

SECTION 260575 – ELECTRICAL FOR STEAM UTILITY DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This section includes the furnishing and installation of electrical work in steam tunnels and vaults.

1.3 SUBMITTALS

- A. Shop Drawings:

- 1. Include the following general information for each Shop Drawing submittal listed:

- a. Manufacturer.
- b. Model number.
- c. Details of construction and installation.
- d. Voltage
- e. Dimensions.
- f. Project specific wiring diagrams.

- 1) Diagrams shall clearly identify all field wiring requirements.

- 2) Typical diagrams are acceptable for multiple motors controlled in the same manner.

- g. Options and accessories.
- h. Color and finish.
- i. Ballast data.

- 2. Receptacles.
- 3. Receptacle cover plates.
- 4. Fused disconnect switches.
- 5. Motor starters.
- 6. Transformers:
 - a. KVA.
 - b. Primary and secondary voltages.
 - c. Impedance.
 - d. Temperature rise.
- 7. Panelboards.
- 8. Overcurrent Protective Devices (fuses and circuit breakers):

- a. Time-current curve.
- b. Interrupt rating.
9. Flow measurement device.
10. Luminaires: Sworn affidavit of luminaire conformance to state fire safety board rules.
11. Combination lighting contactors.
12. Nameplate schedule identifying each device to be labeled and project specific label text.

1.4 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:

1. Trained and experienced in the fabrication and installation of the materials and equipment.
2. Knowledgeable of the design.
3. Licensed electrician for installation.

B. Regulatory Requirements: Comply with the following:

1. MSU Construction Standards.
2. 2005 National Electric Code (NEC).
3. National Electrical manufacturer's Association standards (NEMA).
 - a. NEMA AB1-Molded Case Circuit Breakers.
 - b. NEMA 250-Enclosures for Electrical Equipment.
4. National Electrical Contractor's Association's (NECA): Applicable portions of "Standard of Installation".
5. Underwriters' Laboratories, Inc., Standards: UL 489-Molded Case Circuit Breakers
6. ANSI-UL:
 - a. 935-Fluorescent-Lamp Ballasts.
 - b. 1598-Luminaires
7. Local codes and authorities.
8. UL Standards 467.
9. State fire safety board rules.

1.5 DELIVERY, STORAGE AND HANDLING

- ##### A. Deliver all materials in original, unbroken, brand marked containers or wrapping as applicable.

- B. Handle and store materials in a manner which will prevent deterioration or damage (e.g., bending, end damage, finish scoring), contamination with foreign matter, damage by weather or elements, and in accordance with manufacturer's directions.
- C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, watertight wrapping.
- D. Reject damaged, deteriorated, or contaminated material and immediately remove from the site. Replace rejected materials with new materials at no additional cost to Owner.

1.6 WARRANTY

- A. Extend to Owner all warranties extended by the manufacturer of equipment and devices installed and furnished under this section.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General:
 - 1. All materials shall be new and conform with the standards of Underwriter's Laboratories.
 - 2. All stainless steel (not limited to equipment, unistrut, fasteners, etc.) shall be Type 316L.
- B. Ground Rods: Where indicated on the Drawing, provide UL labeled 3/4-inch x 10-foot, Copperweld; or equal ground rods.
- C. Power Wire (Under 600V):
 - 1. All conductors and cables shall be new with a minimum wire size of No. 12 AWG. Manufacture's name, type, and size shall be permanently marked on the outer covering at regular intervals and delivered in complete coils or reels.
 - 2. Provide factory fabricated conductors of size, rating, material, and type as indicated for each service. Where not indicated provide proper selection as determined by installer to comply with installation requirements and with NEC standards, from only following types and conductors:
 - a. Type THHN/THWN, 600 Volt, 90 Degrees C rated, stranded copper with nylon jacket:
 - b. Bare conductors: Stranded copper for all sizes.
- D. Control Cable: No. 14 AWG minimum, Type THHN/THWN, 600 volt, 90 degrees C rated, stranded copper with nylon jackets.
- E. Instrumentation Signal Cable:
 - 1. No. 14 AWG stranded, tinned copper conductors, 600V polyethylene insulation, twisted pair, 100% coverage aluminum polyester shield, No. 14 AWG stranded, tinned copper drain wire with vinyl outer jacket, UL listed.

