

larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.03 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches .

2.04 VALVE TAGS

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

2.05 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.01 PREPARATION

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

3.02 EQUIPMENT LABEL INSTALLATION

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

3.03 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 9.
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:

1. Refrigerant Piping:
 - a. Background Color: White.
 - b. Letter Color: Blue.
2. Vent Piping:

- a. Background Color: White.
- b. Letter Color: Black.

3. Waste Piping:

- a. Background Color: Black.
- b. Letter Color: White.

4. Propane Piping:

- a. Background Color: Yellow.
- b. Letter Color: Black.

5. Fire Protection Piping:

- a. Background Color: Red.
- b. Letter Color: White.

6. Domestic Water Piping:

- a. Background Color: Blue.
- b. Letter Color: White.

3.04 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

- a. All Piping: 1-1/2 inches, round.

2. Valve-Tag Color:

- a. All Piping: Natural.

3. Letter Color:

- a. All Piping: Black.

3.05 WARNING-TAG INSTALLATION

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

END OF SECTION

SECTION 22 1116

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
2. Encasement for piping.

B. Related Requirements:

1. Division 2 Section "Facility Water Distribution Piping" for water-service piping and water meters outside the building from source to the point where water-service piping enters the building.

1.03 ACTION SUBMITTALS

- A. Product Data: For transition fittings and dielectric fittings.

- B. Shop Drawings: Detail, at 1/4 scale, the piping layout with coordination with other disciplines.

1.04 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.

- B. Field quality-control reports.

1.05 FIELD CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of water service.

2. Do not interrupt water service without Owner's written permission.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

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

2.02 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.
- B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- E. Copper Unions:
 1. MSS SP-123.
 2. Cast-copper-alloy, hexagonal-stock body.
 3. Ball-and-socket, metal-to-metal seating surfaces.
 4. Solder-joint or threaded ends.
- F. Copper-Tube, Extruded-Tee Connections:
 1. Description: Tee formed in copper tube according to ASTM F 2014.
- G. Appurtenances for Grooved-End Copper Tubing:
 1. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75 (ASTM B 75M) copper tube or ASTM B 584 bronze castings.
 2. Mechanical Couplings for Grooved-End Copper Tubing:
 - a. Copper-tube dimensions and design similar to AWWA C606.
 - b. Ferrous housing sections.
 - c. EPDM-rubber gaskets suitable for hot and cold water.
 - d. Bolts and nuts.

e. Minimum Pressure Rating: 300 psig (2070 kPa).

H. Press Seal Fittings for Copper:

1. Press-connect Fittings: Bronze or copper shall conform to the material requirements of ASME B16.18 or ASME B16.22, and the performance requirements of IAPMO PS117, and ICC/ANSI LC1002 and NSF/ANSI 61-pw (if used in a potable water system.) Press-connect fittings ½-inch thru 4-inch for use with ASTM B88 copper tube shall have an EPDM sealing element, and an un-pressed fitting, leak identification feature. 2-1/2-inch thru 4-inch shall have a 420 stainless steel grip ring, PBT separator ring, and EPDM sealing element. Sealing elements shall be verified for the intended use.

2.03 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Standard-Pattern, Mechanical-Joint Fittings:

1. AWWA C110/A21.10, ductile or gray iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Compact-Pattern, Mechanical-Joint Fittings:

1. AWWA C153/A21.53, ductile iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.04 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

- E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.05 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105/A21.5.
- B. Form: tube.

2.06 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.

2.07 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Standard: ASSE 1079.
 - 2. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C), 150 psig (1035 kPa), 250 psig (1725 kPa).
 - 3. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 - 1. Standard: ASSE 1079.
 - 2. Factory-fabricated, bolted, companion-flange assembly.
 - 3. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C), 150 psig (1035 kPa), 175 psig (1200 kPa), 300 psig (2070 kPa)
 - 4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
 - 1. Nonconducting materials for field assembly of companion flanges.

2. Pressure Rating: 150 psig (1035 kPa)
3. Gasket: Neoprene or phenolic.
4. Bolt Sleeves: Phenolic or polyethylene.
5. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Standard: IAPMO PS 66.
2. Electroplated steel nipple complying with ASTM F 1545.
3. Pressure Rating and Temperature: 300 psig (2070 kPa) at 225 deg F (107 deg C).
4. End Connections: Male threaded or grooved.
5. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.01 EARTHWORK

- A. Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.02 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105/A21.5.
- E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Division 15 Section "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Division 15 Section "Domestic Water Piping Specialties."
- F. Install shutoff valve immediately upstream of each dielectric fitting.
- G. Install domestic water piping level without pitch and plumb.

- H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- I. Install seismic restraints on piping where required.
- J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- K. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- M. Install piping to permit valve servicing.
- N. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- O. Install piping free of sags and bends.
- P. Install fittings for changes in direction and branch connections.
- Q. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- R. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump.
- S. Install thermostats in hot-water circulation piping.
- T. Install thermometers on outlet piping from each water heater.
- U. Install sleeves for piping penetrations of walls, ceilings, and floors.
- V. Install sleeve seals for piping penetrations of concrete walls and slabs.
- W. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.03 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2104. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- G. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.
- H. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- I. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.
- J. Press Seal Joints for Copper Tubing: Use tools and methods as required by fitting manufacturer. Copper and copper alloy press connections shall be made in accordance with the most current manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool(s) approved by the manufacturer.

3.04 TRANSITION FITTING INSTALLATION

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

3.05 DIELECTRIC FITTING INSTALLATION

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

- B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric [couplings or nipples] [unions].
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.
- D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.06 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices in Division 15 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger, support products, and installation in Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
 - 3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
 - 4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
 - 5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
- F. Install supports for vertical copper tubing every 10 feet (3 m).

- G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.07 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Plumbing Fixtures: Cold water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
 - 2. Equipment: Cold water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.08 IDENTIFICATION

- A. Identify system components.
- B. Label pressure piping with system operating pressure.

3.09 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
 - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.

- d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

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

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

C. Prepare test and inspection reports.

3.10 ADJUSTING

A. Perform the following adjustments before operation:

- 1. Close drain valves, hydrants, and hose bibbs.
- 2. Open shutoff valves to fully open position.
- 3. Open throttling valves to proper setting.
- 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
- 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.

6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

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

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

- C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building-service piping, NPS 3 (DN 80) and smaller shall be one of the following:
 - 1. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A); wrought-copper, solder-joint fittings; and brazed, copper press-seal fittings; and press-sealed joints.
- E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 (DN 100 to DN 200) and larger shall be one of the following:
 - 1. Mechanical-joint, ductile-iron pipe; standard- or compact-pattern, mechanical-joint fittings; and mechanical joints.
- F. Under-building-slab, domestic water piping, NPS 2 (DN 50) and smaller shall be one of the following:
 - 1. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A); wrought-copper, solder-joint fittings; and brazed, copper pressure-seal fittings; and pressure-sealed joints.
- G. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:
 - 1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast- or [wrought-]copper, solder-joint fittings; and brazed soldered joints.
 - 2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper press seal-joint fittings; and press-sealed joints.
- H. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
 - 1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast- or wrought-]copper, solder-joint fittings; and brazed soldered joints.

2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); grooved-joint, copper-tube appurtenances; and grooved joints.

END OF SECTION

SECTION 22 1119

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Strainers.
5. Hose bibbs.
6. Water meters.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For domestic water piping specialties.
 1. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 6 and NSF 14.

2.02 PERFORMANCE REQUIREMENTS

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

2.03 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. FEBCO; a division of Watts Water Technologies, Inc.
 - b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle third of flow range.
5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Configuration: Designed for horizontal, straight-through flow.
8. Accessories:
 - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
 - c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Backflow-Preventer Test Kits:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. FEBCO; a division of Watts Water Technologies, Inc.

- b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.04 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Honeywell International Inc.
 - b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
5. Valves for Booster Heater Water Supply: Include integral bypass.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.05 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:

- a. Strainers NPS 2 and Smaller: 0.033 inch .
 - b. Strainers NPS 2-1/2 to NPS 4 : 0.045 inch .
 - c. Strainers NPS 5 and Larger: 0.10 inch .
6. Drain: Factory-installed, hose-end drain valve.

2.06 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Rough bronze.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Operating key.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Includewall flange with each chrome- or nickel-plated hose bibb.
16. Provide shut-off cock for each hose bib in accessible location.

2.07 WATER METERS

A. Displacement-Type Water Meters:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. E-mon, LLC

- b. Badger Meter, Inc.
- c. Mueller Co. Ltd.; a subsidiary of Mueller Water Products Inc.

2. Description:

- a. Standard: AWWA C700.
- b. Pressure Rating: 150-psig working pressure.
- c. Body Design: Nutating disc; totalization meter.
- d. Registration: In gallons or cubic feet or as required by utility company.
- e. Case: Bronze.
- f. Accuracy: +/-2% with the flow ranges.
- g. End Connections: Threaded or flanged.

B. Remote Registration System: Direct-reading type complying with AWWA C706; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 - 1. Locate backflow preventers in same room as connected equipment or system.
 - 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
- B. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- C. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve and pump.

3.02 CONNECTIONS

- A. Comply with requirements for piping specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements for ground equipment in Division 16 Section "Grounding and Bonding."

C. Fire-retardant-treated-wood blocking is specified in Division 16 Section "Conductors and Cables" for electrical connections.

3.03 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test each reduced-pressure-principle backflow preventer and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.04 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

END OF SECTION

SECTION 22 1316

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.
3. Encasement for underground metal piping.

B. Related Sections:

1. Section 02530 "Sanitary Sewerage" for sanitary sewerage piping and structures outside the building.
2. Section 15223 "Chemical-Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.
3. Section 15445 "Sewage Pumps" for effluent and sewage pumps.

1.03 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.

- B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.04 ACTION SUBMITTALS

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

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
 2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Shop Drawings: Detail, at 1/4 scale, the piping layout with coordination with other disciplines.

1.05 QUALITY ASSURANCE

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

1.06 PROJECT CONDITIONS

- A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 1. Notify Owner no fewer than two days in advance of proposed interruption of sanitary waste service.
 2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

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

2.02 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.

1. 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. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Solvent Cement: ASTM D 2564.

1. 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).
2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.03 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:
 - a. Standard: ASTM C 1173.
 - b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - c. Sleeve Materials:
 - 1) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 2) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

PART 3 - EXECUTION

3.01 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 02300 "Earthwork."

3.02 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping at indicated slopes.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Install piping to allow application of insulation.
- I. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 15073 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- J. 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.
- K. 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.
- L. 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; 2 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
- M. Install underground PVC piping according to ASTM D 2321.
- N. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Section 15155 "Sanitary Waste Piping Specialties."
 2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 15155 "Sanitary Waste Piping Specialties."
- O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- P. Install sleeves for piping penetrations of walls, ceilings, and floors.
- Q. Install sleeve seals for piping penetrations of concrete walls and slabs.
- R. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.03 JOINT CONSTRUCTION

- A. Plastic, Non-pressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.04 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
1. Install transition couplings at joints of piping with small differences in OD's.
 2. In Drainage Piping: Unshielded Shielded, non-pressure transition couplings.

3.05 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Section 15073 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 230529 "Hangers and Supports for Plumbing Piping and Equipment."
1. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
 2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 3. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.

4. Vertical Piping: MSS Type 8 or Type 42, clamps.
 5. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 6. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 7. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
- I. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
- J. Install supports for vertical PVC piping every 48 inches.
- K. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.06 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

- C. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- D. Make connections according to the following unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.07 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 1 "Identification for Plumbing Piping and Equipment."

3.08 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground and nderground, soil, waste, and vent piping shall be any of the following:
 - 1. Hubless, cast-iron soil pipe and fittings with encasement; CISPI hubless-piping couplings; and coupled joints.
 - 2. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints. Shall be used only when the fluids being discharged into the pipe are less than 140F.
 - 3. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

END OF SECTION

SECTION 22 1319

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Cleanouts.
2. Floor drains.
3. Trench drains.
4. Miscellaneous sanitary drainage piping specialties.

B. Related Requirements:

1. Section 221413 "Storm Drainage" for storm drainage piping and piping specialties outside the building.
2. Section 221423 "Storm Drainage Piping Specialties" for storm drainage piping inside the building, drainage piping specialties, and drains.

1.03 DEFINITIONS

- A. PVC: Polyvinyl chloride plastic.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

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

1.06 COORDINATION

- A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.01 CLEANOUTS

- A. Plastic Floor 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.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- B. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

3.02 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220550 "Identification for Plumbing Piping and Equipment."

3.03 PROTECTION

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

END OF SECTION

SECTION 22 1413

STORM DRAINAGE PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:

- 1. Pipe, tube, and fittings.

- B. Related Sections:

- 1. Section 02630 "Storm Drainage" for storm drainage piping outside the building.
 - 2. Section 15446 "Sump Pumps" for storm drainage pumps.

1.03 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

- 1. Storm Drainage Piping: 10-foot head of water.

- B. Seismic Performance: Storm drainage piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.04 ACTION SUBMITTALS

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

- B. Shop Drawings: Detail, at 1/4 scale, the piping layout with coordination with other disciplines.

1.05 QUALITY ASSURANCE

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

1.06 PROJECT CONDITIONS

- A. Interruption of Existing Storm-Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of storm-drainage service.
 - 2. Do not proceed with interruption of storm-drainage service without Owner's written permission.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

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

2.02 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:
 - 1. Standards: ASTM C 1277 and CISPI 310.
 - 2. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.03 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.

1. 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. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Solvent Cement: ASTM D 2564.

1. 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).

2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 3 - EXECUTION

3.01 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 02300 "Earthwork."

3.02 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping at indicated slopes.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Install piping to allow application of insulation.
- I. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 15073 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- J. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- K. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- L. Install storm drainage piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 2 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.
- M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.
- N. Install aboveground PVC piping according to ASTM D 2665.
- O. Install underground PVC piping according to ASTM D 2321.

P. Install engineered drain specialties and storm drainage piping in locations indicated.

Q. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping. Comply with requirements for cleanouts specified in Section 15165 "Storm Drainage Piping Specialties."

2. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Section 15165 "Storm Drainage Piping Specialties."

R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 15092 "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 15092 "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 15097 "Escutcheons for Plumbing Piping."

3.03 JOINT CONSTRUCTION

A. Hubless, Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

B. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.04 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Section 15073 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 15061 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
 - 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 - 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 - 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 6. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 - 7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches of each fitting and coupling.
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 2. NPS 3: 60 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
 5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
 6. Spacing for 10-foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
 2. NPS 3: 48 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
 5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.
- I. Install supports for vertical PVC piping every 48 inches.
- J. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.
- K. Provide all piping hangers and supports with 2 coats of exterior-rated, corrosion resistant paint to match adjacent/surrounding color/finish. Coordinate exact color with architect

3.05 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
 - 1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
 - 2. Comply with requirements for cleanouts and drains specified in Section 15165 "Storm Drainage Piping Specialties."
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.06 IDENTIFICATION

- A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Section 15076 "Identification for Plumbing Piping and Equipment."

3.07 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Storm drainage piping shall be any of the following:
 - 1. Hubless, cast-iron soil pipe and fittings; CISPI, hubless-piping couplings; and coupled joints.
 - 2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints, where indicated on plans.

END OF SECTION

SECTION 22 1423

STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Roof drains.
2. Miscellaneous storm drainage piping specialties.
3. Cleanouts.
4. Backwater valves.

1.03 ACTION SUBMITTALS

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

1.04 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.01 ROOF DRAINS

A. Cast-Iron, Medium-Sump, General-Purpose Roof Drains:

1. Standard: ASME A112.6.4, for general-purpose roof drains.
2. Body Material: Cast iron.

3. Dimension of Body: 8- to 12-inch diameter.
4. Combination Flashing Ring and Gravel Stop: Not Required.
5. Flow-Control Weirs: Not Required.
6. Extension Collars: If required.
7. Underdeck Clamp: If required.
8. Dome Material: Not Required.
9. Perforated Gravel Guard: Stainless steel.
10. Vandal-Proof Dome: Required.
11. Water Dam: 2 inches high.

B. Metal, Medium-Sump, Deck Roof Drains:

1. Standard: ASME A112.6.4, for deck roof drains; ASME A112.6.3, for floor drains.
2. Body Material: Metal.
3. Flange: Anchor with weep holes.
4. Clamping Device: If required..
5. Grate Material: Cast iron.
6. Grate Finish: Painted.
7. Overall Dimension of Frame and Grate: Nominal 14 inches round or square.
8. Top-Loading Classification: Heavy Duty.
9. Vandal-Proof Frame and Grate: Required.

2.02 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Downspout Adaptors:

1. Description: Manufactured, gray-iron casting, for attaching to horizontal-outlet, parapet roof drain and to exterior, sheet metal downspout.
2. Size: Inlet size to match parapet drain outlet.

B. Downspout Boots:

1. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 outlet; and shop-applied bituminous coating.
2. Size: Inlet size to match downspout and NPS 4 outlet.

C. Conductor Nozzles:

1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
2. Size: Same as connected conductor.

2.03 CLEANOUTS

A. Floor Cleanouts:

1. Standard: ASME A112.36.2M, for cleanouts.
2. Size: Same as connected branch.
3. Body or Ferrule Material: Cast iron.
4. Frame and Cover Shape: Round.
5. Top-Loading Classification: Heavy Duty.
6. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

B. Wall Cleanouts:

1. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
2. Size: Same as connected drainage piping.

3. Body Material: Hubless, cast-iron soil-pipe test tee as required to match connected piping.
4. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
5. Wall Access: Round, cover plate with screw and wall-installation frame and cover.

