class equipment or material are to be used for similar purposes, they shall be the products of the same manufacturer. All equipment shall be installed in accordance with the manufacturer’s recommendations.

1.3 CLEANING

- A. All dirt, rubbish, grease, or stains due to the operations of the Contractor shall be removed from all floors, walls, fixtures, etc., with the premises left in perfect condition. All mechanical equipment under this contract shall be set and connected, ready for operation.

1.4 PERMITS AND FEES

- A. Contractor shall secure all necessary permits or licenses to carry work, and shall pay all lawful fees, taxes, etc., in connection with the work. Contractor shall arrange for all tests and inspections on any or all parts of work, required by authorities and organizations having jurisdiction, and shall pay all charges for the same.

1.5 LAW AND ORDINANCES

- A. Work performed shall be in accordance with all local and state or national codes, laws and ordinances pertinent to such work. In case of any conflict wherein methods or standards on installation of materials specified do not equal or exceed requirements of laws of ordinances but not specified or shown on the drawings shall be furnished without extra charge as if shown or specified.

1.6 JOB FORMAN

- A. The Contractor shall have a competent representative available at all times while the project is under construction who will be responsible for coordination of the trades and installation of the work according to plans and specifications.

1.7 WORK TO BE PERFORMED BY OTHER TRADES

- A. Electrical Subcontractor is responsible for all wiring, including interconnecting wiring between controls and any electrical temperature control wiring.
- B. The Developer will perform the following work in connection with the mechanical contract.
 - 1. Build into building construction all pipe sleeves, bolts and inserts necessary for supporting mechanical equipment. These items will be furnished by the Contractor and will be set in place by him.
 - 2. Provide all chases, shafts and recesses necessary for installation of all mechanical equipment and furring necessary to conceal piping, ductwork, etc. The Contractor shall provide all necessary information as to size, exact location of chases, recesses, furring, etc., required.
 - 3. Provide wall, floor, and roof openings necessary for the installation of the mechanical systems. Contractor shall provide exact size and location of such openings, and shall be responsible for completed installations being watertight and waterproof.
 - 4. Provide bases and supports for principle items of mechanical equipment. The Contractor shall provide exact size and location and shall be responsible for all bases and supports other than these specified above.

1.8 OPERATION AND MAINTENANCE INSTRUCTIONS (O&M)

- A. The Developer shall furnish the Indian Housing Authority (IHA) two bound sets of operating and maintenance instructions covering all equipment furnished under specifications for each total contract. The instructions shall be assembled in an indexed brochure. Separate equipment brochures will not be acceptable. NOTE: These manuals must be delivered to the above before final payment.
- B. A competent supervisor shall instruct the IHA representative in the care, operation, and maintenance of the equipment.

1.9 PROTECTION OF MATERIAL AND WORK

- A. Protect and preserve all materials, supplies and equipment and all work performed.

1.10 FINAL AND GUARANTEE

- A. Nothing herein contained may be construed to relieve the Developer and Contractor from making good and perfect work in all details of construction of installation, and they will be held responsible to provide and furnish necessary material, and to perform all necessary labor, and to bear all expenses incidental to the satisfactory completion of the work embraces herein.
- B. At final inspection, prior to purchase by the Indian Housing Authority, the Developer and Contractor shall demonstrate completely the system and equipment performance. Developer and Contractor shall guarantee all labor, material, and equipment furnished under this contract against any defects developing from faulty or poor workmanship or material for a period of one (1) year from the date of final acceptance by the Indian Housing Authority. The Developer or Contractor shall remedy any defect appearing within that time without extra charge to the Indian Housing Authority within a reasonable time after notice. The term “defect” excludes occurrences, as would normally follow improper treatment, accident, or wear and tear of normal use.
- C. Furnish written guarantees for each piece of equipment so covered by manufacturer’s warranties. These shall be furnished for each dwelling unit and shall be bound, indexed and labeled for the appropriate dwelling.

1.11 SINGULAR NUMBER

- A. Where any device or part of equipment is herein referred to in the singular number (such as “the pump”), such reference shall be deemed to apply to as many devices as are required to complete the installation as shown on the drawings.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 SCOPE

- A. The work performed under this heading includes all labor, materials, equipment and services installation of all heating systems, in strict accordance with specification and the applicable drawings. Contractor shall keep a competent foreman on the premises while his work is in progress.
- B. The following are furnished by others: Cutting and framing for ducts and grilles, gas services to furnaces. Electrical work as explained hereinafter and all headers and buck for ducts.

- C. Except as above, the Mechanical Contractor shall furnish material, labor, equipment and transportation required for a complete system as shown.
- D. Contractor shall obtain necessary permits and pay all fees therefore. He shall be responsible for damage to property caused by him or his employees. He shall protect his work from damage and work in harmony with other trades.
- E. From time to time as the work progresses, he shall remove all rubbish and accumulation resulting from his work. Mechanical work shall comply with all laws having jurisdiction of the work including the Local Code, State Health Department and the BOCA Mechanical Code.
- F. The mechanical contractor shall examine the general plans and specifications, and make sure he understands the conditions under which he must work.
- G. Cooperation: Install roof vents, flashings, etc., before or during the application of the roof. If for any reason, roof repairs are necessary after the completion of the roof, this Subcontractor shall make the necessary arrangements with roofer to provide proper guarantee.