2. Manufacturers: Belden; Alpha; West Penn.

F. Conduit:

1. Rigid Steel Conduit (RSC): Galvanized steel, heavy wall conduit with threaded fittings, 3/4 inch trade size minimum, insulated bushings.
2. Liquid Tight Flexible Metal Conduit (LTFMC): 3/4-inch trade size minimum. Galvanized steel flexible conduit with flexible, moisture-proof PVC jacket and liquid tight connectors.
3. Provide color coded end cap thread protectors on exposed threads of threaded metal conduit.

G. Boxes:

1. Outlet Boxes:
 - a. Corrosion resistant, weatherproof cast-metal outlet and device boxes of the type, shape, and size, including depth of box, to suit each respective location and installation; constructed with cast hubs in sides, and with threaded holes with stainless steel screws for securing weatherproof box covers and wiring devices.
 - b. Accessories: Provide as required for each installation, including mounting brackets, fixture studs, cable clamps, and metal straps for supporting outlet boxes. Accessories shall be compatible with outlet boxes being used and meet the requirements of individual wiring situations.
2. Junction and Pull Boxes: NEMA 4X 316L stainless steel junction and pull boxes, with clamp-on covers; of the shape and size to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws, and washers.

H. Panelboard Enclosure and Splitter Box:

1. General:
 - a. Splitter box enclosure shall be NEMA 4X 316L stainless steel, manufactured by Hoffman (Model CSD12126SS6 minimum size); or equal.
 - b. Splitter block assembly shall be shall be 600V rated Hoffman Series AS; or equal. Provide quantities and configurations as required for the Project.
 - c. Panelboard enclosures shall be NEMA 4X, 316L stainless steel, manufactured by Hoffman (Model No. CSD302412SS6); or equal.
 - d. Coordinate and provide necessary mounting hardware. Identify mounting details in submittals. Include the following options for panelboard enclosures:
 - 1) Keylockable handle Hoffman Model CWHK or equal; key as directed by Owner.

- 2) Door Stop Kit Hoffman Model ADSTOPK; or equal.
- 3) Adjustable depth mounting kit or panel conversion kit Hoffman; or equal.

I. Wiring Devices:

1. Simplex Receptacles:

- a. Ratings: 20 amp, 125V, industrial, heavy duty specification grade, corrosion resistant.
- b. Provisions: Side wiring.
- c. Device Color: Brown.
- d. Manufacturers: Hubbell 5362HBL, Cooper 5362, Leviton 5362A, or Pass and Seymour, Inc. 5362A.

2. Ground Fault Circuit Interrupter Receptacles:

- a. Ratings: 20 amp, 125V, industrial, heavy duty specification grade.
- b. Provisions: Side wiring.
- c. Device Color: Brown.
- d. Manufacturers: Hubbell GF5362, Leviton 6899; or approved equal by Pass and Seymour, Inc. or Cooper.

3. Fan Receptacles:

- a. Ratings: 20 amp, 5 HP, 480V, IP 66 rated twist-lock receptacle.
- b. Manufacturer: Hubbell (HBL2430SW); or approved equal.
- c. Adapter Plates: Hubbell (HBL2030AP); or approved equal.

4. Wall Plates:

- a. Number: Provide a single (simplex or duplex outlet) wall plate for wiring devices grouped at each location.
- b. Attachment: Provide stainless steel screws for securing plates to devices, screw heads colored to match finish of plate.
- c. Construction for Plastic: High abuse nylon, color to match device.
- d. Plate Application:
 - 1) Unfinished Areas: Plastic.
 - 2) Tunnel Vault Receptacles: Weatherproof Outlet Covers and Face-Plates:
 - a) Cast aluminum, NEMA 3R, weatherproof while-in-use outlet cover with faceplate, faceplate gasket and corrosion proof fasteners.
 - b) Manufacturers: Hubbell WP26MH; or equal by Leviton.