C. Plastic Floor Cleanouts:

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

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
 1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
 2. Install expansion joints, if indicated, in roof drain outlets.
 3. Position roof drains for easy access and maintenance.
- B. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.
- C. Install downspout boots at grade with top 12 inches above grade. Secure to building wall.
- D. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

- E. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
 - 1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
 - 3. Locate cleanouts at minimum intervals of 50 feet.
 - 4. Locate cleanouts at base of each vertical soil and waste stack.
- F. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- G. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- H. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

3.02 CONNECTIONS

- A. Comply with requirements for piping specified in Section 15160 "Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.03 PROTECTION

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

END OF SECTION

SECTION 23 0000

MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide labor and materials required to install, test and place into operation the heating, ventilating, air conditioning, refrigeration, plumbing and fire protection systems as called for in the Contract Documents and according to applicable codes & regulations.
- B. Provide labor, materials and accessories required to provide complete operating mechanical systems as described or which may be reasonably implied as essential for a complete operating system.

1.02 QUALITY ASSURANCE

- A. Comply with current Hawaii governing codes, ordinances and regulations of the authority or authorities having jurisdiction over any part of the work and secure all necessary permits. Also Refer to Division 1.
- B. Where codes or standards are referenced, the applicable portions apply.
- C. Codes and standards are minimum requirements. Where requirements differ, apply the more stringent.
- D. Should any change in drawings or specifications be required to comply with governing regulations, notify the Owner's Representative prior to submitting bid.
- E. Execute work in strict accordance with the best practices of the trades in a thorough, substantial, skillful and well-executed manner by competent workers. Provide a competent, experienced full-time Superintendent who is authorized to make decisions on behalf of the Contractor.

1.03 ABBREVIATIONS AND DEFINITIONS

- A. Abbreviations:
 - 1. AABC: American Association of Balancing Contractors.
 - 2. AFBMA: Anti-Friction Bearing Manufacturers Association.
 - 3. AGA: American Gas Association.
 - 4. AMCA: Air Movement and Control Association.
 - 5. ANSI: American National Standards Institute.

6. ARI: A/C and Refrigeration Institute.
7. ASA: Acoustical Society of America.
8. ASHRAE: American Society of Heating, Refrigeration & A/C Engineers.
9. ASME: American Society of Mechanical Engineers.
10. ASTM: American Society for Testing and Materials.
11. AWWA: American Water Works Association.
12. CISPI: Cast Iron Soil Pipe Institute.
13. EPA: Environmental Protection Agency.
14. FM: Factory Mutual.
15. IEEE: Institute of Electrical and Electronic Engineers.
16. NEMA: National Electrical Manufacturers Association.
17. NFPA: National Fire Protection Association.
18. OSHA: Occupational Safety and Health Administration.
19. PDI: Plumbing and Drainage Institute.
20. SMACNA: Sheet Metal & A/C Contractors National Association.
21. U.L.: Underwriters Laboratories.
22. WCF: Water Conditioning Foundation.

B. Definitions:

1. Where it is stated in the specifications to submit to Owner or Owner's Representative for review, refer to the General and Supplementary Conditions, Division 1, for proper procedures.
2. "PROVIDE" means to "Furnish" and "Install".
3. "INSTALL" means to join, unite, fasten, link, attach, set up or otherwise connect together before testing and turning over to Owner, complete and ready for regular operation.
4. "FURNISH" means to supply all materials, labor, equipment, testing apparatus, controls, tests, accessories and all other items customarily required for the proper and complete application.
5. "AS DIRECTED" means as directed by the Owner or the Owner's Representative.

6. "CONCEALED" means embedded in masonry or other construction, installed behind wall furring or within double partitions, or installed within hung ceilings.
7. "SUBMIT" means submit to the Owner's Representative for review.

1.04 GUARANTEE

- A. Submit a single guarantee stating that the work is in accordance with Contract Documents. Guarantee work against faulty and improper material, fabrication, installation, start-up and commissioning for a period of one (1) year after a 30 day trouble free period from date of final acceptance by the Owner, except that where guarantees or warranties for longer terms are specified herein, the longer term shall apply. 30 day trouble free period applies to all work guarantees. Correct any deficiencies, which occur during the guarantee period, within 24 hours of notification, at no additional cost to the Owner, to the satisfaction of the Owner. Obtain similar guarantees from subcontractors, manufacturers, suppliers and sub-trade specialists.
- B. During construction the contractor is responsible to maintain all mechanical systems from start-up to the start of the Guarantee/Warranty service.
- C. Contractor shall attend a pre-maintenance meeting with UH FMO Mechanical prior to the start of the Warranty Service. Warranty service requires the contractor to check in and check out with UH FMO mechanical each month. Missed (or deficient) service shall result in the Guarantee/Warranty service period being extended; one month for each month missed.

1.05 USE OF THE ARCHITECTURAL AND ENGINEERING DRAWINGS

- A. The Contractor shall obtain, at the Contractor's expense, from the Owner's Representative, a set of AutoCAD or compatible format architectural and engineering drawings on electronic media where desired by the Owner and/or required by the Specifications for use in preparing the shop drawings, coordination drawings, and record drawings. The Contractor shall provide to the Owner Representative a written release of liability acceptable to the Owner Representative prior to receiving the electronic media files.

PART 2 - PRODUCTS

2.01 EQUIPMENT AND MATERIALS

- A. Provide products and materials that are new, clean, free of defects and free of damage and corrosion.
- B. Products and materials shall not contain asbestos, PCB's or any other material, which is considered hazardous by the Environmental Protection Agency, or any other authority having jurisdiction.
- C. Replace materials of less than specified quality and relocate work incorrectly installed as directed by the Owner's Representative.
- D. Statically and dynamically balance rotating equipment for minimum vibration and lowest operating noise level.

- E. Provide name/data plates on major components of equipment with manufacturer's name, model number, serial number, capacity data and electrical characteristics attached in a conspicuous place.
- F. Install materials and equipment with qualified trades people.
- G. Maintain uniformity of manufacture for equipment used in similar applications and sizes.
- H. Applicable equipment and materials to be listed by Underwriters Laboratories and manufactured in accordance with ASME, AWWA, or ANSI standards, and as approved by authorities having jurisdiction. The Energy using products shall be certified for use in State of Hawaii and meet Owner energy efficient standards.
- I. Fully lubricate equipment when installed.
- J. Do not operate air systems until ductwork is complete, temporary filters are in place and construction debris is removed. Provide one-inch thick fiberglass filter media across the face of each return air opening prior to start of each air system during temporary system operation and system clean-out.
- K. Do not operate water system until piping has been cleaned and startup strainers are in place.
- L. Install floor mounted equipment on a concrete pad. Concrete work shall be provided by another trade. Coordinate size and location with actual equipment used and accepted layout shop drawings.
- M. Secure equipment with bolts, washers and locknuts of ample size to support equipment. Embedded anchor bolts to have bottom plate and pipe sleeves. Grout machinery set in concrete under entire bearing surface. After grout has set, remove wedges, shims and jack bolts and fill space with grout.
- N. Locate valves, traps, damper operators, access doors, etc. to be easily accessible, either in mechanical spaces or through access panels specified. Obtain Owner's Representative's approval of access panel locations.
- O. Follow manufacturers' recommendations and instructions for installing, connecting, and adjusting equipment. Provide a copy of such instructions at the equipment during installation.
- P. Pressure vessels and relief valves shall be selected, built and labeled in accordance with ASME.
- Q. Equipment capabilities, etc., are scheduled or specified for job site operating conditions. Equipment sensitive to altitude shall be derated with the method of derating identified on shop drawings.

PART 3 - EXECUTION

3.01 FEES

- A. Pay all required fees and obtain required permits related to the mechanical installation.
- B. Pay royalties or fees in connection with the use of patented devices and systems.
- C. Provide controlled or witnessed inspection where required by authorities having jurisdiction or by these specifications.

3.02 SUBMITTALS AND REVIEWS

- A. Submit in accordance with SECTION 01300 – SUBMITTALS.
- B. Submit shop drawings, manufacturer's data, samples and test reports as specified. Refer to Section 01330 for additional requirements.
- C. Within two (2) months after notice to proceed by the Owner, or after execution of Owner Agreement, submit a complete list of all mechanical equipment manufacturers and material suppliers for the equipment proposed to be provided on this project as well as names of all third-tier subcontractors.
- D. Within three (3) months after notice to proceed by the Owner or Owner's Representative or after execution of Owner Agreement, prepare an index of all submittals for the project. Include a submittal identification number, a cross-reference to the Specification sections or Drawing number, and an item description. Prefix the submittal identification number by the Specification sections to which they apply. Indicate on each submittal, the submittal identification number in addition to the other data specified.
- E. Prior to submission of the Shop Drawings, Product Data and Samples to the Owner, the Contractor shall thoroughly review the Shop Drawings, Product Data and Samples and certify they are in compliance with the Contract Documents. The Contractor shall provide a compliance review ("Compliance Review") of the applicable Drawings, Specifications and Addenda for the equipment and materials where specified in the individual Specification sections. Refer to each Specification section for proposal requirements. The Compliance Review will be a paragraph-by-paragraph review of the Specifications with the following information marked for each Specification section paragraph or in the margin of the original Specification and any subsequent Addenda.
 - 1. "C": Comply with no exceptions.
 - 2. "D": Comply with minor deviations. For each and every deviation, provide a numbered footnote with reasons for the proposed deviation and how the intent of the Specification can be satisfied.
 - 3. "E": Exception. Equipment, product or material does not comply. For each and every exception, provide a numbered footnote with reasons for each exception and suggest possible alternatives for the Owner's consideration.

4. "N/A": The Specification paragraph does not apply to the proposed equipment, material or product.
 5. Unless a deviation or exception is specifically noted in the Compliance Review, it is assumed that the Contractor is in complete compliance with the Contract Documents. Deviations or exceptions taken in cover letters, subsidiary documents, by omission or by contradiction do not release the Subcontractor from being in complete compliance, unless the exception or deviation has been specifically noted (explicitly, not by implication) in the Compliance Review.
- F. Check all materials and equipment upon their arrival on the job site and verify their compliance with the Contract Documents. Modify any work, which proceeds prior to receiving accepted shop drawings as required to comply with the Contract Documents and the shop drawings.
 - G. Review of submittals is for general compliance with the design concept and Contract Documents. Comments or absence of comments does not relieve the Contractor from compliance with the Contract Documents. The Contractor remains solely responsible for details and accuracy, for confirming and correlating all quantities and dimensions, for selecting fabrication processes, for techniques of construction, for performing the work in a safe manner, and for coordinating the work with that of other trades.
 - H. No part of the work shall be ordered, procured, started in the shop or in the field until the shop drawings and samples for that portion of the work have been submitted, reviewed and returned.
 - I. Submissions will be stamped as follows:

Stamp	Interpretation
<p style="text-align: center;">PROVIDE AS SUBMITTED</p>	<p>Indicates that Owner's Representative takes no specific exception to the information contained in the submittal; Contractor may proceed with that portion of the Work described in the submittal -- subject to compliance with all applicable requirements of the Contract Documents</p>

Stamp	Interpretation
PROVIDE AS NOTED	Indicates that Owner's Representative reviews the submittal for general design conformance with the specific exceptions noted; Contractor may proceed with that portion of the Work provided that the notations made by Owner's Representative are incorporated in the work -- and subject to compliance with all applicable requirements of the Contract Documents
REVISE AND RESUBMIT	Indicates that Owner's Representative has noted nonconforming work on the submittal, and/or desires clarification on some aspects of the submittal; Contractor must make revisions and resubmit. Contractor may not proceed with the work described in the submittal
REJECTED	Indicates that Owner's Representative believes the submittal contains significant error or nonconformance and is, therefore, rejected. A new submittal is required. Contractor may not proceed with that portion of the Work described by the submittal.
NO ACTION REQUIRED	Indicates that Owner's Representative views submittal as informational only and no action is required before work can proceed.
SUBMITTAL NOT REQUIRED, RETURNED WITHOUT REVIEW	Indicates that Owner's Representative does not believe submittal is required by contract documents and therefore has returned submittal without review.

- J. Submit materials and equipment by manufacturer, trade name and model number. Include clear, legible copies of applicable brochure or catalog material. Maintenance and operating manuals are not suitable substitutes for shop drawings.
- K. Identify each sheet of printed submittal pages (using arrows, underlining or circling) to show applicable sizes, types, model numbers, ratings, capacities and options actually being proposed. Cross out non-applicable information. Note specified features such as voltages, motor efficiencies, special tank linings, pump seals, materials or paint finishes. Cross out all references to "options". Cross out statements such as "subject to change without notice" or "not for construction". Anything not specifically excluded is assumed to be included.
- L. Include dimensional data for roughing in and installation, technical data sufficient to verify that equipment meets requirements of the Contract Documents. Include wiring, piping and service connection data, motor sizes complete with voltage ratings and schedules.
- M. Maintain a complete set of the most current reviewed and stamped shop drawings and product data on site.
- N. Prepare and submit detailed shop drawings for ductwork, piping work and other distribution services in minimum 1/4 inch = 1 foot scale, including elevations and locations and sizes of openings in floor decks, walls and roofs.
- O. The work described in shop drawing and product data submittals shall be carefully checked by all trades for clearances (including those required for code compliance, maintenance and servicing), field conditions, maintenance of architectural conditions and proper coordination with other trades on the job. Each submitted shop drawing to include a certification that related field conditions and requirements have been checked and that conflicts do not exist.
- P. The Contractor is not relieved of the responsibility for dimensions or errors that may be contained on submissions or for deviations from requirements in the Contract Documents. The noting of some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the shop drawings, product data and samples, the Contract Documents govern the work and are neither waived nor superseded in any way by the review of shop drawings, product data and samples.
- Q. Inadequate or incomplete shop drawings, product data and/or samples will not be reviewed and will be returned to the Contractor for resubmittal.
- R. Indicate the following in the lower right hand corner of each shop drawing, and on the front cover of each product data brochure. The submittal identification number; title of the sheet or brochure; name and location of the Project; names of the Contractor's Representative, Contractor Subcontractor, Manufacturer, Supplier, and Vendor; the date of submittal; and the date of each correction, version and revision. Number all pages and drawings in product data brochures, test reports or submittals consecutively from beginning to end. Unless the above information is included, the submittal will be returned for resubmission. Resubmittals of shop drawings or product data or brochures shall include a cover letter summarizing the corrections made in response to the review comments.

3.03 COORDINATION OF WORK

- A. The Contract Documents established scope, materials and quality but are not detailed installation instructions. Drawings are diagrammatic.
- B. The Contract Documents show the general arrangement of equipment, ductwork, piping and accessories. Follow these drawings as closely as the actual construction and the work of other trades will permit. Provide offsets, fittings, and accessories, which may be required but not shown on the drawings. Investigate the site and review drawings of other trades to determine conditions affecting the work and provide such work and accessories as may be required to accommodate such conditions.
- C. Certain products will be provided by other trades. Examine the Contract Documents to ascertain the requirements for installation of these products.
- D. Carefully check space requirements with other trades to insure that material can be installed in the spaces allotted.
- E. Wherever work interconnects with work of other trades, coordinate with other trades to insure that they have the information necessary so that they may properly install the necessary connections and equipment. Identify items (valves, dampers, coils, etc.) requiring access in order that the ceiling and partition contractors can install access doors and panels in the correct locations.
- F. Consult with other trades regarding equipment so that, wherever possible, motors, motor controls, pumps and valves are of the same manufacturer.
- G. Furnish and set sleeves for passage of pipes, ducts and conduits through structural masonry and concrete walls, roofs and floors and elsewhere as will be required for the proper protection of each pipe and duct passing through building surfaces.
- H. Install firestopping around all pipes, conduits, etc. which pass through rated walls, partitions and floors in strict accordance with the manufacturers published approval listing and rating.
- I. Provide detailed information on openings and holes required in structural elements and precast panels or components for mechanical work.
- J. Provide required structural and engineering supports and hangers for ductwork, piping and equipment, designed so as not to exceed allowable loadings of structures.
- K. Examine and compare the Contract Drawings and Specifications with the drawings and specifications of other trades, report any discrepancies between them to the Owner's Representative and obtain written instructions for changes necessary in the work. Install and coordinate the work in cooperation with other related trades. Before installation, make proper provisions to avoid interferences.
- L. Wherever the work is of sufficient complexity, prepare additional detail drawings to scale to coordinate the work with the work of other trades. Detailed work shall be

clearly identified on the Drawings as to the area to which it applies. Submit these drawings to the Owner's Representative for review. At completion include a set of these drawings with each set of record drawings.

- M. Before commencing work, examine adjoining work on which this work is in any way dependent and report conditions, which prevent performance of the work. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.
- N. Adjust location of pipes, ducts, panels, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each pipe and duct prior to fabrication.
 - 1. Right-of-Way: Lines which pitch have right-of-way over those which do not pitch. For example: Condensate and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
 - 2. Provide offsets, transitions and changes in direction of pipes and ducts as required to maintain proper headroom and pitch on sloping lines. Provide traps, air vents, drains, etc., as required to effect these offsets, transitions and changes in direction.
- O. Install mechanical work to permit removal (without damage to other parts) of hydronic coils, heat exchanger, controls, fan shafts and wheels, smoke detectors, filters, belt guards, sheaves and drives, and any other parts requiring periodic replacement or maintenance. Arrange pipes, ducts, and equipment to permit access to valves, cocks, traps, starters, motors, and control components, and to clear the openings of swinging doors and access panels.
- P. Changes in the cross-sectional dimensions of ductwork are permissible when required to meet job conditions. Maintain at least the same equivalent cross-sectional duct area in accordance with the latest edition of the ASHRAE Guide. Secure the approval of the Owner's Representative prior to fabrication of ductwork requiring these changes.
- Q. Provide access panels in equipment, ducts, etc., as required for inspection and maintenance of concealed or internal equipment, dampers, plenums, smoke detectors, humidifiers, controls, etc.
- R. In cases of doubt as to the Work intended, or in the event of need for explanation thereof, request supplementary instructions from the Owner's Representative.