3.2 SITE VISIT

- A. Contractor shall visit the site of the project and thoroughly familiarize himself with the existing conditions prior to submitting a proposal. Additional payment will not be authorized for extra work for reason of unforeseen conditions due to failure to make site visit.

3.3 FOUNDATIONS, BASES AND SUPPORTS

- A. Contractor shall furnish all special foundations, bases, and supports required for the proper installation and operation of any equipment furnished under this Division. Equipment with moving parts shall have special cork or rubber-and-metal isolation bases for prevention of noise and vibration.

3.4 MOTORS AND CONTROL (S)

- A. Contractor shall furnish all motors and integral motor starters for mechanical equipment.
- B. Unless otherwise specified or noted, all motors less than ½ HP shall be wound for single phase, 6—cycle, 120-volt current.
- C. Motors shall be constructed in accordance with NEMA standards, shall be applied to operate at not more than 100% of their rating, and shall have ball or roller bearings.
- D. Where motor sizes are increased above those shown on plans, due to variations in manufacturer's equipment, the Developer and Subcontractor will ascertain the requirements and make due allowances for increased service thereto. Any additional cost in electrical work caused by variation in manufacturers' equipment shall be the responsibility of the Developer and Subcontractor.

3.5 VENTS

- A. Refer to appropriate Division 23 specifications for allowable materials.
- B. All Fuel Vents: Furnish and install where shown on plans all fuel, 8” jacketed flue, complete with escutcheon cover at ceiling, ceiling base support, stack, roof jack and roof cap. NOTE: Location of flue as determined by IHA.
- C. Dryer Vent: Furnish and install jacketed dryer vent and flashing from dryer location to outside with rain-proof roof or wall cap as required, complete with rodent screen.
- D. Combustion Air Supply: Required at each compartment containing a furnace and/or water heater; install to each such compartment two 6” round combustion air ducts into attic 4” above top of insulation. One duct shall extend 1” below ceiling line; one shall extend 12” above floor line. Secure ducts to prevent moving and provide bug screens over ducts in attic.
- E. Vent Hood: Furnish, install, complete, and make all connections to (one-in-all) range hood, 30” wide, with 2 speed fan, light socket, rear wiring, 120V electrical service, permanent washable filter, and automatic damper. Hood shall vent through roof with 7” round duct and be provided with flashing and vent cap at roof. Hood shall be mounted as detailed above range.
- F. Bathroom Vent with Heat Light: Furnish and install duct through roof with roof jack and vent cap. Coordinate work with electrical contractor.

3.6 INSTALLATION

- A. Control Thermostat/Switch System: Furnish for installation by the Electrician, a wall mounted thermostat with heat/cool/fan/off settings. Thermostat shall be of type that will operate the fan without the activation of the furnace burner or the condensing unit, and shall be adjustable with a range of 55 to 85, low voltage type. Thermostat shall not be installed on wall of heater closet or exterior wall.
- B. It shall be the responsibility of the Electrician to install wiring and make all connections for control. It will be the responsibility of the Mechanical contractor to direct such work and give proper notice of any change required.
- C. Flue and Flue Connections: Furnish and install complete to all heating units, flue and flue connections. System shall be METALBESTOS double, metal wall, type, assembled with necessary fittings and couplings as directed by manufacturer. Provide roof flashing as required and waterproof flue cap.
- D. Ductwork and Plenums: Refer to appropriate Division 23 section.
- E. Grilles, Registers and Diffusers: Refer to appropriate Division 23 section.
- F. Furnace: Refer to appropriate Division 23 section.
- G. Condensing Unit: Refer to appropriate Division 23 section.

- H. Run insulated refrigerant piping in attic, from heating and air conditioning closet to exterior soffit for installation of optional air conditioning equipment. Seal piping penetration in soffit and ceiling.
- I. Duct Insulation: Refer to appropriate Division 23 section.

3.7 PROTECTION OF WORK

- A. At all times, take precautions necessary to properly protect the mechanical equipment and accessories from damage. Protect work from possible damage from freezing and stoppage of the pipes, traps, floor drains, and waste lines by building materials. The Contractor shall repair any damage without additional charge.

3.8 LEAK DAMAGE

- A. The General Contractor shall be responsible for damages to the building, or its contents, etc., caused by leaks in any of the equipment installed by him or his Subcontractors, through equipment or material failures, disconnected pipes, and fittings or by overflows caused by improper installation and/or protection. The Contractor shall be responsible for all repairs to merchandise, fixtures and equipment damaged.

3.9 REMOVL OF RUBBISH

- A. The Contractor shall keep the premises free from accumulations of waste material or rubbish caused by this work during construction period. At the completion of the work, remove all rubbish from the building site. Leave the building “Broom Clean”.

3.10 TESTING AND ADJUSTING

- A. Refer to appropriate Division 23 section.

3.11 GUARANTEE

- A. This Contractor shall guarantee all materials, equipment and labor of this section as called for in Supplemental General Conditions. This guarantee shall include the performance of the component parts of the system in strict accordance with the intent of the specifications.