3) Tunnel Vault Switches: Weatherproof Plate:

- a) Cast aluminum, with fiber shield, and corrosion proof fasteners.
- b) Manufacturers: Hubbel HBL7420; or equal by Leviton

J. Disconnect Switches:

1. Manufacturers: Provide products produced by 1 of the following Manufacturers (for each type of switch):
 - a. Square D Company.
 - b. General Electric.
 - c. Siemens Energy & Automation.
 - d. Cutler Hammer.
2. General: Provide heavy duty disconnect switches for all motors and equipment as indicated on the Drawings.
3. Switch Enclosures: Provide disconnect switches with NEMA enclosures 1, 3R, 4X, 7, or 12 as indicated on the Drawings, or in absence thereof, as determined by installer to fulfill the requirements of the environment. NEMA 4X disconnect switch enclosures shall be stainless steel.
4. Heavy Duty Safety Switches:
 - a. Provide heavy duty type, sheet steel enclosed safety switches, of the type and size and electrical characteristics indicated, surface mounted, fusible or nonfusible, rated at 600 volts, 60 hertz, 3 blades, incorporating quick-make, quick-break type switches, constructed so switch blades are visible in "off" position with door open; equipped with operating handle which is an integral part of the enclosure base and whose position is easily recognizable and is padlockable in the "off" position; with current carrying parts constructed of high-conductivity copper, and silver-tungsten type switch contact; with positive pressure type reinforced fuse clips.
 - b. Fuse clips shall accept only Class R type fuses.
 - c. All disconnect switches shall be horsepower rated.
5. Switch Interlock:
 - a. Provide switches with dual cover interlock to prevent opening door with switch in "on" position or closing switch with door open.
 - b. Interlocks shall be defeatable with the use of a screwdriver to intentionally gain access to an energized switch in the "on" position.

K. Motor Starters:

1. Provide products produced by one of the following manufacturers:

- a. Square D Company.
 - b. Cutler-Hammer.
 - c. General Electric.
 - d. Siemens Energy and Automation.
2. Provide combination, full voltage, nonreversing magnetic starters and fusible disconnect switches in a common enclosure. Fractional sizes and ratings in accordance with IEC recommendations are not acceptable.
 3. Provide fused 3-pole load break disconnect switches with time delay, dual element fuses, external operating handle, and lock-off facility.
 4. Contactors: NEMA size 1 minimum, magnetically held, field replaceable coil and contacts, auxiliary contacts field installable and removable. Terminal temperature rise is not to exceed 50 degrees C in accordance with NEMA standards. Provide transient voltage surge suppressor across each contactor coil.
 5. Overload Relays: Solid state type, self powered with current trip range adjustability. Relay shall provide phase loss, phase unbalance protection and include switch selectable Class 10 or Class 20 trip protection. Provide cover mounted reset pushbutton.
 6. Terminal Blocks: Pull apart type for power and control. Use screw type terminals suitable for ring and tongue lugs for control wiring and box lug type for power wiring.
 7. Enclosures:
 - a. Provide magnetic motor starters with NEMA enclosures 1, 3R, 4X, 7 or 12 as indicated on the Drawings or schedules, or in absence thereof, as determined by installer to fulfill the requirements of the environment.
 - b. Restrict opening of starter enclosure by use of a latch unless the switch is in the "off" position. Latch shall be defeatable with a screwdriver.
 8. Control Devices:
 - a. Elapsed Time Indicators: Six digit, nonreset, 3-1/2-inch square case.
 - b. Indicating Lights and Selectors: Heavy duty, oil tight, industrial grade with octagonal ring. Pilot lights shall be LED, push-to-test type.
 - c. Control Relays: Heavy duty, 600 volt, machine tool type, 10 amp contact rating. Time delay forms are solid state type.
 - d. Control Power Transformer: Provide control transformer with 2 primary and 1 secondary fuse. Transformer to be sized to accommodate the contactor and all control circuit loads.
 - e. Provide each starter with 2 spare Form C contacts in addition to those indicated on Drawings. Each Form C contact shall have 1 normally open and 1 normally closed contact.

f. Refer to wiring diagrams for specific control device requirements.