3.04 CONTRACTOR'S COORDINATION DRAWINGS

- A. The Contractor shall coordinate efforts of all trades and shall furnish (in writing, with copies to the Owner's Representative) any information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay.
- B. The Contractor shall prepare a complete set of construction Coordination Drawings for all trades indicating the equipment actually purchased and the exact routing for all lines such as piping, busway, conduit, ductwork, etc.,

including conduit embedded in concrete floors and walls. The Coordination Drawings shall be submitted complete to the Owner's Representative, within 90 days, or prior to the start of any work after notice to proceed is given and in compliance with the construction schedule for the project. The sheet metal drawings, at a scale of not less than 1/4 inch to 1 foot, shall serve as the base drawings to which Contractor shall add their work. Contractor shall draw the work of each trade on separate layers with different color assignments to facilitate coordination. The Contractor shall complete and submit the Coordination Drawing prior to the installation of the HVAC, plumbing, electrical and fire sprinkler work in the area covered by the specific drawing. The Contractor's work shall be installed according to the shop drawings and coordination drawings. If the Contractor allows one trade to install their work before coordination with the work of other trades, the Contractor shall make all necessary changes to correct the installation at no additional cost to the Owner.

1. Coordination drawings are required for the following systems at a minimum:

a. Ductwork:

1) Supply.

2) Return.

3) Exhaust.

b. Piping:

1) Sanitary.

2) Vent.

3) Storm water.

4) Overflow drain.

5) Domestic cold water.

6) Domestic hot water.

7) Propane.

8) Fire protection.

C. The Contractor's Coordination Drawings shall indicate structural loads at support points for all piping 6 inch and larger, racked piping, racked conduit and busway. Submit to Owner's Representative for review and approval. The elevation, location, support points, static, dynamic and expansion forces and loads imposed on the structure at support and anchor points shall be indicated. All beam penetrations and slab penetrations shall be indicated and sized and shall be coordinated. Work routed underground or embedded in concrete shall be indicated by dimension to column and building lines and shall be coordinated. Coordination Drawings shall document all required structural penetrations for initial construction. Penetrations shall be dimensioned for walls, floors and roofs.

These structural coordination requirements require review and approval by the Owner's Representative prior to completion and submittal of the drawings.

- D. This requirement for Coordination Drawings shall not be construed as authorization for the Contractor to make any unauthorized changes to the Contract Documents. Contract document space allocations shall be maintained such as ceiling height, designated clearance for future construction and flexibility, chase walls, equipment room size, unless prior written authorization is received from the Owner's Representative to change them.
- E. Prior to final acceptance of the Work the Contractor shall submit the Coordination Drawings as part of the Record Drawing submittal.

3.05 EXAMINATION OF SITE

- A. Evaluate existing conditions, which may affect methods or cost of performing the work, based on examination of the site or other information. Failure to examine the Drawings or other information does not relieve the Contractor of responsibility for satisfactory completion of the work.

3.06 EXCAVATION AND BACKFILL

- A. Provide excavation for the work. Excavate all material encountered, to the depths indicated on the Drawings or required. Remove from the site excavated materials not required or suitable for backfill. Provide grading as may be necessary to prevent surface water from flowing into trenches or other excavations. Remove any water, which accumulates. Provide sheeting and shoring as may be necessary for the protection of the work and for the safety of personnel.
- B. Provide trenches of widths necessary for the proper execution of the work. Grade bottom of the trenches accurately to provide uniform bearing and support the work on undisturbed soil at every point along its entire length. Except where rock is encountered, do not excavate below the depths indicated. Where rock excavations are required, excavate rock to a minimum overdepth of four inches below the trench depths indicated on the Drawings or required. Backfill overdepths in the rock excavation and unauthorized overdepths with loose, granular, moist earth, thoroughly machine tamped to a compaction level of at least 95 percent of standard proctor density or 75 percent relative density or as specified by the Owner's Representative. Whenever unstable soil that is incapable of properly supporting the work is encountered in the bottom of the trench, remove soil to a depth required and backfill the trench to the proper grade with coarse sand, fine gravel or other suitable material.
- C. Excavate trenches for utilities that will provide the required minimum depths of cover from existing grade or from indicated finished grade, whichever is lower, unless otherwise specifically shown.
- D. Trenches shall not be placed within ten feet of foundation or soil surfaces, which must resist horizontal forces.

3.07 PAINTING

- A. Where ductwork, piping or equipment is mounted on a painted finished surface, or a surface to be painted, paint to match the surface. Cold galvanize bare metal whenever support channels are cut.

3.08 CUTTING AND PATCHING

- A. Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided provide cutting and patching to accommodate penetrations at no additional cost to the Owner.
- B. All outlets, lights, diffusers, sprinkler escutcheons and other wall or ceiling penetrations in BSL-3 Suite needs to be sealed air tight to meet air pressurization requirements and to be rodent proof. Refer to Division 1 for additional requirements.

3.09 DELIVERY, DRAYAGE AND HAULING

- A. Include all drayage, hauling, hoisting, shoring and placement in the building of equipment specified and be responsible for the timely delivery and introduction of equipment to the project as required by the construction schedule. If any item of equipment is received prior to the time it is required, be responsible for its proper storage and protection until the time it is required. Pay for all costs of damage or storage.
- B. If equipment is not delivered or installed at the project site in a timely manner as required by the project construction schedule, the Contractor shall be responsible for disassembly, re-assembly, manufacturer's supervision, shoring, general construction modification, delays, overtime costs, etc. at no additional cost to the Owner.

3.10 EQUIPMENT AND MATERIAL PROTECTION

- A. Protect the work equipment and material of other trades from damage by work or workers of this trade, and correct damage caused without additional cost to the Owner.
- B. The Contractor shall be responsible for all work, materials and equipment until finally inspected, tested and accepted. Protect work against theft, injury or damage; and carefully store material and equipment received on site, which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of dust, dirt, water or other obstructing material. Cover and protect equipment and materials from damage due to water, moisture, humidity, paint, spray-on fireproofing, construction debris, etc. Store equipment subject to moisture damage, such as insulation or electrical components in dry heated spaces.
- C. Provide adequate means for fully protecting finished parts of the materials and equipment against damage from whatever cause during the progress of the work until final acceptance. Protect materials and equipment in storage and during construction in such a manner that no finished surfaces will be damaged or marred, and moving parts are kept clean and dry. Do not install damaged

items; take immediate steps to obtain replacement or repair. Replace all wet or damp insulation or acoustic lining.

- D. The Contractor shall follow manufacturer's recommendations to manually turn rotating equipment on a periodic basis, and other items as detailed by the manufacturer, to maintain equipment condition and warranty during storage period.

3.11 ELECTRICAL EQUIPMENT AND ELECTRICAL ROOM PRECAUTIONS

- A. Do not install piping, equipment or ductwork for heating, ventilation, air conditioning, plumbing or any piping systems not included as part of the electrical work, in the following rooms: switchgear, transformer, generator, elevator equipment, telephone, fire command, security, dimmer or electrical equipment rooms. Exception: where the HVAC system is directly servicing the affected electrical rooms.
- B. Do not install piping, equipment or ductwork above switchboards, disconnects, panelboards, dimmers, control panels, VFD's, motor control centers, individual motor controllers, electronics, etc or the code required service space for these electrical devices.

3.12 EQUIPMENT GUARDS

- A. Provide easily (without tools) removable expanded metal guards for all hot surfaces, belts, couplings, exposed fan inlets and outlets, and other moving parts of machinery. Provide tachometer openings in the guards at least 2 inches in diameter, for all belt-driven, gear-driven or variable speed machinery. Comply with OSHA requirements for all equipment guards.

3.13 LUBRICATION

- A. Provide means for lubricating all bearings and other machine parts. If a part requiring lubrication is concealed or inaccessible, extend a metallic lubrication tube with suitable fitting to an accessible location and identify it with permanent laminated plastic nameplates. Identify this location in the maintenance manual.
- B. After installation, properly lubricate all parts requiring lubrication and keep them adequately lubricated with a lubricant recommended by the equipment manufacturer until Owner acceptance.

3.14 DATE OF COMPLETION AND TESTING OF MECHANICAL SYSTEMS

- A. Comply with the project construction schedule for the date of final performance and acceptance testing, and complete work sufficiently in advance of the Contract completion date to permit the execution of the testing prior to occupancy and the Contract closeout. Complete any adjustments and/or alterations, which the final acceptance tests indicate as necessary for the proper functioning of all equipment prior to the completion date. See individual sections for extent of testing required.
- B. Provide a detailed schedule of completion indicating when each system is to be completed and outlining when tests will be performed. Submit completion

schedule for review within three (3) months after the notice to proceed by Owner or Owner's Representative has been given. Update this schedule periodically as the project progresses.

3.15 OPERATING INSTRUCTIONS AND OPERATOR TRAINING

- A. Provide the services of factory trained specialists to supervise the operation of all equipment and systems specified and train the Owner's operating and maintenance personnel for a ten (10) day operating/instruction period. Operating instruction time is defined as straight time working hours and not including nights, weekends or travel time to and from the project. Refer to individual sections for additional training and instruction by manufacturer's trained specialists.
- B. Notify the Owner in writing at least three (3) weeks before the operating/instruction period begins. Do not commence until the Owner has issued written acceptance of the starting time and schedule.
- C. In addition to the operating/instruction period, organize and conduct a seminar to instruct the Owner's personnel in the operation and general preventative maintenance of equipment and systems provided at the completion of the project.
- D. Instruct Owner's operating personnel in proper starting sequences, operation, shutdown, and maintenance procedures, including normal and emergency procedures.
- E. Make arrangements to give instructions by system and not by building areas.
- F. Provide services of qualified personnel, including each sub-trade, each major equipment supplier to attend seminar and instruct on respective equipment or systems. Seminar shall be conducted by the Contractor and may be video taped and attended by the Owner's Representative.
- G. Submit seminar agenda, schedule and list of representatives to the Owner for review thirty (30) days prior to seminar. Confirm attendance at seminar by written notification to participants.
- H. At seminar, submit final copies of record drawings and operating and maintenance manuals to Owner.
- I. Submit a written record of the seminar, complete with an attendance list to the Owner.

3.16 OPERATING AND MAINTENANCE MANUALS

- A. Provide operating instructions and maintenance manuals for all equipment and materials.
- B. Submit final copies of operating and maintenance data books for review at least ten (10) weeks before the completion date or as required by Owner. Provide 8½ inch x 11 inch, expanding spine catalog binders bound with identifying project name and Owner's name. Provide Adobe Acrobat PDF or equal electronic copy of the data book on CD-ROM or DVD media. Assemble data in a completely

indexed volume or volumes and identify the size, model, and features indicated for each item.

- C. Index the maintenance manual according to the following system:
1. Tab – 1.0 Mechanical Systems: Title page identifying project, Owner and Owner's Representatives with clear plastic protection cover.
 2. Tab – 1.1 List of HVAC, Plumbing and Fire Protection Drawings.
 3. Tab – 1.2 Description of Systems: Provide complete descriptions of the operating sequence for each system. Include detailed system description, with individual components described, and description of how components interface with others and to the complete system.
 4. Tab – 1.3 Operating Division: Provide information on locations of components, how to energize switches and controls, how components interface with other components, operation of controls including operational sequence, operational changes for cooling, heating or changeover, how to accomplish the changeover, complete troubleshooting sequence, and failure and safeguards to indicate if equipment goes off-line.
 5. Tab – 1.4 Maintenance and Lubrication Division: Provide general maintenance and lubrication schedule for major components and include daily, weekly, monthly, quarterly, semiannual and yearly checks and tasks. Explain how to execute maintenance tasks required for typical equipment such as bearings, drives, motors and filters. Compile this information for equipment separate from shop drawings.
 6. Tab – 1.5 List of Equipment Suppliers: Provide list of equipment suppliers, including street addresses, web site addresses, fax and toll-free telephone numbers.
 7. Tab – Certification (2.0, 2.1, etc.): Include copy of test data on degreasing and flushing of hydronic systems, analysis of system water taken at time system was put into operation, hydrostatic or air tests performed on piping systems, equipment alignment certifications, copy of balancing data for air and water systems, copy of valve and damper identification and pipe color code and inspection approval certificates from authorities having jurisdiction.
 8. Tab – Shop Drawings and Maintenance Bulletins (3.0, 3.1, 3.2, etc.): Provide material received in compliance with clause "Submittals and Reviews".
- D. The manual divider and tabs shall be laminated mylar plastic and colored as follows:
1. Mechanical Systems: 1.0 – 1.5, Orange.
 2. Certification: 2.0 – 2.4, Green.
 3. Shop Drawings & Maintenance: 3.0 – 3.17, Yellow.
- E. Plastic tabs with typewritten card insertions will not be accepted.

- F. Maintenance information shall include complete lubrication, cleaning, and servicing data compiled in clearly and easily understandable format. Show model and serial number of each piece of equipment, complete lists of replacement parts, capacity ratings, and actual loads.
- G. Provide the following equipment maintenance information where applicable:
 - 1. Identifying name and number.
 - 2. Locations (where several similar items are used, provide a list).
 - 3. Complete nameplate data.
 - 4. Parts list.
 - 5. Performance curves and data.
 - 6. Wiring diagrams.
 - 7. Lubrication charts.
 - 8. Manufacturers' recommended operating and maintenance instructions with all non-applicable information deleted.
 - 9. List of spare parts recommended for normal service requirements.
 - 10. Assembly and disassembly instructions with exploded view Drawings where necessary.
 - 11. Trouble shooting diagnostic instructions where applicable.

3.17 RECORD DRAWINGS

- A. The Contractor shall maintain on a daily basis at the Project site a complete set of Record Drawings. The Record Drawings shall initially consist of a set of blue line prints or AutoCAD files of the Contractor's Coordination Drawings. The prints shall be marked or the AutoCAD files electronically updated to show the precise location of all buried or concealed work and equipment, including embedded piping and valves, and all changes and deviations in the Mechanical work from that shown on the Contract Documents. This requirement shall not be construed as authorization for the Contractor to make changes in the layout or work without definite written instructions from the Owner's Representative. The updated Coordination Drawings shall be used to produce the final Record Drawings that shall be delivered to the Owner in AutoCAD electronic format media upon Project completion.
- B. Record dimensions clearly and accurately to delineate the work as installed. Suitably identify locations of all equipment by at least two dimensions to permanent structures.
- C. The Contractor shall mark all in-progress Record Drawings on the front lower right hand corner with a rubber stamp impression or an AutoCAD image similar to the following:

RECORD DRAWING
(3/8 inch high letters)

To be used for recording Field Deviations
and Dimensional Data Only

(5/16 inch high letters)

- D. Submit final record drawing on electronic AutoCAD format on CD-ROM.
- E. Upon completion of the work, the Contractor shall certify all Record Drawings on the front lower right hand corner adjacent to the above marking with a rubber stamp impression or an AutoCAD image similar to the following:

RECORD DRAWING
CERTIFIED CORRECT
(3/8 inch high letters)

(Printed Name of General Contractor)
(5/16 inch high letters)

Date:

(Printed Name of Subcontractor)
(5/16 inch high letters)

Date:

- F. Prior to final acceptance of the Work, the Contractor shall submit properly certified Record Drawings to the Owner's Representative for review and shall make changes, corrections, or additions as the Owner's Representative may require to the Record Drawings. After the Owner's Representative's review, and any required Owner revisions, the Record Drawings shall be delivered to the Owner on electronic

media in AutoCAD format. The Owner's Representative does not assume any responsibility for the accuracy or completeness of the Record Drawings.

3.18 CERTIFICATION

- A. Any certifications required by the Specifications, in addition to those required for shop drawings, product data, equipment and other items, are to be so certified in writing.

3.19 FINAL REVIEW

- A. At a time designated by the Owner, the entire system shall be reviewed for compliance with the Contract Drawings and Specifications. Be available at all times during this review.
- B. Demonstrate to the Owner and/or the Owner's Representative's personnel prior to the Final Review that systems and equipment have been properly balanced and adjusted and are in compliance with the requirements of the Contract Documents. After these demonstration tests are satisfactorily completed, but prior to the Final Review, submit a written certification that: 1) attests to the Contract Document compliance for this Project, and 2) certifies that the equipment and materials installed in this project contain no lead, asbestos or PCB. Prior to the final review the Contractor shall confirm the following items regarding the status of key elements of the work. Negative responses to any of the items indicate that the construction is not substantially complete, and the building is not ready for a final review. The Contractor shall confirm the following in writing:
 - 1. Building air systems (fans, air handling units, etc.) are completely installed, commissioned and operating.
 - 2. Building hydronic systems are completely installed, commissioned, operating and pressure tested.
 - 3. Building management system is installed, commissioned and operating.
 - 4. Building has normal electrical power.
 - 5. The emergency or stand-by power system has been started-up, commissioned, and is standing by.
 - 6. Building systems have been cleaned.
 - 7. Seismic restraints have been inspected as specified. Any required special inspections have been completed.
 - 8. Building systems have been balanced and copy of balance report submitted to the Owner's Representative.
 - 9. Building fire and life safety systems have been tested and accepted by the local authorities. Any required Special Inspections have been completed.
 - 10. All final wiring connections have been rechecked.
 - 11. All base building lighting systems are completely installed and operating.

12. The domestic cold water system has been installed, flushed, disinfected, tested and operating.
 13. The sanitary sewer, sanitary vent, storm sewer and overflow storm sewer systems are completely installed, operating, connected to the required city, public or private utilities and pressure tested.
 14. Propane system
 15. The fire protection systems are completely installed, operating, connected to the required city, public or private utilities and pressure tested.
 16. There is no deviations or non-compliance with the Contract Documents, or provide a detailed account of any and all deviations or non-compliance.
 17. All items on field review reports have been responded to in writing and are resolved to the satisfaction of the Owner.
 18. All outstanding items on submittals and shop drawings have been addressed in writing and are resolved to the satisfaction of the Owner.
 19. Schedule the final review only after providing written confirmation of all items above. Provide a minimum of ten (10) days notice.
- C. Operate the entire system properly with all systems balanced and all controls adjusted.
- D. Certificates and Documents required by the Contract shall be presented to the Owner's Representative at least two (2) weeks prior to the Final Review.
- E. After the Final Review, any changes or corrections noted as necessary for the work to comply with the Contract Documents shall be accomplished without delay in order to secure final acceptance of the work.