END OF SECTION 230000

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: ethylene-propylene-diene-monomer-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. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement nonshrink grout; recommended for interior and exterior applications.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

- C. Fire-Barrier Penetrations: Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

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.

END OF SECTION 230517

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals:
 - 1. Certified TAB reports.
- B. TAB Firm Qualifications: AABC or NEBB certified.
- C. TAB Report Forms: Standard TAB contractor's forms approved by Architect.

PART 2 - PRODUCTS (Not Used)

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 the approved submittals for HVAC systems and equipment.
- C. Examine systems for installed balancing devices, such as manual volume dampers. Verify that locations of these balancing devices are accessible.
- D. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- E. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- F. Examine automatic temperature system components to verify the following:
 - 1. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 - 2. Sensors are located to sense only the intended conditions.
- G. Report deficiencies discovered before and during performance of test and balance procedures.

3.2 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in 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. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish.
- C. Mark equipment and balancing devices, including damper-control positions, 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.

3.3 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare schematic diagrams of systems' "as-built" duct layouts.
- B. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- C. Verify that motor starters are equipped with properly sized thermal protection.
- D. Check for airflow blockages.
- E. Check condensate drains for proper connections and functioning.
- F. Check for proper sealing of air-handling unit components.
- G. Check for proper sealing of air duct system.

3.4 TOLERANCES

- A. Set HVAC system airflow 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.

END OF SECTION 230593

SECTION 231123 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.
2. Service Regulators: 65 psig minimum unless otherwise indicated.
3. Service Meter Minimum Operating Pressure: 5 psig.

- ##### B. Natural-Gas System Pressure within Building: One distribution pressure. 0.5 psig or less.

2.2 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and polyethylene (PE).

- ##### B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1: Includes flame-retardant PE coating, copper-alloy threaded ends, and striker plates.

C. PE Pipe: ASTM D 2513, SDR 11.

1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D2513, SDR 11 and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

2.3 SPECIALTIES

- A. Appliance Flexible Connectors:
 - 1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
 - 2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
 - 3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
 - 4. Corrugated stainless-steel tubing with polymer coating.
- B. Strainers: ASTM A 126, Class B, cast-iron body, Y-pattern, full size of connecting piping, CWP rating of 125 psig (860 kPa). Include [40] [60]-mesh startup strainer and perforated stainless-steel basket.
- C. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.
- D. Service Meters: Comply with gas company requirements.
- E. Detectable Warning Tape: PE-film warning tape 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection; colored yellow.

2.4 MANUAL GAS-SHUTOFF VALVES

- A. General Requirements for Metallic, Manual Gas-Shutoff Valves: Comply with ASME B16.33.
 - 1. CWP Rating: 125 psig.
- B. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
 - 1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
 - 2. Body: Bronze, complying with ASTM B 584.
 - 3. Ball: Chrome-plated brass.
 - 4. Stem: Bronze; blowout proof.
 - 5. Seats: Reinforced TFE; blowout proof.
 - 6. Packing: Separate packnut with adjustable stem-packing threaded ends.
 - 7. CWP Rating: 600 psig (4140 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.
- C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
 - 1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
 - 2. Body: Bronze, complying with ASTM B 584.
 - 3. Ball: Chrome-plated bronze.
 - 4. Stem: Bronze; blowout proof.

5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded body packnut design with adjustable stem packing.
7. CWP Rating: 600 psig (4140 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.

D. Bronze Plug Valves: MSS SP-78.

1. Body: Bronze, complying with ASTM B 584.
2. Plug: Bronze.
3. Operator: Square head or lug type with tamperproof feature where indicated.
4. Pressure Class: 125 psig (862 kPa).
5. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
6. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Cast-Iron, Nonlubricated 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. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig (862 kPa).
7. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Valve Boxes: Cast iron, two sections, with base to fit over valve, barrel a minimum of 5 inches (125 mm) in diameter, and cover with "GAS" lettering.

2.5 PRESSURE REGULATORS

A. General Requirements: Single stage, steel jacketed, and corrosion resistant. Include elevation compensator.

B. Service-Pressure Regulators: ANSI Z21.80:

1. 100-psig maximum inlet pressure. Factory- or field-installed, stainless-steel screen in vent opening if not connected to vent piping.

C. Line Pressure Regulators: ANSI Z21.80:

1. 5-psig maximum inlet pressure. Factory- or field-installed, stainless-steel screen in vent opening if not connected to vent piping.

D. Appliance Pressure Regulators: ANSI Z21.18:

1. 1-psig maximum inlet pressure. Regulator may include vent-limiting device, instead of vent connection, if approved by authorities having jurisdiction.

2.6 SLEEVES AND SLEEVE SEALS

- A. Galvanized-Steel Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- B. Modular rubber sealing-element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 1. Sealing Elements: Ethylene-propylene-diene-monomer-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.