L. Transformers:

1. Provide products produced by one of the following manufacturers:
 - a. Square D Company.
 - b. Cutler-Hammer.
 - c. General Electric.
 - d. Siemens Energy and Automation.
2. Voltage and phase as indicated on the Drawings.
3. Voltage Taps:
 - a. Three Phase: Two 2-1/2% FCAN and four 2-1/2% FCBN.
4. Insulation:
 - a. An UL recognized 220 degrees C insulating system, operating at 115 degrees C rise over an ambient of 40 degrees C.
 - b. Transformers shall have the ability to carry a 30% overload at rated voltage without exceeding this rating.
5. Vibration: Completely isolate the core and coil unit from the enclosure by means of vibration absorbing mounts.
6. Ground Lugs: Supply transformers with external ground lugs internally connected to transformer neutral.
7. Cores:
 - a. Construct cores of nonaging, high-permeability, grain-oriented, cold-rolled silicon steel.
 - b. Minimum Acceptable Steel Grade: Electrical steel graded M-6.
 - c. Keep magnetic flux densities well below the saturation point.
 - d. The core shall not saturate even when the transformer is subjected to 120% of nameplate voltage.
 - e. Clamp core with structural angle and bolt to the enclosure to prevent damage during shipment.
8. Coils: Wound of continuous aluminum or copper conductors without splices.
9. Impregnation:
 - a. Thoroughly dry core and coil with core brackets.
 - b. Epoxy-resin encapsulated core and coil.

- c. Complete with 1 finishing coat of a high temperature sealer varnish.
 10. Enclosure: Constructed of stainless steel 316L, rated NEMA 3R.
 11. Terminal Compartments:
 - a. Readily accessible with clamp type terminals sturdily mounted.
 - b. Size wiring compartment covers so that when removed the entire wiring compartment area is exposed.
 12. Core Mounting: Mount core and coil of all cabinet type transformers above the base in order to provide space at the bottom of the transformer enclosure so that wiring is never exposed to temperatures higher than the ambient temperature.
 13. Grounding: Ground core and coil assembly to the enclosure with flexible copper strap.
 14. Nameplates: Permanently attach metal nameplates, marked in accordance with NEMA specifications, to the transformer in a readily accessible position.
 15. Case Temperature: The maximum top or case temperature at full load shall not exceed 35 degrees C above ambient.
- M. Panelboards: Refer to panelboard schedule on the Drawings.
 1. Provide products produced by one of the following manufacturers:
 - a. Square D Company.
 - b. Cutler Hammer.
 - c. General Electric.
 - d. Siemens Energy and Automation.
 2. General:
 - a. Panelboards shall have plated copper bus bars and full-sized neutral bar.
 - b. Bussing shall meet UL Standard 67 for maximum heat rise.
 - c. Bussing Type: Distributed phase.
 3. Circuit Breaker Panels:
 - a. Automatic circuit breaker type with individual breaker unit for each circuit, interchangeable, and removable without disturbing adjacent units.
 - b. Complete front trim with door and semi-flush lock (Corbin Catalog No. 15751), with 2 (No. TEU-1) keys. Panelboards shall have common keying.
 - c. Cabinets and fronts shall meet UL Standards for gutter space and material gage.
 - d. Panelboards shall have common keying. Provide keying as directed by Owner.

- e. Panels shall have a circuit directory frame with plastic cover and card mounted inside cover.
 - f. Panel shall have electrical rating as indicated on the Drawings.
 - g. Finish panels in gray enamel over rust inhibitor primer.
 - h. Load centers not allowed.
4. Short-Circuit Rating: Provide a single integrated rating of each panelboard certifying capability of withstanding fault stresses equal to the lowest interrupting rating of any overcurrent protective device contained in the panelboard.
- N. Combination Lighting Contactors with Fused Disconnect Switch:
1. Provide products manufactured by 1 of the following:
 - a. Square D Company Class 8903.
 - b. Cutler Hammer Class A202.
 - c. Automatic Switch Company 917.
 - d. Siemens Energy and Automation CLH or CLM.
 - e. Allen Bradley Bulletin 500L or 500LP.
 2. Lighting Contactors:
 - a. Provide lighting contactors that have voltage and current rating as indicated on the Drawings.
 - b. Suitable for continuous duty with all types of lighting loads.
 - c. Totally enclosed silver alloy double break power contacts capable of making and breaking any load within the rating of the contactor without the assistance of auxiliary arcing contacts. Contacts shall be removable without disturbing line or load wiring.
 3. Industrial duty and rated 600 volts even though they may be used for commercial duty or at lower voltage or both.
 4. Electrically Held: Lighting contactor coils shall be continuously rated and encapsulated.
- O. Electrical Identification:
1. Provide engraved laminated plastic nameplate to identify each piece of electrical equipment examples:
 - a. Fused disconnect switches.
 - b. Motor starters.
 - c. Panelboards.
 - d. Lighting contactors.
 2. Nameplates:

- a. Shall have 3/8-inch minimum black letters on a white background.
- b. Punched or drilled for mechanical fasteners.
- c. Stainless steel screw type fasteners.

P. Overcurrent Protective Devices:

1. Fuses General:

- a. Provide fuses manufactured by Bussmann, Inc. as required for motor starters, fused disconnect switches, and other equipment requiring fuse protection as indicated on the Drawings, or in absence thereof, as selected by the installer to meet the specific electrical requirements of the equipment being served. Select only the following:
 - 1) Dual element plug fuses, 0-30 ampere, 150 volt, 10,000 ampere interrupting rating: Buss "Fusetron".
 - 2) Dual element fuse, 0-600 ampere, 250 or 600 volt, 200,000 ampere interrupting rating, Type RK-5: Buss "Fusetron".
- b. Fuses shall be by one manufacturer.

2. Circuit Breakers General:

- a. Provide required circuit breakers for installation in panelboards, switchboards, individual enclosures, or motor control centers. Circuit breaker manufacturer shall be that of the equipment in which it is installed or shall be supplied by that equipment manufacturer.

Match existing AIC ratings where installing new current breakers in existing equipment for the following paragraph.

- b. Breakers shall be rated for the applied voltage and shall have a minimum of 10,000 AIC.
- c. Mechanism: Molded case circuit breakers shall have over center toggle-type mechanisms, providing quick-make, quick-break action. Breakers shall be calibrated for operation in an ambient temperature of 40 degrees C. Each circuit breaker shall have trip indication by handle position and shall be trip-free. 2 and 3 pole breakers shall be common trip.
- d. Thermal Magnetic Trip:
 - 1) Each circuit breaker shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole.
 - 2) A push-to-trip button shall be provided on the cover for mechanically tripping the circuit breaker.
 - 3) Single pole 15 and 20 ampere breakers shall be SWD rated.

e. Enclosures:

- 1) Provide a UL listed circuit breaker enclosure for each individually mounted circuit breaker.
- 2) Enclosure to have NEMA rating for its intended location (NEMA 12, 3R, .4).
- 3) Provide handle mechanism padlockable in "OFF" position.

Q. Flow Measurement Device:

1. General: Flow meter manufacturers shall submit results of flow calibration tests to confirm the stated accuracy.
2. Magnetic Type:
 - a. General:
 - 1) Designed for use on flow as indicated in schedule.
 - 2) Accuracy: Within $\pm 0.5\%$ of meter scale for a velocity of 0.7 to 33 fps and the repeatability shall be within $\pm 0.1\%$ of full scale.
 - 3) Low frequency electromagnetic induction type.
 - b. Complete with 316 stainless steel or Hastelloy C grounding rings. Probes not acceptable.
 - c. Meter Tube:
 - 1) 304 stainless steel flow tube.
 - 2) Liner: Hard rubber.
 - a) Teflon.
 - 3) Electrodes:
 - a) 316 Stainless steel.
 - b) [Hastelloy C, bullet nose.]
 - 4) Flanges: ANSI 150-pound, raised or flat.
 - 5) Epoxy Coated: 2 coats for a minimum of 7 mils.
 - 6) Pipe Laying Lengths: 1.5 upstream and downstream pipe diameters.
 - d. Transmitter:
 - 1) One for each flow tube.