END OF SECTION

SECTION 23 0517

SLEEVES AND SLEEVE SEALS FOR PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes the following for Plumbing, HVAC and Fire Sprinkler piping:

1. Sleeves.
2. Sleeve-seal fittings.
3. Grout.

1.03 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.01 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.
- B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.02 SLEEVE-SEAL FITTINGS

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

2.03 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, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 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. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- C. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 07920 "Joint Sealants."
- D. 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 07841 "Through-Penetration Firestop Systems."

3.02 SLEEVE-SEAL-FITTING INSTALLATION

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

3.03 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves.
 - 2. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6: Sleeve-seal fittings.
 - 3. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.

END OF SECTION

SECTION 23 0518

ESCUTCHEONS FOR PLUMBING, HVAC AND FIRE PROTECTION PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

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

PART 2 - PRODUCTS

2.01 ESCUTCHEONS

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

2.02 FLOOR PLATES

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

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

- 1. Escutcheons for New Piping:

- a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

- 2. Escutcheons for Existing Piping:

- a. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
- b. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
- c. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated finish.
- d. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge.

- C. Install floor plates for piping penetrations of equipment-room floors.

- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

- 1. New Piping: One-piece, floor-plate type.

- 2. Existing Piping: Split-casting, floor-plate type.

3.02 FIELD QUALITY CONTROL

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

END OF SECTION

SECTION 23 0529

HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Pipe stands.
4. Equipment supports.

B. Related Sections:

1. Section 05500 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 15074 "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
3. Section 15124 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
4. Section 15815 "Metal Ducts" and Section 15816 "Nonmetal Ducts" for duct hangers and supports.

1.03 DEFINITIONS

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

1.04 PERFORMANCE REQUIREMENTS

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

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.05 ACTION SUBMITTALS

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

1.06 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:

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

- B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

- C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel stainless steel

2.02 TRAPEZE PIPE HANGERS

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

2.03 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece plastic stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 2. Base: Plastic, Stainless steel.
 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand:
 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 2. Bases: One or more; plastic.
 3. Vertical Members: Two or more protective-coated-steel channels.
 4. Horizontal Member: Protective-coated-steel channel.
 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

- F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.04 EQUIPMENT SUPPORTS

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

2.05 MISCELLANEOUS MATERIALS

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

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 07720 "Roof Accessories" for curbs.
- D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

- E. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- G. Install lateral bracing with pipe hangers and supports to prevent swaying.
- H. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- J. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- L. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

- a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.02 EQUIPMENT SUPPORTS

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

3.03 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.04 ADJUSTING

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

3.05 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in "Exterior Painting", "Interior Painting" and "High Performance Coatings" spec sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.
- D. Provide all piping hangers and supports in unconditioned areas/ exposed to the elements with 2 coats of exterior-rated, corrosion resistant paint to match adjacent/surrounding color/finish. Coordinate exact color with architect

3.06 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- D. Use carbon-steel pipe hangers and supports and attachments for general service applications.
- E. Use stainless-steel or corrosion-resistant attachments for hostile environment applications.

- F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 4. 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.
 - 5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8.
 - 6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 7. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 9. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
 - 10. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 - 11. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

- J. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

- K. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- L. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
- M. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

END OF SECTION

SECTION 23 0719

HVAC PIPING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping, indoors and outdoors.
2. Refrigerant suction and hot-gas piping, indoors and outdoors.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.07 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 15 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.08 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

2.02 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric 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 when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.03 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 4. Color: White.

2.04 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 3. Service Temperature Range: 0 to plus 180 deg F.
 4. Color: White.

2.05 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
 1. Materials shall be compatible with insulation materials, jackets, and substrates.

2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.06 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-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.07 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd.

2.08 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. Metal Jacket:
 1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - d. Factory-Fabricated Fitting Covers:

- 1) Same material, finish, and thickness as jacket.
- 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
- 3) Tee covers.
- 4) Flange and union covers.
- 5) End caps.
- 6) Beveled collars.
- 7) Valve covers.
- 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.09 TAPES

A. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

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

1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing seal or closed seal.

2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
 3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.

- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.04 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

3.05 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the

insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.07 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

3.08 FINISHES

- A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 9 painting Sections.
1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.09 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Drainage piping located in crawl spaces.

2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 3/4 inch thick.

B. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch thick.

3.11 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE.

A. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 2 inches thick.

3.12 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material for all insulation installed outdoors. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. Painted Aluminum, Corrugated or Stucco Embossed: 0.024 inch thick.

D. Piping, Exposed:

1. Painted Aluminum, Corrugated or Stucco Embossed with Z-Shaped Locking Seam: 0.040 inch thick.

END OF SECTION

SECTION 23 1123

FACILITY GAS PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Valves.

1.03 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Natural gas in specification refers to synthetic natural gas.

1.04 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
- B. Natural-Gas System Pressure within Buildings: 0.5 psig or less.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Piping specialties.
 - 2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
- B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
 - 1. Shop Drawing Scale: 1/4 inch per foot.

1.06 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
- B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.
- C. Qualification Data: For qualified professional engineer.
- D. Welding certificates.
- E. Field quality-control reports.

1.07 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

1.09 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of natural-gas service.
 - 2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.10 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 8 Section "Access Doors and Frames."

PART 2 PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.

3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
 5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
 6. Mechanical Couplings:
 - a. Stainless-steel flanges and tube with epoxy finish.
 - b. Buna-nitrile seals.
 - c. Stainless-steel bolts, washers, and nuts.
 - d. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - e. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.
- B. PE Pipe: ASTM D 2513, SDR 11.
1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
 2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 3. Anodeless Service-Line Risers: Factory fabricated and leak tested.

- a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
 - b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.
 - c. Aboveground Portion: PE transition fitting.
 - d. Outlet shall be threaded or flanged or suitable for welded connection.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
4. Transition Service-Line Risers: Factory fabricated and leak tested.
- a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
 - b. Outlet shall be threaded or flanged or suitable for welded connection.
 - c. Bridging sleeve over mechanical coupling.
 - d. Factory-connected anode.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
5. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.
- a. PE body with molded-in, stainless-steel support ring.
 - b. Buna-nitrile seals.
 - c. Acetal collets.
 - d. Electro-zinc-plated steel stiffener.

6. Plastic Mechanical Couplings, NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - a. Fiber-reinforced plastic body.
 - b. PE body tube.
 - c. Buna-nitrile seals.
 - d. Acetal collets.
 - e. Stainless-steel bolts, nuts, and washers.
7. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - a. Stainless-steel flanges and tube with epoxy finish.
 - b. Buna-nitrile seals.
 - c. Stainless-steel bolts, washers, and nuts.
 - d. Factory-installed anode for steel-body couplings installed underground.

2.02 PIPING 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.
5. Operating-Pressure Rating: 0.5 psig (3.45 kPa).
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches (1830 mm).

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
 2. Nitrile seals.
 3. Hand operated with automatic shutoff when disconnected.
 4. For indoor or outdoor applications.
 5. Adjustable, retractable restraining cable.
- 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.

2.03 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F (540 deg C) complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.04 MANUAL GAS SHUTOFF VALVES

- A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
1. CWP Rating: 125 psig.
 2. Threaded Ends: Comply with ASME B1.20.1.
 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig.
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Body: Bronze, complying with ASTM B 584.
2. Ball: Chrome-plated bronze.
3. Stem: Bronze; blowout proof.
4. Seats: Reinforced TFE; blowout proof.
5. Packing: Threaded-body packnut design with adjustable-stem packing.
6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. CWP Rating: 600 psig.
8. Listing: Valves NPS 1 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. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

4. Operator: Square head or lug type with tamperproof feature where indicated.
 5. Pressure Class: 125 psig (862 kPa).
 6. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 7. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- 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. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 6. Operator: Square head or lug type with tamperproof feature where indicated.
 7. Pressure Class: 125 psig.
 8. Listing: Valves NPS 1 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.
- F. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
1. Body: Cast iron, complying with ASTM A 126, Class B.
 2. Plug: Bronze or nickel-plated cast iron.
 3. Seat: Coated with thermoplastic.
 4. Stem Seal: Compatible with natural gas.

5. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 6. Operator: Square head or lug type with tamperproof feature where indicated.
 7. Pressure Class: 125 psig (862 kPa).
 8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- G. Valve Boxes:
1. Cast-iron, two-section box.
 2. Top section with cover with "GAS" lettering.
 3. Bottom section with base to fit over valve and barrel a minimum of 5 inches (125 mm) in diameter.
 4. Adjustable cast-iron extensions of length required for depth of bury.
 5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.05 EARTHQUAKE VALVES

- A. Earthquake Valves: Comply with ASCE 25.
1. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 2. Maximum Operating Pressure: 5 psig (34.5 kPa).
 3. Cast-aluminum body with nickel-plated chrome steel internal parts.
 4. Nitrile-rubber valve washer.
 5. Sight windows for visual indication of valve position.
 6. Threaded end connections complying with ASME B1.20.1.
 7. Wall mounting bracket with bubble level indicator.

- B. Earthquake Valves: Comply with ASCE 25.
 - 1. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 2. Maximum Operating Pressure: 7 psig.
 - 3. Cast-aluminum body with stainless-steel internal parts.
 - 4. Nitrile-rubber, reset-stem o-ring seal.
 - 5. Valve position, open or closed, indicator.
 - 6. Composition valve seat with clapper held by spring or magnet locking mechanism.
 - 7. Level indicator.
 - 8. End Connections: Threaded for valves NPS 2 (DN 50) and smaller; flanged for valves NPS 2-1/2 (DN 65) and larger.

2.06 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to NFPA 54 and the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

- C. Comply with NFPA 54 and the International Fuel Gas Code requirements for prevention of accidental ignition.

3.03 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.
 - 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Install underground, PE, natural-gas piping according to ASTM D 2774.
- D. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 - 3. Replace pipe having damaged PE coating with new pipe.
- E. Install fittings for changes in direction and branch connections.

3.04 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
 - 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 - 2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as

reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.

3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
 4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
 5. Prohibited Locations:
 - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- R. Connect branch piping from top or side of horizontal piping.
- S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- T. Do not use natural-gas piping as grounding electrode.
- U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- V. Install sleeves for piping penetrations of walls, ceilings, and floors.
- W. Install sleeve seals for piping penetrations of concrete walls and slabs.
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.05 SERVICE-METER ASSEMBLY INSTALLATION

- A. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.
- B. Install strainer on inlet of service-pressure regulator and meter set.

- C. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.
- D. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.
- E. Install service meters downstream from pressure regulators.
- F. Install metal bollards to protect meter assemblies. Comply with requirements in Division 5 Section "Metal Fabrications" for pipe bollards.

3.06 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install earthquake valves aboveground outside buildings according to listing.
- E. Install anode for metallic valves in underground PE piping.

3.07 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

- D. 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.

3.08 HANGER AND SUPPORT INSTALLATION

- A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- B. Comply with requirements for pipe hangers and supports specified in Division 15 Section "Hangers and Supports."
- C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 - 5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.09 CONNECTONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.10 LABELING AND IDENTIFYING

- A. Comply with requirements in specifications.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.11 PAINTING

- A. Comply with requirements in architectural spec sections for painting interior and exterior natural-gas piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel flat.
 - d. Color: As selected by architect.
- C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex flat.
 - d. Color: As selected by architect.
- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.12 FIELD QUALITY CONTROL

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

3.13 DEMONSTRATION

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

3.14 OUTDOOR PIPING SCHEDULE

- A. Underground natural-gas piping shall be one of the following:
 - 1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
 - 2. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
- B. Aboveground natural-gas piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
 - 3. Annealed-temper copper tube with wrought-copper fittings and brazed joints.
- C. Branch Piping in Cast-in-Place Concrete to Single Appliance: Annealed-temper copper tube with wrought-copper fittings and brazed joints. Install piping embedded in concrete with no joints in concrete.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.15 INDOOR PIPING SCHEDULE

- A. Aboveground, distribution piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
 2. Steel pipe with steel welding fittings and welded joints.
 3. Drawn-temper copper tube with wrought-copper fittings and brazed joints.
- B. Underground, below building, piping shall be one of the following:
1. Steel pipe with malleable-iron fittings and threaded joints.
 2. Steel pipe with wrought-steel fittings and welded joints.
- C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.
- D. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.16 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:
1. One-piece, bronze ball valve with bronze trim.
 2. Two-piece, full-port, bronze ball valves with bronze trim.
 3. Bronze plug valve.

END OF SECTION

SECTION 23 3400

HVAC FANS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes: For each product.
 - 1. Fans.

1.03 ACTION SUBMITTALS

- A. Product Data:
 - 1. Include rated capacities, furnished specialties, and accessories for each fan.
 - 2. Certified fan performance curves with system operating conditions indicated.
 - 3. Certified fan sound-power ratings.
 - 4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 5. Material thickness and finishes, including color charts.
 - 6. Dampers, including housings, linkages, and operators.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
- B. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fans to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. AMCA Compliance:
 1. Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.
 2. Operating Limits: Classify according to AMCA 99.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.02 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210/ASHRAE 51, "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating."

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install fans level and plumb.
- B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.
- D. Install units with clearances for service and maintenance.
- E. Label fans according to requirements specified.

3.02 CONNECTIONS

- A. Install ducts adjacent to fans to allow service and maintenance.
- B. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.

3.03 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Adjust belt tension.
 - 6. Adjust damper linkages for proper damper operation.

7. Verify lubrication for bearings and other moving parts.
 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 9. See Division 15 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.
 10. Remove and replace malfunctioning units and retest as specified above.
- D. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.
 - E. Prepare test and inspection reports.

3.04 DEMONSTRATION

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

END OF SECTION

SECTION 23 6413

AIR-COOLED REFRIGERANT CONDENSERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes packaged, air-cooled refrigerant condensers for outdoor installation. These serve the split system FCU.

1.03 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Air-cooled refrigerant condensers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.04 ACTION SUBMITTALS

- A. Product Data: For each air-cooled refrigerant condenser. Include rated capacities, operating characteristics, furnished specialties, and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.05 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For air-cooled refrigerant condensers, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-cooled refrigerant condensers to include in emergency, operation, and maintenance manuals.

1.07 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. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Standard for Refrigeration Systems."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.08 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in architectural and structural specs.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 07720 "Roof Accessories."
- C. Coordinate location of refrigerant piping and electrical rough-ins.

1.09 WARRANTY

- A. Manufacturer shall provide a "parts only" warranty for a period of 12 months from the date of equipment startup or 18 months from the date of shipment, whichever is less. A warranty of 5 years shall be provided on the compressor. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer's written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance and refrigerant.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. AAON.
2. McQuay International.
3. LG.
4. Hitachi
5. Carrier Corporation.
6. Trane.

2.02 SPLIT SYSTEM CONDENSING UNIT

A. Description: Factory assembled and tested; consisting of casing, condenser coils, condenser fans and motors, and unit controls.

B. Refrigerant: R-410A.

C. General Description.

1. Condensing unit shall include compressors, air-cooled condenser coils, condenser fans, suction and liquid connection valves, and unit controls.
2. Unit shall be factory assembled and tested including leak testing of the coil and run testing of the completed unit. Run test report shall be supplied with the unit in the controls compartment's literature pocket.
3. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
4. Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components.
5. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's access door.
6. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's access door.

D. Construction.

1. Unit shall be completely factory assembled, piped, wired and shipped in one section.
2. Unit shall be specifically designed for outdoor application.
3. Condenser coils shall be mechanically protected from physical damage by painted galvanized steel louvers (wire grille) covering the full area of the coil.
4. Access to condenser coils, condenser fans, compressors, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles.
5. Exterior paint finish shall be capable of withstanding at least 5,000 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
6. Unit shall include a forkliftable base.

E. Electrical.

1. Unit shall be provided with standard power block for connecting power to the unit.
2. Control circuit transformer and wiring shall provide 24 VAC control voltage from the line voltage provided to the unit.
3. Unit shall be provided with factory installed and factory wired 115V, 15 amp GFI outlet with outlet disconnect switch in the unit control panel.
4. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more that 10% out of balance on voltage, the voltage is more that 10% under design voltage, or on phase reversal.

F. Refrigeration System.

1. Compressor shall be scroll type with thermal overload protection.
2. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged access doors shall provide access to the compressors.

3. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
4. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides, and service valves for liquid and suction connections. Liquid line filter driers shall be factory provided. Finished field installed refrigerant circuits shall include the low side cooling components, refrigerant, thermal expansion valve, liquid line (insulated hot gas bypass line) (insulated hot gas line) and insulated suction line.
5. Unit shall include a factory holding charge of R-410A refrigerant and oil.
6. Each compressor shall be equipped with a 5 minute off, delay timer to prevent compressor short cycling.

G. Condensers.

1. Condenser fans shall be vertical discharge, axial flow, direct drive fans.
2. Fan motor shall be weather protected, single phase, direct drive, and open drip proof with inherent overload protection.
3. Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum (copper) fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
4. Coils shall be helium leak tested.

2.03 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate air-cooled refrigerant condensers according to ARI 460.
- B. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of air-cooled refrigerant condensers.

- B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.
- C. Examine walls, floors, and roofs for suitable conditions where air-cooled condensers will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.
- B. Equipment Mounting: Install air-cooled condenser refrigerant condensers on base(s) using elastomeric pads.
 - 1. Minimum Deflection: 1/4 inch.
- C. Maintain manufacturer's recommended clearances for service and maintenance.
- D. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.03 CONNECTIONS

- A. Piping installation requirements are specified in Section 15181 "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. 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 15183 "Refrigerant Piping."

3.04 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

- a. Inspect for physical damage to unit casing.
 - b. Verify that access doors move freely and are weathertight.
 - c. Clean units and inspect for construction debris.
 - d. Verify that all bolts and screws are tight.
 - e. Adjust vibration isolation and flexible connections.
 - f. Verify that controls are connected and operational.
2. Lubricate bearings on fan motors.
 3. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
 4. Adjust fan belts to proper alignment and tension.
 5. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.
 6. Measure and record airflow and air temperature rise over coils.
 7. Verify proper operation of capacity control device.
 8. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
 9. After startup and performance test, lubricate bearings.