2.7 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

2.8 ESCUTCHEONS AND FLOOR PLATES

- A. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- B. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- C. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

PART 3 - EXECUTION

3.1 OUTDOOR PIPING INSTALLATION

- A. Install piping free of sags and bends.
- B. Install fittings for changes in direction and branch connections.
- C. Install underground, natural-gas piping buried at least 36 inches below finished grade.
 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- D. Install underground, PE, natural-gas piping according to ASTM D 2774.
- E. Install shutoff valve, downstream from gas meter, outside building at gas service entrance.

- F. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight.
 - 1. Sleeves:
 - a. Exterior Wall, Pipe Penetrations: Mechanical sleeve seals installed in steel or cast-iron pipes for wall sleeves.
 - b. 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 specified in Section 078446 "Penetration Firestopping."
 - 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.
- G. Install service meters to comply with gas company requirements.

3.2 INDOOR PIPING INSTALLATION

- A. Install piping free of sags and bends.
- B. Install fittings for changes in direction and branch connections.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install escutcheons at penetrations of interior walls, ceilings, and floors.
- 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 in Section 078413 "Penetration Firestopping."
- F. Install gas stops for shutoff to appliances with low-pressure gas supply.
- G. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- H. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- I. Connect branch piping from top or side of horizontal piping.
- J. 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.

- K. Connect gas piping to equipment and appliances with shutoff valves and unions. Install gas valve upstream from and within 72 inches (1800 mm) of each appliance using gas. Install union or flanged connections downstream from valves.
- L. Do not use natural-gas piping as grounding electrode.

3.3 PIPING JOINT CONSTRUCTION

- A. Threaded Joints: Thread pipe with tapered pipe threads complying with ASME B1.20.1.
- B. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators.
- C. Joints in Steel Piping with Protective Coating: Apply joint-cover kits to pipe after joining to cover, seal, and protect joints.
- D. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- E. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.4 VALVE INSTALLATION

- A. Install manual gas-shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install anode for metallic valves in underground, PE piping.

3.5 OUTDOOR PIPING SCHEDULE

- A. Underground, natural-gas piping shall be the following:
 - 1. PE pipe and fittings joined by heat fusion or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
- B. Aboveground, natural-gas piping shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
- C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.6 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

- A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:
 - 1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping, if approved by authority having jurisdiction (AHJ).
 - 2. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
- C. Underground, below building, shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
- D. Containment Conduit: Steel with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.7 UNDERGROUND, MANUAL GAS-SHUTOFF VALVE SCHEDULE

- A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.
- B. Underground:
 - 1. PE valves.
 - 2. NPS 2 and Smaller: Bronze plug valves.

3.8 ABOVEGROUND, MANUAL GAS-SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 and smaller shall be one of the following:
 - 1. One-piece, bronze ball valve with bronze trim.
 - 2. Two-piece, full-port, bronze ball valves with bronze trim.
 - 3. Bronze plug valve.
- B. Valves in branch piping for single appliance shall be one of the following:
 - 1. One-piece, bronze ball valve with bronze trim.
 - 2. Two-piece, full-port, bronze ball valves with bronze trim.
 - 3. Bronze plug valve.

END OF SECTION 231123

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop based on manufacturer's test data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Line-Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).
2. Suction Lines for Heat-Pump Applications: 535 psig (3689 kPa).
3. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).

B. Comply with ASME B31.5, "Refrigerant Piping," and with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

2.2 TUBES AND FITTINGS

- A. Copper Tube: ASTM B 88, Types K and L (ASTM B 88M, Types A and B) and ASTM B 280, Type ACR.
- B. Wrought-Copper Fittings and Unions: ASME B16.22.
- C. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- D. Brazing Filler Metals: AWS A5.8.

2.3 VALVES AND SPECIALTIES

A. Thermostatic Expansion Valve: Comply with ARI 750.

1. Forged brass or steel body, stainless-steel internal parts, copper tubing filled with refrigerant charge for 40 deg F suction temperature; 700-psig working pressure, and 240 deg F (116 deg C) operating temperature.

B. Straight-Type Strainers:

1. Welded steel with corrosion-resistant coating and 100-mesh, stainless-steel screen with socket ends; 500-psig (3450-kPa) working pressure and 275 deg F (135 deg C) working temperature.

C. Permanent Filter Dryers: Comply with AHRI 730.

1. Steel shell with ductile-iron cover; 500-psig (3450-kPa) operating pressure; 240 deg F (116 deg C) operating temperature.

2.4 REFRIGERANTS

- A. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with requirements in Section 230500 "Common Work Results for HVAC" for basic piping installation requirements.
- B. Install wall penetration system at each pipe penetration through foundation wall. Make installation watertight. Comply with requirements in Section 230500 "Common Work Results for HVAC" for wall penetration systems.
- C. Install refrigerant piping and charge with refrigerant according to ASHRAE 15.
- D. Belowground, install copper tubing in PVC conduit. Vent conduit outdoors.
- E. Insulate suction lines to comply with Section 230700 "HVAC Insulation."
- F. Slope refrigerant piping as follows:
1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 2. Install horizontal suction lines with a uniform slope downward to compressor.
 3. Install traps and double risers to entrain oil in vertical runs.
 4. Liquid lines may be installed level.
- G. Install solenoid valves upstream from each thermostatic expansion valve. Install solenoid valves in horizontal lines with coil at top.
- H. Install thermostatic expansion valves as close as possible to distributors on evaporator coils.
- I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- J. Install strainers upstream from and adjacent to solenoid valves, thermostatic expansion valves, and compressors unless they are furnished as an integral assembly for device being protected.

- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

3.2 PIPING APPLICATIONS FOR REFRIGERANT R-410A

- A. Suction Lines: Copper, Type ACR, Type K or Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
- B. Hot-Gas and Liquid Lines: Copper, Type ACR, Type K or Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

END OF SECTION 232300

SECTION 233100 - HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: For each type of product indicated.
2. For adhesives and sealants, documentation including printed statement of VOC content.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"
- C. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems" and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- D. Comply with UL 181 for ducts and closures.

2.2 DUCTS

- A. Galvanized-Steel Sheet: ASTM A 653/A 653M, with G60 (Z180) hot-dip galvanized coating.
- B. Joint and Seam Tape, and Sealant: Comply with UL 181A.
- C. Rectangular Metal Duct Fabrication: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 ACCESSORIES

- A. Volume Dampers and Control Dampers: Single-blade and multiple opposed-blade dampers, standard leakage rating, and suitable for horizontal or vertical applications; factory fabricated and complete with required hardware and accessories.
- B. Flexible Connectors: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

- C. Flexible Ducts: Factory-fabricated, insulated, round duct, with an outer jacket enclosing 1-inch-thick, glass-fiber insulation around a continuous inner liner complying with UL 181, Class 1.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg ((500 Pa)) and Lower: Seal Class B.
 - 2. Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 3. Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 4. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg ((500 Pa)) and Lower: Seal Class C.
 - 5. Conditioned Space, Exhaust Ducts: Seal Class B.
 - 6. Conditioned Space, Return-Air Ducts: Seal Class C.
- C. Conceal ducts from view in finished and occupied spaces.
- D. Avoid passing through electrical equipment spaces and enclosures.
- E. Support ducts to comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Hangers and Supports."
- F. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.
- G. Install volume and control dampers in lined duct with methods to avoid damage to liner and erosion of duct liner.
- H. Ductwork and Plenums: Furnish and install all ducts, branches, etc., as necessary to make the complete system as shown on the drawings. All ducts shall be fabricated in accordance with SMACNA standards from galvanized sheet steel in accordance with the following:
 - 1. Round Duct:
 - a. Up to 8" duct, 28-gauge, 2" slip joints, 1" lock seams
 - b. 9" to 16" duct, 26-gauge, 2" slip joints, 1" lock seams
 - 2. Rectangular Duct:
 - a. Up to 12" wide, 26-gauge, 1" S-drive joints, 1" lock seams.
 - b. 23" to 30" wide, 24-gauge, 1" S-drive joints, 1" lock seams.
 - 3. Shall be fabricated of galvanized steel, of gauge specified above, from plenum to room register boot. Metal supply plenum shall be built in absorption coefficient of not less than .70 at ta frequency of 500hz.
 - 4. All joints shall be taped and made air tight before insulating, minimum three screws per joint. Strap anchor to rafters (trusses) at maximum 10'-0" o.c., and at corners and transition. Strap anchor size to be minim 1" wide by 16-gauge thickness.

3.2 TESTING, ADJUSTING, AND BALANCING

- A. Balance airflow within distribution systems, including submains, branches, and terminals, to indicated quantities.

END OF SECTION 233100

SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Products shall be licensed to use the AMCA-Certified Ratings Seal.
- B. Power ventilators shall comply with UL 705.
- 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.

2.2 CEILING-MOUNTED VENTILATORS

- A. Housing: Steel, lined with acoustical insulation.
- B. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- C. Grille: Plastic, louvered grille with flange on intake and thumbscrew attachment to fan housing.
- D. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- E. Accessories:
 1. Manual Starter Switch: provide light switch for control.
 2. Isolation: Rubber-in-shear vibration isolators.
 3. Backdraft damper.

2.3 MOTORS

- A. Motors to be totally enclosed, fan cooled, and 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.

1. Comply with NEMA MG 1 unless otherwise indicated by authorities having jurisdiction. Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units with clearances for service and maintenance.
- B. Ceiling-Mounted Units: Suspend units from structure using steel wire or metal straps.
- C. Furnish and install duct through roof with roof jack and vent cap.
- D. Ground power ventilators.

END OF SECTION 233423

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: For each type of product indicated, including color charts for factory finishes.

PART 2 - PRODUCTS

2.1 REGISTERS AND GRILLES

- A. Grilles and registers shall be pressed steel, factory finished in “Off-white”, with fins ½” o.c.; similar to AIRMATE #140, #160 or #190, or as required for airflow direction. Grills by LIMA, BARBER-COLMAN, TITUS or AIRMATE.