- 2) Solid state type.
- 3) Remote mounted adjacent to meter tube. Provide galvanized channel support structure adjacent to flow element as required.
- 4) Local Flow Rate Indication: 1/2-inch high red LED. Display in gallons per minute (gpm), and totalized gallons or 1,000 gallons.
- 5) Transmitter shall include nonvolatile memory so that the flow totalization is not lost during power interruptions.
- 6) Output: 4-20mA dc proportional and calibrated to stated flow range.
- 7) Power: 120-Vac, 60 HZ.
- 8) Enclosure: NEMA 4X.
- 9) Provide required lengths of manufacturer's cable for remote mounted indicators.

e. Schedule:

- 1) Tag Line Size Flow Range Flow Type
- 2) FE/FIT-1 8 inches 0-X Effluent

f. Manufacturer:

- 1) Toshiba.
- 2) ABB.
- 3) Krohne.
- 4) Yokogawa.
- 5) Endress & Hauser.

R. Luminaire:

1. Type SD-4: Industrial enclosed and gasketed, wet location, T5, fluorescent, 277 volt, with high ambient (90 degrees C) temperature ballast. Fixture type shall be 1 of the following:
 - a. The Light Edge, Inc. MON1-28-41 with stainless steel latches.
 - b. Eclipse Lighting, Inc. VTC-N-4C-SSL-T5 - (1) 28-EBHT.
2. Lamps:
 - a. Model Number: F28T5/841.
 - b. Manufacturer: Phillips; or equal.
3. Ballasts: Universal voltage (120 volts to 277 volts), electronic high power factor type ballast, high ambient temperature (90 degrees C case temperature minimum), UL listed, total harmonic distortion shall be less than 20%, Ballast factor 0.85 or higher, and 5 year warranty. AC Electronics, ESD A35T5S; or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Coordinate electrical device locations with Drawings and Owner.
- B. Prior to acceptance of the work of this section, clean all electrical items and related areas in accordance with Division 01 requirements.
- C. Ground Connections:
 - 1. Ground rods shall extend 10 feet into undisturbed soil.
 - 2. Make cable to rod and cable to cable connections by using Exothermic Welding Process by Cadweld, compression type connectors made for direct burial, by Thomas & Betts; or approved equal.
 - 3. Conduit, pipe racks, switches, supports, cable sheaths, cabinets, transformers, special equipment, and non-current carrying parts shall be permanently and effectively grounded to one of the ground systems.
 - 4. Circuit Grounding: Install grounding bushings, grounding studs, and grounding jumpers at pull boxes, and panelboards.
 - 5. Receptacles and Power Outlets: Ground receptacles and power outlets to the conduit system with a Type THHN green grounding conductor sized in accordance with NEC Article 250 and connected between the device grounding screw and outlet box.
 - 6. Ground motor bases and frames by pulling a separate conductor in with the motor feeder.
 - 7. Expansion Joints: Install a bonding jumper around expansion fittings in metallic conduit to maintain ground continuity.
 - 8. An equipment grounding conductors shall be installed with feeders and branch circuits and connected to all devices and equipment.
 - 9. Conductors used for grounding that are installed separately in electrical rooms or other locations shall be installed in conduit in areas where they are subject to physical damage. The conduit shall be bonded to the conductor.
 - 10. Separately Derived Systems: Grounding of separately derived systems, i.e., secondary transformers, shall be in accordance with NEC, Article 250. Use suitable ground lugs and clamps approved for this purpose.
- D. Conduit:
 - 1. Conduit Schedule:
 - a. In All Areas: RSC.
 - b. Short Runs to Individual Pieces of Vibrating Equipment or Instruments: LTFMC.