3.05 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-cooled refrigerant condensers.

END OF SECTION

SECTION 23 8219

FAN-COIL UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes fan-coil units and accessories.

1.03 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Operation and maintenance manuals.

1.04 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.05 COORDINATION

- A. Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

PART 2 - PRODUCTS

2.01 FAN-COIL UNITS

- A. Available Manufacturers or approved equal:
 - 1. LG.
 - 2. Daikin.

3. Mitsubishi.

B. Description:

1. Unit components shall be labeled, including pipe stub outs, refrigeration system components, and electrical and controls components.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install fan-coil units level and plumb.
- B. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above finished floor.
- C. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

3.03 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 1. Install piping adjacent to machine to allow service and maintenance.
 2. Connect condensate drain to indirect waste.
 - a. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.

3.04 DEMONSTRATION

- A. Engage a factory-authorized service representative to train owner's maintenance personnel to adjust, operate and maintain fan-coil units.

END OF SECTION

SECTION 26 0500

REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. As specified in Section 010000.

1.02 SUMMARY

- A. The section applies to applicable Division 26, 27 and 28 sections.
- B. Furnish and install electrical wiring, systems, equipment, accessories, tests, adjustments, instructions and documentation in accordance with the specifications and drawings for a proper, complete, satisfactory and operable system.
- C. Include complete testing of all equipment and wiring at the completion of the work and making any minor connection changes or adjustments necessary for the proper functioning of the system and equipment. All systems shall be properly adjusted and in working order at time of final acceptance.
- D. All earthwork, painting, and grouting shall conform to the applicable requirements of the detailed equipment specifications as prescribed in appropriate sections.
- E. It is the intent of these Specifications and other Contract Documents to require an installation complete in every detail. Consequently, the Contractor is responsible for minor details or for any special construction which may be found necessary to properly finish, install, adjust, test, and place in successful and continuous operation of the entire electrical system.
- F. Capacities and ratings of motors, transformers, cables, switchboards, switchgear, panelboards, motor control centers, and other electrical items and arrangements shall be of sufficient capacity as shown on drawings, specifications and as required by the applicable National Electrical Code, codes and standards.
- G. The contractor shall be solely responsible for safety on the jobsite.
- H. The contractor shall furnish and install all equipment for temporary construction power as required.

1.03 RELATED WORK

- A. Telecommunication equipment and wiring.
- B. Fire Alarm System equipment and wiring.

- C. Security System equipment and wiring.
- D. Audio Visual System equipment and wiring.

1.04 RULES, REGULATIONS AND STANDARDS

- A. Comply with local ordinances and building department directives including the International Building Code, National Electrical Code, Uniform Fire Code, statutes and official requirements of the State of Hawaii.
- B. Apply and pay for electrical permit.
- C. Comply with serving utility agency rules and requirements, and pay for service charges levied by such agencies for work performed during the agencies' non-working hours and days.
- D. Applicable Documents: Relevant definitions and requirements to current versions of applicable ANSI, UL, NEMA, EEI, IEEE, NFPA, TIA/EIA, ADAAGS references.
- E. After completion of the work, the Contractor shall be furnished a certificate of final inspection and approval from the electrical inspection department of local authority having jurisdiction.

1.05 DRAWINGS AND SPECIFICATIONS

- A. Electrical drawings are illustrative and representational. Locations of outlets, devices, raceways, apparatus and other electrical items shown are approximate and shall be installed with the required maintenance and code clearances and to correct inconsistencies with existing conditions, other building systems and trades. Survey site and building conditions to verify lineal footages required and check scales and dimensions shown on construction drawings, verify locations, routing and lineal footages of electrical work required. Study existing civil, architectural, structural and mechanical conditions and install electrical system orderly and coordinated with existing site and building appurtenances.
- B. Refer to all project Drawings and to all Sections of the project Specification. Coordinate and fit all work accordingly so that all electrical outlets and equipment will be properly located and readily accessible. The Drawings indicate the relation of wiring and connections and must not be scaled for exact locations. Verify all construction dimensions at the project and make changes necessary to conform to the building as constructed. Work improperly installed due to lack of construction verification shall be corrected at the Contractor's expense.
- C. Provide additional components and wiring not shown or specified herein but are required for proper control and operation to provide for a complete and operable system within intent indicated on the drawings and specifications.
- D. Conduct site survey and thoroughly review drawings and specifications prior to bidding to provide necessary wiring, apparatus, devices and other equipment for a complete installation.

- E. Relocate devices, apparatus and associated wiring including raceways, from locations shown, for code compliance and to correct inconsistencies with existing conditions, structures, utilities and when directed before installation.
- F. Equipment ratings and wire sizes shall have adequate capacity to serve the required load and shall comply with the NEC.
- G. Verify voltages and other ratings of electrical utilization equipment prior to placing order with factory. Input voltages of equipment shall match serving utility or system voltage available.
- H. Where inconsistencies between the drawings, specifications, referenced codes, standards and requirements exist, the more rigorous requirement shall govern.
- I. Schedule work to avoid delays, interferences, and unnecessary work. If any conflicts occur necessitating departures from the Drawings and Specifications, details of departures and reason therefore shall be submitted immediately for consideration by the Contractor.

1.06 Warranty

- A. Installation complete in every detail as specified and ready for use. Any items supplied by Contractor developing defects of design, constructions, or quality within one (1) year of final acceptance by Owner shall be replaced by such new materials, apparatus or parts to make such defective portion of the complete system conform to the true intent of the Drawings and Specifications at no additional cost to the Owner.
- B. The warranty shall be countersigned by the General Contractor as applicable.

PART 2 PRODUCTS

2.01 GENERAL

- A. Equipment and material shall be new and those items listed, labeled or certified for the intended application by a recognized testing organization to meet Underwriters Laboratories, Inc., standards where test standards have been established and in accordance with the National Electrical Code.
- B. No products containing asbestos shall be used on this project.
- C. Where equipment and material are specified by catalog numbers and names that are of obsolescence, supersedure, or error in identification, the intent implied by the description, application, required performance and features noted shall govern.
- D. Brand names, manufacturer's names and catalog numbers indicate standard of design and quality required. Substitute materials may be used if pre-qualified prior to bidding by the Engineer.
- E. Electrical equipment shall be supplied through the manufacturer's designated representative by a local distributor.

- F. Equipment and materials shall be suitable for intended location and use and include all accessories for proper installation and operation.
- G. Where two or more similar type items are furnished, all shall be of the same manufacture, e.g., receptacle shall be the same manufacturer unless otherwise noted.
- H. Provide NEMA 3R or 4X housings, as indicated on drawings, where electrical apparatus is to be installed outdoors.
- I. Provide all hardware, supports, backing and other accessories necessary to install electrical equipment. Wood materials shall be treated against termite, iron or steel materials shall be galvanized for corrosion protection, and non-ferrous materials shall be brass or bronze. Provide stainless steel materials where indicated.
- J. Bolts, nuts, washers, and screws used for outside shall be high quality stainless steel or brass.
- K. Duct Seal: Pliable, non-toxic material used for application around conductors in raceway and in empty conduits to minimize moisture and rodent/insect infiltration. Must be re-enterable material allowing for removal/reapplication after initial installation. Non-drying, non-cracking, non-corrosive material that will not adversely affect raceway and conductors.

PART 3 EXECUTION

3.01 INSTALLATION

- A. General: Comply with manufacturers' instructions and directions pertaining to equipment, practices recommended by latest versions of the American Electricians Handbook, National Electrical Code, National Electrical Safety Code, National Fire Code, Institute of Electrical & Electronics Engineers, ANSI/Telecommunications Industry Association/Electronics Industries Association, Public Utilities Commission General Order No. 10 and the servicing utility agency requirements.
 - 1. Installation shall be appropriate for intended location and use and be complete and operable within intent indicated on the plans and specifications. Provide all accessories as required for proper installation and operation.
 - 2. For actual fabrication, installation and testing of the work use only certified, trained and experienced workmen familiar with items required and with manufacturers' recommended methods of installation. Rejection of installed work made due to the lack of skill shall be corrected.
 - 3. Factory trained technician shall perform work for electrical items where specifically recommended by the manufacturer.
- B. Delivery, Handling, and Storage

1. Deliver all materials of this Division in manufacturer's original unopened packages or containers with label intact and legible.
 2. Use means necessary to protect the materials of this section before, during, and after installation; to protect installed work; and to protect the original structure, work and materials of the Owner.
 3. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Owner and at no additional cost to the Owner.
- C. Cut and Patch: Trench, excavate, cut and core as required to install electrical systems.
1. Backfill, repair and patch walls, floors, ceilings and structure and pavement and replant/regrass as required to restore finished surfaces, grade and landscape to original condition. Paint exposed raceways and boxes to match surrounding finish.
 2. Seal all excess openings.
 3. Carefully chip concrete to avoid cutting structural steel. Repair any damage to rebars by welding.
- D. Equipment Connections: Unless indicated otherwise, provide wiring for all equipment furnished by other trades. Provide disconnect switches for all motorized equipment and water heaters. Install starters and controllers furnished by other trades. Wiring shown on any drawing is based on equipment rating. Verify with the owner or trade furnishing equipment and adjust wiring and associated protective device as required to accommodate actual size of equipment to be furnished. Trench, excavate, cut and core as required to install electrical systems.
1. Check and insure that proper polarity and phase rotation is provided for all outlets and equipment connections.
- E. Existing Conditions: Verify existing field conditions prior to bidding. Reroute existing electrical and signal/communication lines and relocate equipment as necessary to avoid conflict with new construction.
1. Verify and check traverse of new electrical, signal and telecommunication lines for possible conflicts with existing utilities and obstructions and new construction prior to installation of new lines.
 2. Repair any existing utility lines damaged during construction.
 3. Remove existing wiring and equipment no longer in use. Phase removal and new work as required to allow existing facilities to remain operational.
- F. Restrictions
1. Noisy construction operations which interfere with the usual existing procedures in adjacent areas shall be scheduled with the owner.

G. Adjustments and Settings

1. Adjust breaker trips and other equipment settings and controls per manufacturer's recommendations and as required unless otherwise directed.
 2. Balance feeder loading equally on each phase as closely as practicable. Rearrange feeder and branch circuit connections as necessary to balance loads.
- H. Neat appearances in the finished work will be required. Only experienced electrical workers shall be employed for the electrical installation.
- I. All work not installed and completed in accordance with the latest rules and regulations of OSHA and all local ordinances shall be removed and reinstalled correctly at the Contractor's expense.
- J. Install all electrical materials and equipment in accordance with manufacturer's recommendations for the seismic zone classification at the project site.
- K. The Electrical Contractor shall coordinate all electrical work to avoid conflicts with existing mechanical, structural, and architectural elements of this project.
- L. Verify that electrical system may be installed in strict accordance with the original design, the Drawings and Specifications and the manufacturer's recommendations.
- M. In the event of discrepancy, immediately notify the Architect. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.02 OUTAGES

- A. Schedule all work to minimize power outages. Outages will be permitted only after normal operating hours unless approved by the owner. Contractor shall request for outages in writing at least two weeks in advance. Contractor shall pay for charges for work required after normal operating hours and provide temporary power and wiring as necessary.

END OF SECTION

SECTION 26 0519

CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 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.

1.03 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.04 ACTION SUBMITTALS

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

1.05 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.06 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

2.01 CONDUCTORS AND CABLES

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

1. American Insulated Wire Corp.; a Leviton Company.
 2. General Cable Corporation.
 3. Senator Wire & Cable Company.
 4. Southwire Company.
- B. Aluminum and Copper Conductors: Comply with NEMA WC 70.
- C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN, XHHW and SO.
- D. Multiconductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC and Type SO with ground wire.

2.02 CONNECTORS AND SPLICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. AFC Cable Systems, Inc.
 2. Hubbell Power Systems, Inc.
 3. O-Z/Gedney; EGS Electrical Group LLC.
 4. 3M; Electrical Products Division.
 5. 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

3.01 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. 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.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW, single conductors in raceway.
- B. Interior Feeders: Type THHN-THWN, single conductors in raceway.

- C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW, single conductors in raceway.
- D. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway, Metal-clad cable, Type MC.
- F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- H. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- I. Class 2 Control Circuits: Type THHN-THWN, in raceway, Power-limited cable, concealed in building finishes.

3.03 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 Section 260529 "Hangers and Supports for Electrical Systems."
- F. Identify and color-code conductors and cables according to Section 260553 "Electrical Identification."
- G. Install MC cable only in the following locations:
 - 1. In accessible ceilings.
 - 2. Concealed in walls where cavity will be accessible from an accessible ceiling above after construction. Do not install under windows or other wall openings.
 - 3. Not to be used as homerun.

3.04 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.05 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260500 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.06 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07841 "Through-Penetration Firestop Systems."

3.07 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.
- 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

SECTION 26 0526

GROUNDING AND BONDING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes: Grounding systems and equipment.

1.03 ACTION SUBMITTALS

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

1.04 INFORMATIONAL SUBMITTALS

- A. Informational Submittals: Plans showing dimensioned of grounding features including the following where indicated on the plans:
 - 1. Ground rods.
 - 2. Grounding arrangements and connections for separately derived systems.
- B. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in Section - Operation and Maintenance Data, include the following:
 - 1. Instructions for periodic testing and inspection of grounding features based on NFPA 70B.
 - a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
 - b. Include recommended testing intervals.

1.06 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 UL 467 for grounding and bonding materials and equipment.

PART 2 PRODUCTS

2.01 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.02 CONNECTORS

- A. Listed and labeled by an NRTL 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, 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.
- D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.03 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 96 by 5/8 inches in diameter.

PART 3 EXECUTION

3.01 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
 - 1. Bury at least 24 inches below grade.
 - 2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.
- E. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Structural Steel: Welded connectors.

3.02 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.

- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Comply with the requirements of the serving utility.

3.03 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- E. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
 - 1. 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.
 - 2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.

3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.04 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. 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 bonding so vibration is not transmitted to rigidly mounted equipment.
 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- D. Grounding and Bonding for Piping:
 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

- E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- F. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.
- G. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
 - 1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
 - 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.05 LABELING

- A. Comply with requirements in Section 260553 - Electrical Identification for instruction signs. The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.
 - 1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.06 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- B. Grounding system will be considered defective if it does not pass tests and inspections.
 - C. Prepare test and inspection reports.
 - D. Report measured ground resistances that exceed the following values:
 1. Power and Lighting Equipment or System with Capacity of 1500 kVA and Less: 25 ohms.
 - E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 26 0529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.
- B. Related Sections include the following:
 - 1. Section 260548 - Vibration and Seismic Controls for Electrical Systems for products and installation requirements necessary for compliance with seismic criteria.

1.03 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.04 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.

1.05 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Equipment supports.

1.06 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

1.07 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section - Roof Accessories.

PART 2 PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.

- g. Wesanco, Inc.
 - 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 3. 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 hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
 - D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
 - E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
 - F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - (1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - (2) Empire Tool and Manufacturing Co., Inc.
 - (3) Hilti Inc.
 - (4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - (5) MKT Fastening, LLC.
 - 2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. Toggle Bolts: All-steel springhead type.
6. Hanger Rods: Threaded steel.

2.02 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 Section - Metal Fabrications for steel shapes and plates.

PART 3 EXECUTION

3.01 APPLICATION

- A. Support work in accordance with the best industry practice. Provide supports, hangers, auxiliary structural members and supplemental hardware required for support of the work.
- B. Provide supporting frames or racks extending from floor slab to ceiling slab for work indicated as being supported from walls where the walls are incapable of supporting the weight. In particular, provide such frames or racks in electric closets and mechanical equipment rooms.
- C. Provide supporting frames or racks for equipment which is to be installed in a freestanding position.
- D. Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members, rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workmanlike arrangement of all equipment mounted on them.
- E. Adequate support of equipment (including outlet, pull and junction boxes and fittings) shall not depend on electric conduits, raceways, or cables for support.
- F. Electrical equipment shall not rest on or depend for support on suspended ceiling media (tiles, lath, plaster, as well as splines, runners, bars and the like in the plane of the ceiling). Provide independent support of electrical equipment. Do not attach to supports provided for ductwork, piping or work of other trades.
- G. Provide required supports and hangers for conduit, equipment, etc., so that loading will not exceed allowable loadings of structure. Electrical equipment and supports shall not come in contact with work of other trades.

- H. Where weight applied to building attachment points exceeds 300 pounds, coordinate with and obtain the approval of Architect and conform to the following as a minimum:
 - 1. Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.
- I. For items, which are shown, as being ceiling-mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.
- J. 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.
- K. 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.
- L. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.
- M. 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.

3.02 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To 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. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
 6. To Light Steel: Sheet metal screws.
 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in 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.

3.04 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 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.

3.05 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Section - Exterior Painting and Section - Interior Painting 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

SECTION 26 0533

RACEWAYS AND BOXES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Metal conduits, tubing, and fittings.
 - 2. Nonmetal conduits, tubing, and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Surface raceways.
 - 5. Boxes, enclosures, and cabinets.
 - 6. Handholes and boxes for exterior underground cabling.

1.03 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. IMC: Intermediate metal conduit.

1.04 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. LEED Submittals:
 - 1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Shop Drawings: For custom enclosures and cabinets. Include scaled plans, elevations, sections, and attachment details.

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans for conduits 2-inches and larger, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
1. Structural members in paths of conduit groups with common supports.
 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- B. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.
- C. Source quality-control reports.

PART 2 PRODUCTS

2.01 METAL CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. AFC Cable Systems, Inc.
 2. Allied Tube & Conduit; a Tyco International Ltd. Co.
 3. Anamet Electrical, Inc.
 4. Electri-Flex Company.