B. Fixed-Face Register:

1. Material: Steel.
2. Finish: Baked enamel, white.
3. Mounting: Countersunk screw.

C. Fixed-Face Grille:

1. Material: Steel.
2. Finish: Baked enamel, white.
3. Mounting: Countersunk screw.

PART 3 - EXECUTION

3.1 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. Make final locations where indicated, as much as practical. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 235100 - BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 LISTED TYPE B AND BW VENTS

- A. Description: Double-wall metal vents tested according to UL 441 and rated for 480 deg F (248 deg C) continuously for Type B or 550 deg F (288 deg C) continuously for Type BW; with neutral or negative flue pressure complying with NFPA 211 and suitable for certified gas-fired appliances.
- B. Construction: Inner shell and outer jacket separated by at least 1/4-inch (6-mm) airspace.
- C. Inner Shell: Type 1100, aluminum.
- D. Outer Jacket: Galvanized steel.
- E. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
 1. Termination: Stack cap designed to exclude 90 percent of rainfall.
 2. Termination: Round chimney top designed to exclude 98 percent of rainfall.

EXECUTION

2.2 INSTALLATION

- A. Install vents according to stipulated minimum clearances from combustibles.
- B. Seal between sections of positive-pressure vents using only sealants recommended by manufacturer.
- C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.

- D. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.

END OF SECTION 235100

SECTION 236313 - AIR-COOLED REFRIGERANT CONDENSERS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Rate air-cooled refrigerant condensers according to ARI 460.
- B. Factory-test sound-power-level ratings according to ARI 270.
- 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. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Standard for Refrigeration Systems."

2.2 AIR-COOLED REFRIGERANT CONDENSERS

- A. Description: Factory assembled and tested; consisting of casing, condenser coils, condenser fans and motors, and unit controls for outdoor installation. R-410A refrigerant.
- B. Condenser Coil: Copper tubing with aluminum or steel coil fins, factory tested at 425 psig (2930 kPa).
- C. Condenser Fans and Drives: Propeller fans for vertical air discharge. Motors to comply with NEMA MG 1.
- D. Operating and Safety Controls: Condenser fan motor thermal and overload cutouts; magnetic contactors for condenser fan motors and factory-mounted and -wired disconnect switch for single external electrical power connection.
 1. Fan Cycling Control: Head pressure switches.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb, firmly anchored in locations indicated; maintain recommended clearances.
- B. Equipment Mounting:
 - 1. Install air-cooled condenser refrigerant condensers on cast-in-place concrete equipment bases.
- C. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.
 - 1. Install electrical devices according to NFPA 70.
- D. Install piping adjacent to machine to allow service and maintenance.
- E. Refrigerant Piping: Connect piping to unit with pressure relief, service valve, filter-dryer, and moisture indicator on each refrigerant-circuit liquid line. Refrigerant piping and specialties are specified in Section 232300 "Refrigerant Piping."

END OF SECTION 236313

SECTION 237339 - INDOOR, DIRECT-FIRED HEATING AND VENTILATING UNITS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: Include rated capacities, furnished specialties, and accessories.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

2.2 INDOOR, DIRECT-FIRED HEATING AND VENTILATING UNITS

- A. Factory-assembled, prewired, self-contained unit consisting of cabinet, supply fan, controls, filters, and direct-fired gas burner to be installed exterior to the building.

2.3 CABINET

- A. Cabinet: Single-wall, galvanized-steel panels with lifting lugs. Lift-out access panels for furnace and fan motor assemblies on both sides of unit. Fibrous-glass duct lining 1 inch thick, complying with ASTM C 1071, Type II, applied on complete unit. Heat-resistant, baked-enamel finish. Horizontal or vertical-pattern, galvanized-steel discharge plenum with diffusers incorporating individually adjustable vanes.
 1. Fabricate mounting base and attachment to air-handling-unit sections, accessories, and components.
- B. Filters: Comply with NFPA 90A; 1 inch thick.

2.4 SUPPLY-AIR FAN

- A. Fan: Centrifugal, rated according to AMCA 210; statically and dynamically balanced, galvanized steel; mounted on solid-steel shaft.
- B. Fan Motor: Permanent-split capacitor, with silicone-controlled rectifier for speed adjustment, premium efficiency motor, with open, drip proof enclosure.

1. Comply with NEMA MG 1 unless otherwise indicated by authorities having jurisdiction. Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.
 - a. NEMA Design: <Insert designation>.
 - b. Service Factor: <Insert value>.
 - c. Motor Speed: [**Single speed**] [**Multispeed**].
- C. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly.
- D. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with restrained, isolators.

2.5 DIRECT-FIRED GAS FURNACE

- A. Description: Factory assembled, piped, and wired; complying with ANSI Z83.4, ANSI Z83.18, and NFPA 54. Cast-iron burner with stainless-steel mixing plates. Single-stage or Two-stage control valve. Electrically ignited by ceramic hot-surface.
 1. Fuel: Natural or Propane gas, refer to plans.
- B. Safety Controls: Airflow-proving switch; high-temperature limit; safety lockout; redundant, automatic, main gas valves; electric pilot valve; modulating temperature control valve; main and pilot gas regulators; main and pilot manual shutoff valves; main and pilot pressure taps; and high-low gas pressure switches to comply with ANSI standards.