2. Conduit Joints: Cut square, reamed smooth and drawn up tight.
3. Bends:
 - a. Do not exceed the equivalent of 4 quarter bends (360 degrees) between pull points.
 - b. Make bends and offsets so as not to reduce the inner diameter of the conduit.
4. Routing:
 - a. Concealed Conduits: Run in a direct line with long sweep bends and offsets.
 - b. Exposed Conduits: Run parallel to, and at right angles to, building lines.
 - c. Run continuous from outlet to outlet and from outlets to cabinets, pull or junction boxes.
 - d. Secure to boxes and cabinets with locknuts and bushings in such a manner that each system is electrically continuous throughout.
5. Cap conduit ends to prevent entrance of foreign materials during construction.
6. Provide insulated bushing on threaded conduit run terminations.
7. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200 pounds (90 kb) tensile strength. Leave at least 12 inches of slack at each end of pull wire.
8. Expansion Fittings:
 - a. Provide conduit expansion couplings where conduits cross building, structure, or vault expansion joints.
 - b. Provide expansion couplings as indicated on the Drawings and in locations where length change, due to temperature variation, exceeds 1/4-inch. Temperature range for calculating thermal expansion of RSC is 40 degrees F to 130 degrees F. Expansion rate is 5/8-inch per 100 feet. Provide a minimum of 1 expansion fitting per 100 feet of conduit. Bond expansion fittings in accordance with NEC Article 250.
 - c. Do not over tighten conduit supports where conduits are installed with expansion fittings.
9. LTFMC Installation:
 - a. Provide separate grounding conductor. Connect each end to a grounding bushing.
 - b. Runs shall not exceed 6 feet.
10. Provide separate raceway systems for:
 - a. Normal power wiring.
 - b. A.C. signal and control wiring.

- c. Low voltage signal and control wiring.
 - d. Analog instrumentation wiring.
 - e. Special systems wiring.
11. Support:
- a. Conduit shall be supported by approved hangars.
 - b. Conduit shall be fastened or suspended from structural members, slabs, or walls only. It shall not be run on or fastened to tee bars of suspended lay-in ceilings.
 - c. Conduit installed in steam tunnels shall be anchored with "Hilti" type anchors. Plastic anchors shall not be used.
12. Conduit shall be terminated with locknuts and bushings in outlet boxes and panels. Insulated bushings shall be used on rigid conduit 1-1/4-inch and larger. Conduit connectors and couplings shall be galvanized steel.
13. Paint conduit in finished areas to match existing finishes.
14. When metal conduit extends below the bottom of a slab on the ground, the slab shall be thickened in the area of the conduit so as to encase the conduit in concrete by at least 2 inches on all sides.

E. Power Wire:

1. General:
- a. Use the following color code for conductors:

Phase A	Phase B	Phase C	Neutral	System
X	Y	Z	N	Any voltage
Black	Red	Blue	White	120/208 volt feeders
Brown	Orange	Yellow	Gray	277/480 volt feeders

- b. In general, branch circuit wiring shall be 600 volt Type THHN or THWN, minimum wire size 12 AWG except where noted otherwise. Branch circuits 100 feet or longer shall be minimum size 10 wire AWG.
 - c. 120 volt control circuits may be number 14 AWG wire.
 - d. Neutral conductor insulation color for emergency and "X" panel circuits shall be as noted above with a red tracer.
2. Installation Procedures:
- a. Each conduit shall be free of moisture and debris before conductors are installed. Remove moisture from conduits by swabbing.
 - b. Outlets:

- 1) Leave at least 6 inches of free conductor at outlets except where conductors are intended to loop without joints through outlets for fixtures or wiring device hook-ups.
- 2) Lights and outlets shall be grouped on circuits as indicated on the Drawings.
- c. Make joints, splices, and connections 600 V or less only at accessible junction or outlet boxes, never inside conduit. Make splices in No. 10 AWG and smaller wire with insulated spiral mechanical connectors.
- d. Make splices in No. 8 AWG and larger copper 600 V or less wire with compression or split-bolt type mechanical connectors.
- e. Insulate joints at splices with "Scotch" brand electrical pressure sensitive tape to 150% of conductor insulation value.
- f. Prior to energization, check conductors and cables for continuity of circuitry and for short circuits. Correct malfunctions when detected.
- g. Lights and outlets shall be grouped on circuits as indicated on the Drawings. Different types of circuits such as feeders, branch circuits, control circuits, and signal circuits, shall not be mixed in common conduit runs, but shall be run separately, although more than 1 circuit of the same system may be run in common conduit runs.