5. O-Z/Gedney; a brand of EGS Electrical Group.
 6. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
 7. Republic Conduit.
 8. Robroy Industries.
 9. Southwire Company.
 10. Thomas & Betts Corporation.
 11. Western Tube and Conduit Corporation.
 12. Wheatland Tube Company; a division of John Maneely Company.
- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. ARC: Comply with ANSI C80.5 and UL 6A.
- E. IMC: Comply with ANSI C80.6 and UL 1242.
- F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
1. Comply with NEMA RN 1.
 2. Coating Thickness: 0.040 inch, minimum.
- G. EMT: Comply with ANSI C80.3 and UL 797.
- H. FMC: Comply with UL 1; zinc-coated steel or aluminum.
- I. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- J. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 2. Fittings for EMT:
 - a. Material: Steel or die cast.
 - b. Type: Setscrew or compression.
 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
 5. Provide insulated throat type connector and bushing fittings.
- K. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.02 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. AFC Cable Systems, Inc.
 2. Anamet Electrical, Inc.
 3. Arnco Corporation.
 4. CANTEX Inc.
 5. CertainTeed Corp.
 6. Condux International, Inc.
 7. Electri-Flex Company.
 8. Kraloy.
 9. Lamson & Sessions; Carlon Electrical Products.
 10. Niedax-Kleinhuis USA, Inc.
 11. RACO; a Hubbell company.
 12. Thomas & Betts Corporation.
- B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. RNC: Type EPC-40-PVC complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- D. LFNC: Comply with UL 1660.
- E. Rigid HDPE: Comply with UL 651A.
- F. RTRC: Comply with UL 1684A and NEMA TC 14.

- G. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- H. Fittings for LFNC: Comply with UL 514B.
- I. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- J. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.03 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman; a Pentair company.
 - 3. Mono-Systems, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1, Type 3R unless otherwise indicated, and sized according to NFPA 70.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Screw-cover type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.04 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Mono-Systems, Inc.
 - b. Panduit Corp.
 - c. Wiremold / Legrand.

2.05 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Adalet.
 2. Cooper Technologies Company; Cooper Crouse-Hinds.
 3. EGS/Appleton Electric.
 4. Erickson Electrical Equipment Company.
 5. FSR Inc.
 6. Hoffman; a Pentair company.
 7. Hubbell Incorporated; Killark Division.
 8. Kraloy.
 9. Milbank Manufacturing Co.
 10. Mono-Systems, Inc.
 11. O-Z/Gedney; a brand of EGS Electrical Group.
 12. RACO; a Hubbell Company.
 13. Robroy Industries.
 14. Spring City Electrical Manufacturing Company.
 15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
 16. Thomas & Betts Corporation.
 17. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Metal Floor Boxes:
 - 1. Material: Cast metal for slab on grade applications or sheet metal slab on deck applications.
 - 2. Type: Fully adjustable.
 - 3. Shape: Rectangular.
 - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- G. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.
 - 1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- J. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- K. Device Box Dimensions: 4-11/16 inches square by 2-1/8 inches deep.
- L. Gangable boxes are prohibited.
- M. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 or Type 3R stainless steel with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- N. Cabinets:

1. NEMA 250, Type 1 galvanized-steel box or Type 3R stainless steel with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.06 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. CDR Systems Corporation; Hubbell Power Systems.
 - d. NewBasis.
 - e. Oldcastle Precast, Inc.; Christy Concrete Products.
 - f. Synertech Moulded Products; a division of Oldcastle Precast, Inc.
2. Standard: Comply with SCTE 77.
3. Configuration: Designed for flush burial with closed bottom with sump hole unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

6. Cover Legend: Molded lettering.
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.07 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 1. Tests of materials shall be performed by an independent testing agency.
 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 EXECUTION

3.01 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 1. Exposed Conduit: GRC.
 2. Concealed Conduit, Aboveground: EMT.
 3. Underground Conduit: RNC, Type EPC-40-PVC direct buried or concrete encased.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R stainless steel.
- B. Indoors: Apply raceway products as specified below 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: GRC. Raceway locations include the following but are not limited to:
 - a. Loading dock.

- b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 - 6. Damp or Wet Locations: GRC.
 - 7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size: 1/2-inch for lighting, 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
- 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 - 2. EMT: Use setscrew or compression, steel or cast-metal fittings. Comply with NEMA FB 2.10.
 - 3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. Install surface raceways only where indicated on Drawings.

3.02 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- 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. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

- F. Install pull boxes such that no more than the equivalent of three 90-degree bends exist in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches of enclosures to which attached.
- I. 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. Secure raceways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange raceways to keep a minimum of 1 inch of concrete cover in all directions unless otherwise indicated.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 - 5. Change from RNC to EMT or GRC before rising above floor.
- J. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or GRC for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

- P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- R. 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. Cap underground raceways designated as spare above grade alongside raceways in use.
- S. Surface Raceways:
 - 1. Install surface raceway with a minimum 2-inch radius control at bend points.
 - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- T. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- U. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service raceway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- V. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- W. Expansion-Joint Fittings:
 - 1. Install in each run of aboveground GRC, and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
 - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

- a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
3. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- X. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations.
- Y. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- Z. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- AA. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- BB. Locate boxes so that cover or plate will not span different building finishes.
- CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

- EE. Set metal floor boxes level and flush with finished floor surface. Install carpet, tile or other flooring insert where floor box cover is capable of accepting an insert.
- FF. Do not install boxes back-to-back.

3.03 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
 - 1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 02300 "Earthwork" for pipe less than 6 inches in nominal diameter.
 - 2. Install backfill as specified in Section 02300 "Earthwork."
 - 3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 02300 "Earthwork."
 - 4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
 - 5. Underground Warning Tape: Comply with requirements in Section 260553 "Electrical Identification."

3.04 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

- E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.05 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260500 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.06 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 " Penetration Firestopping."

3.07 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 26 0544

SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 078413 – Penetration Firestopping for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.03 ACTION SUBMITTALS

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

PART 2 PRODUCTS

2.01 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.02 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products & Systems, Inc.
 - b. CALPICO, Inc.
 - c. Metraflex Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 - e. Proco Products, Inc.
 - 2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Carbon steel.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.03 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Presealed Systems.

2.04 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.05 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
 - 2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 EXECUTION

3.01 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.

- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section - Joint Sealants.
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.03 SLEEVE-SEAL-FITTING INSTALLATION

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

END OF SECTION

SECTION 26 0548

VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Isolation pads.
 - 2. Spring isolators.
 - 3. Restrained spring isolators.
 - 4. Channel support systems.
 - 5. Restraint cables.
 - 6. Hanger rod stiffeners.
 - 7. Anchorage bushings and washers.
- B. Related Sections include the following:
 - 1. Section 260529 - Hangers and Supports for Electrical Systems for commonly used electrical supports and installation requirements.

1.03 DEFINITIONS

- A. The IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.04 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 - 1. Site Class as Defined in the IBC: As indicated by Architectural and Structural documents.

2. Assigned Seismic Use Group or Building Category as Defined in the IBC: As indicated by Architectural and Structural documents.
 - a. Component Importance Factor: As indicated by Architectural and Structural documents.
 - b. Component Response Modification Factor: As indicated by Architectural and Structural documents.
 - c. Component Amplification Factor: As indicated by Architectural and Structural documents.

1.05 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- B. Comply with NFPA 70.

PART 2 PRODUCTS

2.01 VIBRATION ISOLATORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Ace Mountings Co., Inc.
 2. Amber/Booth Company, Inc.
 3. California Dynamics Corporation.
 4. Isolation Technology, Inc.
 5. Kinetics Noise Control.
 6. Mason Industries.
 7. Vibration Eliminator Co., Inc.
 8. Vibration Isolation.
 9. Vibration Mountings & Controls, Inc.
- B. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 1. Resilient Material: Oil- and water-resistant neoprene or rubber.
- C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.02 SEISMIC-RESTRAINT DEVICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Amber/Booth Company, Inc.
 2. California Dynamics Corporation.
 3. Cooper B-Line, Inc.; a division of Cooper Industries.

4. Hilti Inc.
 5. Loos & Co.; Seismic Earthquake Division.
 6. Mason Industries.
 7. TOLCO Incorporated; a brand of NIBCO INC.
 8. Unistrut; Tyco International, Ltd.
- B. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
 - C. Restraint Cables: ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
 - D. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Do not weld stiffeners to rods.
 - E. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.
 - F. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.
 - G. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
 - H. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
 - I. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.03 FACTORY FINISHES

- A. Finish: Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanized metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

3.03 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- B. Drilled-in Anchors:
 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

END OF SECTION

SECTION 26 0553

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 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.

1.03 ACTION SUBMITTALS

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

1.04 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.05 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.01 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 cable size.
- B. Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.
- C. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted, 3-mil- thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the cable diameter such that the clear shield overlaps the entire printed legend.

2.02 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.

2.03 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.
 4. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, 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.
 5. Overall Thickness: 8 mils.
 6. Foil Core Thickness: 0.35 mil.
 7. Weight: 34 lb/1000 sq. ft..
 8. 3-Inch Tensile According to ASTM D 882: 300 lbf, and 12,500 psi.
- B. Color and Printing:
1. Comply with ANSI Z535.1 through ANSI Z535.5.
 2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE,.
 3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE,.

2.04 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. 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."
 3. Arc flash warning per NFPA 70E.

2.05 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.

2.06 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.07 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
 1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
 3. Temperature Range: Minus 40 to plus 185 deg F.
 4. Color: Black except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
 1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
 3. Temperature Range: Minus 40 to plus 185 deg F.
 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
 1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
 3. UL 94 Flame Rating: 94V-0.
 4. Temperature Range: Minus 50 to plus 284 deg F.
 5. Color: Black.

2.08 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in 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

3.01 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape with adhesive appropriate to the location and substrate.
- G. System Identification Color-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.
- H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- I. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.
- J. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

3.02 IDENTIFICATION SCHEDULE

- A. 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.
- B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
 - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG.
 - b. Colors for 208/120-V Circuits:
 - (1) Phase A: Black.
 - (2) Phase B: Red.
 - (3) Phase C: Blue.
 - (4) Neutral: White.
 - (5) Ground: Green.
 - c. Colors for 480/277-V Circuits:
 - (1) Phase A: Brown.
 - (2) Phase B: Orange.
 - (3) Phase C: Yellow.
 - (4) Neutral: Grey.
 - (5) Ground: Green.
 - d. 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.
- C. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive, self-laminating polyester labels or self-adhesive vinyl labels with the conductor or cable designation, origin, and destination.
- D. Control-Circuit Conductor Termination Identification: For identification at terminations provide self-adhesive, self-laminating polyester labels or self-adhesive vinyl labels with the conductor designation.

- E. 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.

- F. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
 - 1. Install underground-line warning tape for both direct-buried cables and cables in raceway.

- G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
 - 1. Comply with 29 CFR 1910.145.
 - 2. Identify system voltage with black letters on an orange background.
 - 3. Apply to exterior of door, cover, or other access.
 - 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.

- H. 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.

- I. 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.

- J. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 - 1. Labeling Instructions:

- a. Indoor Equipment: Self-adhesive, 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.
2. Equipment to Be Labeled:
- a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Switchboards.
 - e. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - f. Emergency system boxes and enclosures.
 - g. Enclosed switches.
 - h. Enclosed circuit breakers.
 - i. Enclosed controllers.
 - j. Variable-speed controllers.
 - k. Push-button stations.
 - l. Power transfer equipment.
 - m. Contactors.
 - n. Remote-controlled switches, dimmer modules, and control devices.
 - o. Power-generating units.
 - p. Monitoring and control equipment.

END OF SECTION

SECTION 26 0923

LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Time switches.
 - 2. Indoor occupancy sensors.
 - 3. Lighting contactors.
- B. Related Requirements:
 - 1. Section 26 2726 "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
 - 1. Interconnection diagrams showing field-installed wiring.
 - 2. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

PART 2 PRODUCTS

2.01 TIME SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper Industries, Inc.
 - 2. Intermatic, Inc.
 - 3. Invensys Controls.
 - 4. Leviton Manufacturing Co., Inc.
 - 5. NSi Industries LLC; TORK Products.
 - 6. Tyco Electronics; ALR Brand.
- B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Contact Configuration: SPST.
 - 3. Contact Rating: 20-A ballast load, 120-/240-V ac.
 - 4. Programs: 8 channels; each channel is individually programmable with 40 on-off operations per week and an annual holiday schedule that overrides the weekly operation on holidays.
 - 5. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
 - 6. Astronomic Time: All channels.
 - 7. Automatic daylight savings time changeover.
 - 8. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

REMOVED SECTION FOR Electromechanical Time Switches

2.02 INDOOR OCCUPANCY SENSORS

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

2. Cooper Industries, Inc.
 3. Hubbell Building Automation, Inc.
 4. Leviton Manufacturing Co., Inc.
 5. Lightolier Controls.
 6. Lithonia Lighting; Acuity Brands Lighting, Inc.
 7. Lutron Electronics Co., Inc.
 8. NSi Industries LLC; TORK Products.
 9. RAB Lighting.
 10. Sensor Switch, Inc.
 11. Square D.
 12. Watt Stopper.
- B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
 4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 5. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 7. Bypass Switch: Override the "on" function in case of sensor failure.

8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.
- C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.
1. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in..
 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
 3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot- high ceiling.
- D. Ultrasonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.
1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch- high ceiling.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
 4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch- high ceiling.
 5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot- high ceiling in a corridor not wider than 14 feet.
- E. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.

2.03 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Bryant Electric.
 - 2. Cooper Industries, Inc.
 - 3. Hubbell Building Automation, Inc.
 - 4. Leviton Manufacturing Co., Inc.
 - 5. Lightolier Controls.
 - 6. Lithonia Lighting; Acuity Brands Lighting, Inc.
 - 7. Lutron Electronics Co., Inc.
 - 8. NSi Industries LLC; TORK Products.
 - 9. RAB Lighting.
 - 10. Sensor Switch, Inc.
 - 11. Square D.
 - 12. Watt Stopper.
- B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
 - 3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
- C. Wall-Switch Sensor:
 - 1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft.
 - 2. Sensing Technology: PIR.
 - 3. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."
 - 4. Voltage: Dual voltage, 120 and 277 V.

5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.04 LIGHTING CONTACTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Allen-Bradley/Rockwell Automation.
 2. ASCO Power Technologies, LP.
 3. Eaton Corporation.
 4. General Electric Company; GE Consumer & Industrial - Electrical Distribution; Total Lighting Control.
 5. Square D.
- B. Description: Electrically operated and mechanically held, combination-type lighting contactors with nonfused disconnect, complying with NEMA ICS 2 and UL 508.
 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 3. Enclosure: Comply with NEMA 250.
 4. Provide with control and pilot devices as indicated on Drawings , matching the NEMA type specified for the enclosure.

2.05 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Conductors and Cables."

- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Conductors and Cables."

PART 3 EXECUTION

3.01 SENSOR INSTALLATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.02 WIRING INSTALLATION

- A. Wiring Method: Comply with Section 260519 "Conductors and Cables." Minimum conduit size is 1/2 inch.
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.03 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Electrical Identification."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.04 FIELD QUALITY CONTROL

ONLY FOR GOVERNMENT PROJECTS

Manufacturer Rep only necessary for complex control systems

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Lighting control devices will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.05 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
 - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
 - 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
 - 3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.06 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 13847 "Addressable-Fixture Lighting Controls" and Section 13848 "Relay-Based Lighting Controls."
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION

SECTION 26 2210

LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
 - 1. Distribution transformers.
 - 2. Buck-boost transformers.

1.03 ACTION SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Section 260548 "Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Source quality-control test reports.

C. Field quality-control test reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.06 QUALITY ASSURANCE

A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

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

C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.07 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.08 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 PRODUCTS

2.01 MANUFACTURERS

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

1. Eaton Electrical Sector; Eaton Corporation; Cutler-Hammer Products.

2. General Electric Company.

3. Siemens Energy & Automation, Inc.

4. Square D Co./Groupe Schneider NA; Schneider Electric.
5. Jefferson Electric, Inc.

2.02 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
 1. Internal Coil Connections: Brazed or pressure type.
 2. Coil Material: Aluminum or Copper.

2.03 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Cores: One leg per phase.
- C. Enclosure: Ventilated, NEMA 250, Type 2.
 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- D. Transformer Enclosure Finish: Comply with NEMA 250.
 1. Finish Color: Gray.
- E. Taps for Transformers Smaller Than 3 kVA: None.
- F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.
- I. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 1. Complying with NEMA TP 1, Class 1 efficiency levels.
 2. Tested according to NEMA TP 2.
- J. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.

2. Indicate value of K-factor on transformer nameplate.
- K. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
 2. Include special terminal for grounding the shield.
 3. Shield Effectiveness:
 - a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
 - b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
 - c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.
- L. Wall Brackets: Manufacturer's standard brackets.
- M. Fungus Proofing: Permanent fungicidal treatment for coil and core.
- N. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.04 BUCK-BOOST TRANSFORMERS

- A. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall comply with NEMA ST 1 and shall be listed and labeled as complying with UL 506 or UL 1561.
- B. Enclosure: Ventilated, NEMA 250, Type 2.
1. Finish Color: Gray.

2.05 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Electrical Identification."

2.06 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
 - 1. Brace wall-mounting transformers as specified in Section 260548 "Seismic Controls for Electrical Systems."
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

3.03 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding."
- B. Connect wiring according to Section 260519 "Conductors and Cables."

3.04 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Remove and replace units that do not pass tests or inspections and retest as specified above.
- D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.05 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.06 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 26 2413

SWITCHBOARDS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 1. Service and distribution switchboards rated 600 V and less.
 2. Transient voltage suppression devices.
 3. Disconnecting and overcurrent protective devices.
 4. Instrumentation.
 5. Accessory components and features.
 6. Identification.

1.03 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.

2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail utility company's metering provisions with indication of approval by utility company.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.
9. Include schematic and wiring diagrams for power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Field Quality-Control Reports:
 1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.

1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type, but no fewer than one of each size and type.

1.08 QUALITY ASSURANCE

- A. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA PB 2.
- E. Comply with NFPA 70.