2.6 CONTROLS

- A. Factory-wired, fuse-protected control transformer, with connection for power supply and field-wired unit to remote control panel.
- B. Control Panel: Recessed, with trim ring, remote panel, with engraved plastic cover. Include on-off-auto fan switch, supply-fan operation light, heating operation light, dirty-filter light operated by unit-mounted differential pressure switch, and safety-lockout light.
- C. Control Devices: Seven-day programmed timer with minimum four periods per day.
- D. Temperature Control: Operates gas valve to maintain supply-air or room temperature.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install gas-fired units according to NFPA 54.
- B. Connect gas piping with shutoff valve and union and with sufficient clearance for burner removal and service.

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- C. Drawings indicate the general arrangement of ducts. Connect supply and return ducts to indirect-fired H&V units with flexible duct connectors.

END OF SECTION 237339

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.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.

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. 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 and SO.
- C. Multiconductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC, nonmetallic-sheathed cable, Type NM.

2.2 CONNECTORS AND SPLICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Hubbell Power Systems, Inc.
 - 3. O-Z/Gedney; EGS Electrical Group LLC.

4. 3M; Electrical Products Division.
 5. Tyco Electronics Corp.
- B. 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. Service Entrance: Type THHN-THWN, single conductors in raceway.
- B. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway, Metal-clad cable Type MC, or Nonmetallic-sheathed cable Type NM.
- C. Branch Circuits Concealed in Ceilings, Walls, and Partitions: : Type THHN-THWN, single conductors in raceway, Metal-clad cable Type MC, or Nonmetallic-sheathed cable Type NM.
- D. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- E. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- F. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. 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 Sections "Hangers and Supports for Electrical Systems."
- F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."
- G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- H. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
- I. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
 - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
 - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- 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 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.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.

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. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch 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.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad; 3/4 inch in diameter x 10 feet in length.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No.8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No.2/0 AWG minimum. Bury at least 24 inches below grade.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

- A. 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. 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.

- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

- D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

- E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

- F. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch 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. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
 - 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- C. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.
 - 1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- D. 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.
- E. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

- F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

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, and at ground test wells.
 - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.3 SUBMITTALS

- A. Product Data: For steel slotted support systems.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.

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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 5. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. 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.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
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 required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with 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 and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To 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 thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches 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.
- 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 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 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
 1. 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.

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- 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

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.

1.2 SUBMITTALS

- A. Product Data: For surface raceways and fittings.

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. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit: ANSI C80.1.
- B. IMC: ANSI C80.6.
- C. EMT: ANSI C80.3.
- D. FMC: Zinc-coated steel.
- E. LFMC: Flexible steel conduit with PVC jacket.
- F. 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 or die-cast compression type.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. ENT: NEMA TC 13.
- B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
- C. LFNC: UL 1660.
- D. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
- E. Fittings for LFNC: UL 514B.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
 - 1. Exposed Conduit: Rigid steel conduit, RNC, Type EPC-40-PVC.
 - 2. Concealed Conduit, Aboveground: Rigid steel conduit, EMT, RNC, Type EPC-40-PVC.
 - 3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
- 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: EMT.
 - 5. Damp or Wet Locations: Rigid steel conduit.
- C. Minimum Raceway Size: 1/2-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

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 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. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Change from ENT to RNC, Type EPC-40-PVC, rigid steel conduit, before rising above the floor.
- 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 tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- K. 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.

END OF SECTION 260533

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. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.2 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.3 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

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.
- C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.2 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. 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.
- C. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.
- D. Snap-Around Labels: Slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. 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.
- C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- D. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.4 FLOOR MARKING TAPE

- A. 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.5 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- B. Color and Printing:
 - 1. Comply with ANSI Z535.1 through ANSI Z535.5.
 - 2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
 - 3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.
- C. Tag: Type I:
 - 1. Pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.

2. Thickness: 4 mils.
3. Weight: 18.5 lb/1000 sq. ft.
4. 3-Inch Tensile According to ASTM D 882: 30 lbf, and 2500 psi.

D. Tag: Type ID:

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Overall Thickness: 5 mils.
3. Foil Core Thickness: 0.35 mil.
4. Weight: 28 lb/1000 sq. ft.
5. 3-Inch Tensile According to ASTM D 882: 70 lbf, and 4600 psi.

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 grommets in corners for mounting.
3. Nominal size, 7 by 10 inches.

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, non-fading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 10 by 14 inches.

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.7 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.
- C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.8 EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.
- B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.
- C. Stenciled Legend: In non-fading, waterproof, black ink or paint. Minimum letter height shall be 1 inch..

2.9 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. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

- B. Apply identification devices to surfaces that require finish after completing finish work.
- C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- E. 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 maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.
- G. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits more than 30A, and 120V to ground: Install labels at 10-foot 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 Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - a. Color shall be factory applied.
 - b. Colors for 120/240-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.

- c. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- 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 or marker tape 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. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
 - 1. Limit use of underground-line warning tape to direct-buried cables.
 - 2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- H. 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.
- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels or 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.
- J. 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.

- K. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.

- L. 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-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches 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.

END OF SECTION 260553

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes distribution panelboards and lighting and appliance branch-circuit panelboards.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Panelboard schedules for installation in panelboards.

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 NEMA PB 1.
- C. 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: Flush mounted cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.