F. Panelboard Enclosure and Splitter Box:

1. General:
 - a. Install wiring in a workmanlike manner.
 - b. Wiring shall be sized, labeled and color coded.
 - c. Provide mounting hardware, support brackets, etc., as required to install panelboard splitter blocks, and enclosure(s).
2. Anchoring:
 - a. Anchor enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secured.
 - b. Locate top of enclosures approximately 6'-0" above floor, at a masonry joint if applicable.
3. Directories:
 - a. Fill out the enclosures circuit directory card upon completion of work and install in lighting panels and branch circuit panels.
 - b. Lettering:

- 1) Typewritten.
- 2) Hand lettering will not be acceptable.

G. Pull, Outlet, and Junction Boxes:

1. Pull boxes and junction boxes shall be installed in accessible locations.
2. Provide weatherproof outlet boxes in tunnels.
3. Provide knockout closures to cap unused knockout hole(s) where blanks have been removed.

H. Wiring Devices:

1. Receptacles:
 - a. Locate approximately as indicated on the Drawings, long dimension vertical, with grounding pole at top.
 - b. Refer to mechanical Drawings for coordination with mechanical equipment and systems.
 - c. Provide bonding jumper from outlet to box.
 - d. Mount 18 inches to center above finished floor unless otherwise noted.
2. At time of Substantial Completion, replace those items which have been damaged, including those burned and scored by faulty plugs.

I. Electrical Identification:

1. Attach nameplates directly to each piece of electrical equipment.
2. Nameplates shall include the following information: Device name, voltage, phase, and horsepower or load size (example, "BWP-1, 480V-3Ø, 1 HP").
3. Provide updated typewritten directories for panels modified during installation.
4. Provide nameplates for new circuit breakers, motor controls, motor starters, control panels, fused switches and disconnect switches.
5. Provide label inside each junction and pull box identifying circuit numbers for conductors contained inside the box. Labeling shall be printed neatly with permanent, waterproof, black ink marker.

J. Overcurrent Protective Devices: Install fuse overcurrent protective devices in combination motor starters, panelboards, fused disconnects, and equipment as required. Install circuit breaker overcurrent devices in panelboards, as required.

K. Luminaires:

1. Install surface mounted luminaires to maintain the alignment, spacing, layout, and general arrangement indicated on the Drawings.
2. Install luminaires in accordance with manufacturer's recommendations.
3. Securely mount luminaires and electrical boxes to elements of the building structure such that luminaires will be square, plumb, and rigid; and will not fall or sag.
4. Replace defective lamps and ballasts immediately prior to Substantial Completion.

L. Transformers:

1. Mounting: Mount transformers as indicated on the Drawings.
 - a. Provide wall mount brackets and accessories.
2. Equipment Grounding: Provide transformer enclosure equipment grounding in accordance with the latest applicable edition of the National Electrical Code.
3. Neutral Conductor Grounding:
 - a. Provide a THW insulated grounding conductor from the neutral of a Wye connected secondary 3 phase transformer or the secondary center tap of a single phase transformer to the nearest acceptable grounding electrode.
 - b. This work shall be in accordance with the latest applicable edition of the National Electrical Code.
4. Install transformers in accordance with manufacturer's recommendations.
5. Technical Literature: Turn over all technical literature and manufacturer's guarantee to Owner and obtain a signed receipt.
6. Adjust the full capacity taps under no load so that the average secondary phase to neutral voltage for the 3-phases is as close as possible to 120 volts.

M. Motor Starters:

1. Install motor starter at locations indicated on the Drawings.
2. Adjust overload relay settings based on motor nameplate rating.
3. Label each motor starter with load served.

N. Disconnect Switches:

1. Mount on wall whenever possible, otherwise provide channel support structure adjacent to equipment served.
2. Provide fuses for disconnect switches in accordance with this Specification.

O. Flow Measurement Device:

1. Install the process control equipment and instrumentation in conformance with:
 - a. The Shop Drawings reviewed by Engineer.
 - b. The manufacturer's recommendation.
 2. Field Performance Testing:
 - a. Monitoring Equipment:
 - 1) Verify proper operation.
 - 2) Calibrate to maximum accuracy.
 3. Demonstrate that system performs control and monitoring functions as specified and indicated on the Drawings. Testing procedures shall be developed by the system supplier.
- P. Lighting Contactors: Test lighting controls for proper operation in the presence of Owner's maintenance staff.

END OF SECTION 260575