F. Comply with UL 891.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B. Remove loose packing and flammable materials from inside switchboards and connect factory-installed space heaters to temporary electrical service to prevent condensation.
- C. Handle and prepare switchboards for installation according to NECA 400.

1.10 PROJECT CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. Environmental Limitations:
 - 1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.
- C. Service Conditions: NEMA PB 2, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.
- D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without Owner's written permission.
 - 4. Comply with NFPA 70E.

1.11 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.12 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

2.01 MANUFACTURED UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of 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. Front-Connected, Front-Accessible Switchboards:
 - 1. Main Devices: Panel mounted.
 - 2. Branch Devices: Panel mounted.
 - 3. Sections front and rear aligned.
- C. Nominal System Voltage: 480Y/277 V.
- D. Main-Bus Continuous: As indicated on the drawings.
- E. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- F. Indoor Enclosures: Steel, NEMA 250, Type 1.

- G. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- H. Barriers: Between adjacent switchboard sections.
- I. Insulation and isolation for main and vertical buses of feeder sections.
- J. Utility Metering Compartment: Fabricated, barrier compartment and section complying with utility company's requirements; hinged sealed door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.
- K. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- L. Removable, Hinged Rear Doors and Compartment Covers: Secured by standard bolts, for access to rear interior of switchboard.
- M. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- N. Buses and Connections: Three phase, four wire unless otherwise indicated.
 - 1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity or tin-plated, high-strength, electrical-grade aluminum alloy.
 - 2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical or compression connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
 - 3. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical or compression connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
 - 4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 - 5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical or compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
 - 6. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
- O. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

- P. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

2.02 TRANSIENT VOLTAGE SUPPRESSION DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of 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. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, bolt-on, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:
1. Fuses, rated at 200-kA interrupting capacity.
 2. Fabrication using bolted compression lugs for internal wiring.
 3. Integral disconnect switch.
 4. Redundant suppression circuits.
 5. Redundant replaceable modules.
 6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 7. LED indicator lights for power and protection status.
 8. Audible alarm, with silencing switch, to indicate when protection has failed.
 9. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 10. Four-digit, transient-event counter set to totalize transient surges.
- C. Peak Single-Impulse Surge Current Rating: 120 kA per mode/240 kA per phase.
- D. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.

- E. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277-V, three-phase, four-wire circuits shall be as follows:
 - 1. Line to Neutral: 800 V for 480Y/277.
 - 2. Line to Ground: 800 V for 480Y/277.
 - 3. Neutral to Ground: 800 V for 480Y/277.
- F. Protection modes and UL 1449 SVR for 240/120-V, three-phase, four-wire circuits with high leg shall be as follows:
 - 1. Line to Neutral: 400 V, 800 V from high leg.
 - 2. Line to Ground: 400 V.
 - 3. Neutral to Ground: 400 V.
- G. Protection modes and UL 1449 SVR for 240-, 480-, or 600-V, three-phase, three-wire, delta circuits shall be as follows:
 - 1. Line to Line: 2000 V for 480 V.
 - 2. Line to Ground: 1500 V for 480 V.

2.03 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable 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. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

5. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
6. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical or Compression style, suitable for number, size, trip ratings, and conductor material.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 - f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
- B. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

2.04 INSTRUMENTATION

- A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
 1. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
 2. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.
- B. Multifunction Digital Meter: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
 1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Megawatts: Plus or minus 2 percent.
 - e. Megavars: Plus or minus 2 percent.

- f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
 - i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
 - j. Contact devices to operate remote impulse-totalizing demand meter.
- 2. Data Logging: Records and stores up 40 waveform events of up to one second each.
 - 3. Network Connectivity: Meter connects to web via building LAN or web gateway.
 - 4. Software: PC based, a product of meter manufacturer, suitable for collecting and organizing data gathered from the meter.
 - a. Real-time monitoring through a multi-user web portal
 - b. Trend graphing and aggregation
 - c. Power quality analysis and compliance monitoring.
 - d. Preconfigured and custom reporting
 - 5. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.05 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to NECA 400.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install switchboards and accessories according to NECA 400.
- B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to switchboards.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- D. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- F. Install filler plates in unused spaces of panel-mounted sections.
- G. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- H. Comply with NECA 1.

3.03 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Electrical Identification."

- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Electrical Identification."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Electrical Identification."

3.04 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each switchboard 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.
 - 3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Switchboard will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.05 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as indicated.

3.06 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION

SECTION 26 2416

PANELBOARDS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.03 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. TVSS: Transient voltage surge suppressor.

1.04 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.

3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
6. Include wiring diagrams for power, signal, and control wiring.
7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.

1.06 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Field Quality-Control Reports:
 1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- C. Panelboard Schedules: For installation in panelboards.

1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.08 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two spares for each type of panelboard cabinet lock.
 - 2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.
 - 3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.09 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NECA 407.

1.11 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 1. Ambient temperatures within limits specified.
 2. Altitude not exceeding 6600 feet.
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 1. Notify Owner no fewer than two days in advance of proposed interruption of electric service.
 2. Do not proceed with interruption of electric service without Owner's written permission.
 3. Comply with NFPA 70E.

1.12 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.13 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

2.01 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- B. Enclosures: Flush- and surface-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 stainless steel.
 - 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. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 - 5. Finishes:
 - a. Panels and Trim: Steel galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Same finish as panels and trim.
 - 6. Directory Card: Inside panelboard door, mounted in transparent card holder.
- C. Incoming Mains Location: Top and bottom.
- D. Phase, Neutral, and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 - 3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
- E. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.

2. Main and Neutral Lugs: Compression or Mechanical type.
 3. Ground Lugs and Bus-Configured Terminators: Compression or Mechanical type.
 4. Feed-Through Lugs: Compression or Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 5. Subfeed (Double) Lugs: Compression or Mechanical type type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 6. Gutter-Tap Lugs: Compression or Mechanical type type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and over-current protective devices.
- G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.02 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of 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, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Mains: Circuit breaker or Lugs only.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.03 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of 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: Circuit breaker or lugs only.
- 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.

2.04 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of 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. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 5. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 6. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Compression or Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 - f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - g. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
 - h. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
 - i. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.

2.05 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. 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

3.01 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NECA 407.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install panelboards and accessories according to NECA 407.
- B. Equipment Mounting: Install panelboards on concrete bases, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 03300 "Cast-in-Place Concrete."
 1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor bolts to elevations required for proper attachment to panelboards.
 3. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- D. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- E. Mount top of trim 90 inches above finished floor unless otherwise indicated.

- F. 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.
- G. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- H. Install filler plates in unused spaces.
- I. 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.
- J. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- K. Comply with NECA 1.

3.03 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Electrical Identification."
- B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Electrical Identification."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Electrical Identification."

3.04 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.

3.05 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as indicated.

END OF SECTION

SECTION 26 2653

ELECTRIC VEHICLE CHARGING EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes EV charging equipment that provides Level 2 EV charging.

1.03 DEFINITIONS

- A. EV: Electric vehicle.
- B. EV Cable: The off-board cable containing the conductor(s) to connect the EV power controller to the EV that provides both power and communications during energy transfer.
- C. EV Capable: Parking spaces that include nearby termination of raceway (conduit) to a power source with sufficient electrical panel capacity designed for simultaneous charging of electric vehicles in all planned EV parking spaces. Electrical wiring need not be pulled through raceway (conduit) until charging station is installed.
- D. EV Charger or EV Charging Equipment: See "EVSE".
- E. EV Connector: A conductive device that, when electrically coupled to an EV inlet, establishes an electrical connection to the EV for the purpose of power transfer and information exchange. This device is part of the EV coupler.
- F. EV Coupler: A mating EV inlet and connector set.
- G. EV Inlet: The device in the vehicle into which the EV connector is inserted, and a conductive connection is made for the transfer of power and communication. This device is part of the EV coupler.
- H. EV Make Ready: Parking spaces that include nearby termination of raceway (conduit) and electrical wiring pulled to a power source with sufficient electrical panel capacity for simultaneous charging of electric vehicles in all EV parking spaces.

- I. EVSE: Electric Vehicle Supply Equipment. It includes the EV charging equipment and conductors, including the ungrounded, grounded, and equipment grounding conductors and EV cables, attachment plugs, and all other fittings, devices, power outlets, or apparatus installed specifically for transferring energy between the premise wiring and the EV.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for EV charging equipment.
 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For EV charging equipment.
 1. Include plans, elevations, sections, and mounting details.
 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Detail fabrication and assembly of mounting assemblies for EV charging equipment.
 4. Include diagrams for power, signal, and control wiring.
 5. Include verification of wireless communications service at each location of EV charging equipment.
- C. Product Schedule: For EV charging equipment. Use same designations indicated on Drawings.

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Area plans and details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Structural members to which equipment will be attached.
 2. Electrical service.
 3. Communications service, including wireless communications equipment.
 4. Items penetrating finished floor.

- B. Seismic Qualification Certificates: For EV charging equipment, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.
- D. Sample Warranty: For manufacturer's warranty.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For EV charging equipment to include in operation and maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Online training and help documentation.
 - 2. Station activation sticker.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- C. Comply with UL 2231-1, UL 2231-2, UL 2594, and NEC Article 625.
- D. Comply with SAE J1772.
- E. Comply with FCC Part 15 Class A.

1.08 FIELD CONDITIONS

- A. Wireless Survey: Complete wireless survey to determine if wireless provider signals meet or exceed manufacturer's recommended minimum values.
- B. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not exceeding minus 22 to plus 122 deg F.
 - 2. Altitude: Not exceeding 6600 feet.

- C. Rate Equipment for non-operation under the following conditions:
 - 1. Ambient Temperature: Not exceeding minus 40 to plus 140 deg F.
 - 2. Altitude: Not exceeding 6600 feet.
- D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Construction Manager no fewer than two days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without Construction Manager's written permission.

1.09 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components of EV charging units that fail(s) in materials or workmanship within specified warranty period.
 - 1. Standard Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. ChargePoint CT4000 family of electric vehicle charging stations
 - 2. Approved equal.
- B. Source Limitations: Obtain EV charging equipment from single manufacturer.

2.02 EV CHARGING EQUIPMENT DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Comply with NFPA 70.
- C. ADA compliant.
- D. Metering: +/- 2 percent from 2 percent to full scale of output (30 A).
- E. EV Charging Equipment Mounting: Bollard mount.

F. Enclosures:

1. Rated for environmental conditions at installed location.
 - a. Indoor Locations: NEMA 250, Type 3R.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Aluminum and UV-resistant plastic.
 - d. Paint and Anodized.
 - e. Charging components protected by security screws.
 - f. Charging connectors in locking holsters.
 - g. Meter, modem, and CPU, tamper resistant.

G. EV Cable and Connectors:

1. SAE J1772 connector.
2. One or Two connectors with locking holster.
3. 18-foot cable with cable management system.

H. Status Indicators:

1. LEDs to indicate power, vehicle charging, charging complete, system status, faults, and service, as well as authorization.

I. Display Screen:

1. VGA-resolution, daylight-viewable LCD screen with UV protection. Daylight readable and fingerprint resistant.
2. Displays power, charging, charging complete, remote control, system status, faults, payment and pricing details, and service.

J. Networking:

1. LAN Communications: 2.4 GHz Wi-Fi 802.11b/g/n.
2. Capable of remote configuration, diagnostics and reporting.
3. Capable of remote software updates (future proof).

K. Payment System:

1. RFID (ISO 15693, ISO 14443), NFC, Contactless credit card reader.
2. PCI (Payment Card Industry) compliant.

3. Capable of remote control and authorization including mobile phone application or toll free phone number.
- L. Charging Network: Compatible with the Vendor's EV charging network.
1. Multiple units shall independently connect to charging network.
 2. Multiple units shall have one unit designated as a master unit that is configured as a gateway unit between the EV charging equipment and the charging network.
 3. Individual units shall be capable of indicating station status and availability providing or connecting user to customer support and remote control.

2.03 PERFORMANCE REQUIREMENTS

- A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
- B. Surge Withstand: 6 kV at 3000 A.
- C. Integral GFCI.
- D. Auto-GFCI fault retry.
- E. Input Power:
1. 40 A or two 40 A, 208/240-V ac, 60 Hz, single phase per charger.
 2. Dual circuits do not need to be interlocked.
- F. EV Charging Levels:
1. Single vehicle: AC Level 2 at up to 7.2 kW.
 2. Dual vehicles, AC Level 2 at up to 7.2 kW.
 3. Multiple vehicles simultaneously charging at a site using Automatic Power Load Management may be charged up to 7.2 kW per vehicle.

2.04 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for EV charging equipment electrical conduit to verify actual locations of conduit connections before equipment installation.
- C. Examine walls, floors, and pavement for suitable conditions where EV charging equipment will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Comply with NECA 1 and NECA 413.
- B. Concrete Base Mounting:
 - 1. Install EV charging equipment on 6-inch nominal-thickness concrete base. Base should be 24-inch diameter or square (minimum 12-inch from the center located conduit stub-up). Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete".
 - a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - d. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - e. Secure EV charging equipment to concrete base according to manufacturer's written instructions.
- C. Bollard Mounting:
 - 1. Allow a minimum of 24 inches of clearance around EV charging equipment.
 - 2. EV charging equipment receptacles or holders shall be not less than 24 inches and not more than 4 feet above finished grade.
 - 3. Mount EV charging equipment plumb and rigid without distortion of enclosure.

4. Secure EV charging equipment according to manufacturer's written instructions.
- D. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- E. Wiring Method: Install cables in raceways and cable trays. Conceal raceway and cables except in unfinished spaces.
 1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes."
- F. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- G. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- H. Circuit Breakers: Comply with Section 262816 "Enclosed Switches and Circuit Breakers."
- I. Secure covers to enclosure.

3.03 CONNECTIONS

- A. Connect wiring according to Section 260519 "Conductors and Cables."
- B. Comply with grounding requirements in Section 260526 "Grounding and Bonding."
- C. Comply with requirements for installation of conduit in Section 260533 "Raceways and Boxes." Drawings indicate general arrangement of conduit, fittings, and specialties.
- D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

3.04 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Electrical Identification."

3.05 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:

1. For each unit of EV charging equipment, perform the following tests and inspections:
 - a. Unit self-test.
 - b. Operation test with load bank.
 - c. Operation test with EV.
 - d. Network communications test.
- C. EV charging equipment will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.06 STARTUP SERVICE

- A. Perform startup service.
 1. Complete installation and startup checks according to manufacturer's written instructions.

3.07 ONGOING MANAGEMENT SERVICES

- A. Engage a station manufacturer that offers a service to manage the administration and policies of the electric vehicle charging stations on an ongoing basis.

3.08 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for the duration of an active ChargePoint Network Service Plan.
- B. Upgrade Service: At Substantial Completion, remotely update software to latest version. Install and program software upgrades that become available while an active ChargePoint Network Service Plan is maintained. Upgrading software shall include operating system and new or revised licenses for using software.

3.09 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain EV charging equipment.

END OF SECTION

SECTION 26 2713

ELECTRICITY METERING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

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

1.03 DEFINITIONS

- A. KY Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay opening and closing in response to the rotation of the disk in the meter.
- B. PC: Personal computer.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For electricity-metering equipment.
 - 1. Dimensioned plans and sections or elevation layouts.
 - 2. Wiring Diagrams: For power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.

1.05 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data. In addition to items specified in Section 01782 "Operation and Maintenance Data," include the following:
 - 1. Application and operating software documentation.
 - 2. Software licenses.

3. Software service agreement.
4. Hard copies of manufacturer's operating specifications, design user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy Submittal.

1.07 QUALITY ASSURANCE

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

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Receive, store, and handle modular meter center according to NECA 400.

1.09 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
 2. Do not proceed with interruption of electrical service without Owner's written permission.

1.10 COORDINATION

- A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:
 1. Comply with requirements of utilities providing electrical power services.
 2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

1.11 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade his computer equipment if necessary.

PART 2 PRODUCTS

2.01 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

- A. Meters will be furnished by utility company.
- B. Meter Sockets: Comply with requirements of electrical-power utility company.
- C. 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 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 1 enclosure.
 - 4. Minimum Short-Circuit Rating: 65,000 A symmetrical at rated voltage.
 - 5. Main Disconnect Device: Circuit breaker, series-combination rated for use with downstream feeder and branch circuit breakers.
 - 6. Tenant Feeder Circuit Breakers: Series-combination-rated molded-case units, rated to protect circuit breakers in downstream tenant and to house loadcenters and panelboards that have 65,000-A interrupting capacity.
 - a. Identification: Complying with requirements in Section 260553 "Electrical Identification" with legend identifying tenant's address.
 - b. Physical Protection: Tamper resistant, with hasp for padlock.
 - 7. Meter Socket: Rating coordinated with indicated tenant feeder circuit rating.

2.02 EQUIPMENT FOR ELECTRICITY METERING BY OWNER

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. E-Mon; a division of Hunt Power.

2. National Meter Industries.
 3. Osaki Meter Sales, Inc.
 4. Square D; a brand of Schneider Electric.
- B. General Requirements for Owner's Meters:
1. Comply with UL 1244.
 2. Meters used for billing shall have an accuracy of 0.2 percent of reading, complying with requirements in ANSI C12.20.
 3. Meters shall be certified by Title 4, California Code of Regulations, Article 2.2.
 4. Enclosure: Integrated into distribution panelboards.
 5. Identification: Comply with requirements in Section 16075 "Electrical Identification."
 6. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
 7. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.
 - a. Type: Split and solid core.
 8. Building Automation System (BAS) Interface: One digital KY pulse to a user-definable increment of energy measurement. Match signal to BAS input and arrange to convey the instantaneous, integrated, demand level measured by meter to provide data for processing and possible programmed demand control action by destination system.
- C. Kilowatt-hour Meter: Electronic single-phase meters, measuring electricity used.
1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
 2. Display: LCD with characters not less than 0.25 inch high, indicating accumulative kilowatt-hours and current kilowatt load. Retain accumulated kilowatt-hour in a nonvolatile memory, until reset.
 3. Display: Digital electromechanical counter, indicating accumulative kilowatt-hours.
- D. Data Transmission Cable: Transmit KY pulse data over Class 1 control-circuit conductors in raceway.