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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. Directory Card: Inside panelboard door, mounted in transparent card holder.
- B. Incoming Mains Location: Top and bottom.
- C. Phase, Neutral, and Ground Buses: Hard-drawn copper, 98 percent conductivity.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Main and Neutral Lugs: Compression type.
 3. Ground Lugs and Bus Configured Terminators: Compression type.
 4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards with one or more main service disconnecting and overcurrent protective devices.
- F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: As required.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

- F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

- B. 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. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories (where applicable):
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Compression 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.

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- e. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
- f. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
- g. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
- h. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.4 ACCESSORY COMPONENTS AND FEATURES

- A. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Receive, inspect, handle, store and install panelboards and accessories according to NECA 407.
- B. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- D. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- E. Install filler plates in unused spaces.
- F. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- G. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- H. Comply with NECA 1.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

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- B. Create a directory to indicate installed circuit loads and incorporating 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."

3.3 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 and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262416

SECTION 262713 - ELECTRICITY METERING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes equipment for electricity metering by utility company.

1.2 SUBMITTALS

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

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.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

- A. Meters will be furnished by utility company.
- B. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.
- C. Meter Sockets: Comply with requirements of electrical-power utility company.
- D. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.
- E. Modular Meter Center: Factory-coordinated assembly of a main service terminal box with lugs only, wireways, tenant meter socket modules, and tenant feeder circuit breakers arranged in adjacent vertical sections. Assembly shall be complete with interconnecting buses and other features as specified below.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D; a brand of Schneider Electric.

2. Comply with requirements of utility company for meter center.
3. Housing: NEMA 250, Type 3R enclosure.
4. Minimum Short-Circuit Rating: Equal to rating established at Panel MDP symmetrical amps at rated voltage.
5. Meter Socket: Rating coordinated with indicated tenant feeder circuit rating.
6. Surge Protection: For main disconnect device, comply with requirements indicated on plans.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with equipment installation requirements in NECA 1.
- B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.
- C. Install modular meter center according to NECA 400 switchboard installation requirements.
- D. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
 1. Equipment Identification Labels: Adhesive film labels with clear protective overlay. For residential meters, provide an additional card holder suitable for printed, weather-resistant card with occupant's name.

3.2 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 1. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.
 2. Turn off circuits supplied by metered feeder and secure them in off condition.
 3. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
 4. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.
- C. Electricity metering will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 262713

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. Snap switches and wall-box dimmers.
 - 3. Communications outlets.
- B. See Division 27 Section "Communications Horizontal Cabling" for workstation outlets.

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.
- D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

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. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
 - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).

3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
 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. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 5351 (single), 5352 (duplex).
 - b. Hubbell; HBL5351 (single), CR5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
 - d. Pass & Seymour; 5381 (single), 5352 (duplex).

2.3 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:
 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. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; GF20.
 - b. Pass & Seymour; 2084.

2.4 SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. 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. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
 - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).

- c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
- d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

2.5 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.
- C. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.6 COMMUNICATIONS OUTLETS

- A. Telephone Outlet:
 - 1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 3560-6.
 - b. Leviton; 40649.
 - 2. Description: Single RJ-45 jack for terminating 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1 complying with Category 5e. Comply with UL 1863.

2.7 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 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.

2.8 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
 - 1. Wiring Devices Connected to Normal Power System: Ivory or as selected by Architect, 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. Pigtailling 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. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

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, and retest as specified above.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Cartridge fuses rated 600-V ac and less for use in enclosed switches and panelboards.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and maintenance data.

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 NEMA FU 1 for cartridge fuses.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper Bussmann, Inc.
 - 2. Edison Fuse, Inc.
 - 3. Ferraz Shawmut, Inc.
 - 4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 FUSE APPLICATIONS

- A. Service Entrance: Class L, fast acting.
- B. Feeders: Class L, fast acting.
- C. Motor Branch Circuits: Class RK1, time delay.
- D. Other Branch Circuits: Class RK1, time delay.
- E. Control Circuits: Class CC, fast acting.

3.2 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.3 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Enclosures.

1.2 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.3 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated.

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. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 4. Lugs: Suitable for number, size, and conductor material.
 5. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
 3. Lugs: Suitable for number, size, and conductor material.

2.3 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.

2. Outdoor Locations: NEMA 250, Type 3R.
3. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NECA 1.

3.2 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, 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. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262816

SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Interior lighting fixtures.
- B. See Division 26 Section "Wiring Devices" for manual wall-box dimmers.

1.2 SUBMITTALS

- A. Product Data: Include data on features, accessories, finishes.

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. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility.
- B. Electronic Drivers for LED Devices, Arrays, or Systems: SSL-1-2010
- C. LED Fixtures:
 - 1. Listings and Certifications
 - a. UL/CUL Listed for safety (1598)
 - b. UL/CUL dry/damp location listed
 - c. CE
 - d. RoHS compliant
 - e. FCC Class B
 - f. Lighting Facts (U.S. Department of Energy) certified
 - g. DesignLights Consortium approved

- D. Metal Parts: Free of burrs and sharp corners and edges.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Comply with NFPA 70 for minimum fixture supports.
- C. Adjust aimable lighting fixtures to provide required light intensities.
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

- A. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265100