- E. Software: PC based, a product of meter manufacturer, suitable for calculation of utility cost allocation and billing.
 - 1. Utility Cost Allocation: Automatically import energy-usage records to allocate energy costs for the following: each tenant apartment.
 - 2. Tenant or Activity Billing Software: Automatically import energy-usage records to automatically compute and prepare tenant bills based on metering of energy use. Maintain separate directory for each tenant's historical billing information. Prepare summary reports in user-defined formats and time intervals.

PART 3 EXECUTION

3.01 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.

3.02 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 260553 "Electrical Identification."
 - 1. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.
 - 2. 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.

3.03 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.

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

END OF SECTION

SECTION 26 2726

WIRING DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Twist-locking receptacles.
 - 3. Weather-resistant receptacles.
 - 4. Snap switches and wall-box dimmers.
 - 5. Wall-switch and exterior occupancy sensors.
 - 6. Communications outlets.
 - 7. Pendant cord-connector devices.
 - 8. Cord and plug sets.
 - 9. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

1.03 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.06 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.07 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.01 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; Division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand (Pass & Seymour).

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.02 GENERAL WIRING-DEVICE REQUIREMENTS

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

B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with the requirements in this Section.

2.03 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 5351 (single), CR5362 (duplex).
 - b. Hubbell; HBL5351 (single), HBL5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
 - d. Pass & Seymour; 5361 (single), 5362 (duplex).

B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; IG5362RN.
 - b. Hubbell; IG5362.
 - c. Leviton; 5362-IG.
 - d. Pass & Seymour; IG5362.
2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.04 GFCI RECEPTACLES

A. General Description:

1. Straight blade, feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; VGF20.
 - b. Hubbell; GFR5352L.
 - c. Pass & Seymour; 2095.
 - d. Leviton; 7590.

C. Isolated-Ground, Duplex Convenience Receptacles:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; IG5362BLS.
 - b. Hubbell; IG5362SA.
 - c. Leviton; 5380-IG.
 - d. Pass & Seymour; IG5362BLSP.
2. Description:
 - a. Straight blade, 125 V, 20 A; NEMA WD 6 Configuration 5-20R.
 - b. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.05 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; CWL520R.
 - b. Hubbell; HBL2310.
 - c. Leviton; 2310.
 - d. Pass & Seymour; L520-R.

2.06 PENDANT CORD-CONNECTOR DEVICES

A. Description:

1. Matching, locking-type plug and receptacle body connector.
2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.07 CORD AND PLUG SETS

A. Description:

1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.08 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Single Pole:
 - b. Cooper; AH1221.
 - c. Hubbell; HBL1221.
 - d. Leviton; 1221-2.
 - e. Pass & Seymour; CSB20AC1.
 - f. Two Pole:
 - g. Cooper; AH1222.

- h. Hubbell; HBL1222.
- i. Leviton; 1222-2.
- j. Pass & Seymour; CSB20AC2.
- k. Three Way:
- l. Cooper; AH1223.
- m. Hubbell; HBL1223.
- n. Leviton; 1223-2.
- o. Pass & Seymour; CSB20AC3.
- p. Four Way:
- q. Cooper; AH1224.
- r. Hubbell; HBL1224.
- s. Leviton; 1224-2.
- t. Pass & Seymour; CSB20AC4.

C. Pilot-Light Switches, 20 A:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; AH1221PL for 120 and 277 V.
 - b. Hubbell; HBL1201PL for 120 and 277 V.
 - c. Leviton; 1221-LH1.
 - d. Pass & Seymour; PS20AC1RPL for 120 V, PS20AC1RPL7 for 277 V.
2. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."

D. Key-Operated Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; AH1221L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.

d. Pass & Seymour; PS20AC1-L.

2. Description: Single pole, with factory-supplied key in lieu of switch handle.

2.09 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. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
 - 1. 600 W; dimmers shall require no derating when ganged with other devices.
- D. 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.

2.10 WALL PLATES

- A. Single and combination types shall 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, Type 302 stainless steel or 0.05-inch- thick, anodized aluminum.
 - 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 and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.11 FLOOR SERVICE FITTINGS

- A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: Round, solid brass with satin finish.
- D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
- E. Voice and Data Communication Outlet: Blank cover with bushed cable opening.

2.12 PREFABRICATED MULTIOUTLET ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Hubbell Incorporated; Wiring Device-Kellems.
 - 2. Wiremold/Legrand.
- B. Description:
 - 1. Two-piece surface metal raceway, with factory-wired multioutlet harness.
 - 2. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- C. Raceway Material: Metal, with manufacturer's standard finish or as indicated.
- D. Multioutlet Harness:
 - 1. Receptacles: 15-A, 125-V, NEMA WD 6 Configuration 5-15R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
 - 2. Receptacle Spacing: 12 inches.
 - 3. Wiring: No. 12 AWG solid, Type THHN copper, circuits as indicated.

2.13 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to Emergency Power System: Red.
 - 3. Isolated-Ground Receptacles: As specified above, with orange triangle on face.
- B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:

1. Protect installed devices and their boxes. 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 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 right 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 devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.

6. Use a torque screwdriver when a torque is recommended or required by 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.
 2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.
- 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.
- I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.02 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.03 IDENTIFICATION

- A. Comply with Section 260553 "Electrical Identification."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.04 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test Instruments: Use instruments that comply with UL 1436.
 - 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display 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 unacceptable.
 - 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. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- C. Where installed test straight-blade convenience outlets in patient-care areas and hospital-grade convenience outlets for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz.
- D. Wiring device will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION

SECTION 26 2816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Receptacle switches.
 - 4. Molded-case circuit breakers (MCCBs).
 - 5. Molded-case switches.
 - 6. Enclosures.

1.03 DEFINITIONS

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

1.04 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - 2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.08 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Fuse Pullers: Two for each size and type.

1.09 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NFPA 70.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.

- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without Owner's written permission.
 - 4. Comply with NFPA 70E.

1.11 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.01 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 240 or 600-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. Type HD, Heavy Duty, Six Pole, Single Throw, 240 or 600-V ac, 200 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.
- D. Type HD, Heavy Duty, Double Throw, 240 or 600-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.

E. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical or Compression type, suitable for number, size, and conductor material.
7. Service-Rated Switches: Labeled for use as service equipment.
8. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

2.02 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Six Pole, Single Throw, 240 or 600-V ac, 200 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.
- D. Type HD, Heavy Duty, Double Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Hookstick Handle: Allows use of a hookstick to operate the handle.
5. Lugs: Mechanical or Compression type, suitable for number, size, and conductor material.

2.03 RECEPTACLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy-Duty, Single-Throw Fusible Switch: 240 or 600 V ac; 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; interlocked with cover in closed position.
- C. Type HD, Heavy-Duty, Single-Throw Nonfusible Switch: 240 or 600-V ac; UL 98 and NEMA KS 1; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Interlocking Linkage: Provided between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.
- E. Receptacle: Polarized, three-phase, four-wire receptacle (fourth wire connected to enclosure ground lug).

2.04 MOLDED-CASE CIRCUIT BREAKERS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. 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.
- D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
1. Instantaneous trip.
 2. Long- and short-time pickup levels.
 3. Long- and short-time time adjustments.
 4. Ground-fault pickup level, time delay, and I^2t response.
- F. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- G. Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
 2. Lugs: Mechanical or Compression type, suitable for number, size, trip ratings, and conductor material.
 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

2.05 MOLDED-CASE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Features and Accessories:
 1. Standard frame sizes and number of poles.
 2. Lugs: Mechanical or Compression type, suitable for number, size, trip ratings, and conductor material.
 3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

2.06 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 stainless steel.
 3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4x.
 4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 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 Section 260548 "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.

3.03 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Electrical Identification."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.04 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.
 3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
 - E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.05 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges.

END OF SECTION

SECTION 26 2923

VARIABLE FREQUENCY CONTROLLERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes separately enclosed, pre-assembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.
- B. Related Sections:
 - 1. DIVISION 23 - MECHANICAL; Provide equipment components per manufacturer's recommendations.

1.03 DEFINITIONS

- A. BAS: Building automation system.
- B. CE: Conformance Europeene (European Compliance).
- C. CPT: Control power transformer.
- D. EMI: Electromagnetic interference.
- E. IGBT: Insulated-gate bipolar transistor.
- F. LAN: Local area network.
- G. LED: Light-emitting diode.
- H. MCP: Motor-circuit protector.
- I. NC: Normally closed.
- J. NO: Normally open.
- K. OCPD: Overcurrent protective device.
- L. PCC: Point of common coupling.
- M. PID: Control action, proportional plus integral plus derivative.

- N. PWM: Pulse-width modulated.
- O. RFI: Radio-frequency interference.
- P. TDD: Total demand (harmonic current) distortion.
- Q. THD(V): Total harmonic voltage demand.
- R. VFC: Variable-frequency motor controller.

1.04 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.05 ACTION SUBMITTALS

- A. Product Data: For each type and rating of VFC indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.
- B. LEED Submittals:
 - 1. Product Data for Credit EA 5: For continuous metering equipment for energy consumption.

1.06 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- B. Source quality-control reports.
- C. Field quality-control reports.

1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
 - 2. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

1.08 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 - 3. Indicating Lights: Two of each type and color installed.
 - 4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
 - 5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.09 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.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers.

1.11 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than 14 deg F and not exceeding 104 deg F.
 - 2. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F
 - 3. Humidity: Less than 95 percent (noncondensing).
 - 4. Altitude: Not exceeding 3300 feet.
- B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of electrical systems.
 2. Indicate method of providing temporary electrical service.
 3. Do not proceed with interruption of electrical systems without Construction Manager's written permission.
 4. Comply with NFPA 70E.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.12 COORDINATION

- A. Coordinate features of motors, load characteristics, installed units, and accessory devices to be compatible with the following:
1. Torque, speed, and horsepower requirements of the load.
 2. Ratings and characteristics of supply circuit and required control sequence.
 3. Ambient and environmental conditions of installation location.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
- C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.13 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURED UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB.
 2. Baldor Electric Company.
 3. Danfoss Inc.; Danfoss Drives Div.
 4. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

5. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 6. Rockwell Automation, Inc.; Allen-Bradley Brand.
 7. Siemens Energy & Automation, Inc.
 8. Square D; a brand of Schneider Electric.
 9. Toshiba International Corporation.
 10. Yaskawa Electric America, Inc; Drives Division.
- B. General Requirements for VFCs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.
- C. Application: Variable torque.
- D. VFC Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
 2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
 3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
- E. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- F. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
- G. Unit Operating Requirements:
1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
 2. Input AC Voltage Unbalance: Not exceeding 3 percent.

3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
 4. Minimum Efficiency: 97 percent at 60 Hz, full load.
 5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
 6. Minimum Short-Circuit Current (Withstand) Rating: 65 kA.
 7. Ambient Temperature Rating: Not less than 14 deg F and not exceeding 104 deg F.
 8. Ambient Storage Temperature Rating: Not less than minus 4 deg F and not exceeding 140 deg F
 9. Humidity Rating: Less than 95 percent (noncondensing).
 10. Altitude Rating: Not exceeding 3300 feet.
 11. Vibration Withstand: Comply with IEC 60068-2-6.
 12. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
 13. Speed Regulation: Plus or minus 5 percent.
 14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
 15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- H. Inverter Logic: Microprocessor based, 16 or 32 bit, isolated from all power circuits.
- I. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
1. Signal: Electrical.
- J. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 3. Acceleration: 0.1 to 999.9 seconds.
 4. Deceleration: 0.1 to 999.9 seconds.
 5. Current Limit: 30 to minimum of 150 percent of maximum rating.
- K. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
 2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
 3. Under- and overvoltage trips.
 4. Inverter overcurrent trips.
 5. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
 6. Critical frequency rejection, with three selectable, adjustable deadbands.
 7. Instantaneous line-to-line and line-to-ground overcurrent trips.
 8. Loss-of-phase protection.
 9. Reverse-phase protection.
 10. Short-circuit protection.
 11. Motor overtemperature fault.
- L. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
- M. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.
- N. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- O. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- P. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- Q. Integral Input Disconnecting Means and OCPD: NEMA AB 1, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism.
1. Disconnect Rating: Not less than 115 percent of VFC input current rating.

2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
3. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
5. NC alarm contact that operates only when circuit breaker has tripped.

2.02 CONTROLS AND INDICATION

- A. Status Lights: Door-mounted LED indicators displaying the following conditions:
 1. Power on.
 2. Run.
 3. Overvoltage.
 4. Line fault.
 5. Overcurrent.
 6. External fault.
- B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
 1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
 2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
 - a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.
- C. Historical Logging Information and Displays:
 1. Real-time clock with current time and date.
 2. Running log of total power versus time.
 3. Total run time.
 4. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:
 - a. A minimum of two programmable analog inputs: 0- to 10-V dc 4- to 20-mA dc.
 - b. A minimum of six multifunction programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:
 - a. 0- to 10-V dc.
 - b. 4- to 20-mA dc.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
3. Output Signal Interface: A minimum of one programmable analog output signal(s) (0- to 10-V dc 4- to 20-mA dc operator-selectable "x"- to "y"- mA dc), which can be configured for any of the following:
 - a. Output frequency (Hz).
 - b. Output current (load).
 - c. DC-link voltage (V dc).

- d. Motor torque (percent).
 - e. Motor speed (rpm).
 - f. Set point frequency (Hz).
4. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
- a. Motor running.
 - b. Set point speed reached.
 - c. Fault and warning indication (overtemperature or overcurrent).
 - d. PID high- or low-speed limits reached.
- F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.
- 1. Number of Loops: Two.
- G. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFC status and alarms and energy usage. Allows VFC to be used with an external system within a multidrop LAN configuration; settings retained within VFC's nonvolatile memory.
- 1. Network Communications Ports: Ethernet and RS-422/485.
 - 2. Embedded BAS Protocols for Network Communications: ASHRAE 135 BACnet Echelon LonWorks Johnson Metasys N2 Modbus/Memobus Siemens System 600 APOGEE; protocols accessible via the communications ports.

2.03 LINE CONDITIONING AND FILTERING

- A. Input Line Conditioning: Provide input filtering, as required, to limit TDD at input terminals of all VFCs to less than 5 percent and THD(V) to 3 percent.
- B. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

2.04 BYPASS SYSTEMS

- A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

- B. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.
- C. Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter input and output and permit safe testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode.
 - 1. Bypass Contactor: Load-break, IEC-rated contactor.
 - 2. Input and Output Isolating Contactors: Non-load-break, IEC-rated contactors.
 - 3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.
- D. Bypass Contactor Configuration: Full-voltage (across-the-line) type.
 - 1. NORMAL/BYPASS selector switch.
 - 2. HAND/OFF/AUTO selector switch.
 - 3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
 - 4. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.
 - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
 - b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
 - 5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
 - a. CPT Spare Capacity: 100 Insert number VA.
 - 6. Overload Relays: NEMA ICS 2.
 - a. Melting-Alloy Overload Relays:
 - (1) Inverse-time-current characteristic.
 - (2) Class 20 tripping characteristic.

- (3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
- b. Bimetallic Overload Relays:
 - (1) Inverse-time-current characteristic.
 - (2) Class 20 tripping characteristic.
 - (3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - (4) Ambient compensated.
 - (5) Automatic resetting.
- c. NC isolated overload alarm contact.
- d. External overload reset push button.

2.05 OPTIONAL FEATURES

- A. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

2.06 ENCLOSURES

- A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
 - 1. Dry and Clean Indoor Locations: Type 1.
 - 2. Outdoor Locations: Type 3R stainless steel.
- B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

2.07 ACCESSORIES

- A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
 - 1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty type.
 - a. Push Buttons: Lockable Shielded types; momentary.
 - b. Pilot Lights: LED types; push to test.
 - c. Selector Switches: Rotary type.

- d. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- B. Reversible NC/NO bypass contactor auxiliary contact(s).
- C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
- D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
 - 1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.
- E. Supplemental Digital Meters:
 - 1. Elapsed-time meter.
 - 2. Kilowatt meter.
 - 3. Kilowatt-hour meter.
- F. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
- G. Spare control-wiring terminal blocks; unwired.

2.08 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
 - 1. Test each VFC while connected to its specified motor.
 - 2. Verification of Performance: Rate VFCs according to operation of functions and features specified.
- B. VFCs will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.
- B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

- C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required work-space clearances and required clearances for equipment access doors and panels.
- B. Wall-Mounting Controllers: Install VFCs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."
- C. Seismic Bracing: Comply with requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in each fusible-switch VFC.
- F. Install fuses in control circuits if not factory installed.
- G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- H. Comply with NECA 1.

3.03 IDENTIFICATION

- A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Electrical Identification."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each VFC with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.
- B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.04 CONTROL WIRING INSTALLATION

- A. Install wiring between VFCs and remote devices and facility's central-control system.
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic control devices where applicable.
 - 1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
 - 2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.05 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- D. Tests and Inspections:
 - 1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
 - 3. Test continuity of each circuit.
 - 4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager before starting the motor(s).
 - 5. Test each motor for proper phase rotation.

6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- E. VFCs will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.06 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.

3.07 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager before increasing settings.
- D. Set the taps on reduced-voltage autotransformer controllers.
- E. Set field-adjustable circuit-breaker trip ranges.
- F. Set field-adjustable pressure switches.

3.08 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.
- B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.09 DEMONSTRATION

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

END OF SECTION

SECTION 26 3200

PACKAGED ENGINE GENERATORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes packaged engine-generator sets for emergency power supply with the following features:
 - 1. Diesel engine.
 - 2. Unit-mounted cooling system.
 - 3. Unit-mounted control and monitoring.
 - 4. Outdoor Enclosure
- B. Related Sections include the following:
 - 1. Section 263600 - Transfer Switches for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.03 DEFINITIONS

- A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
 - 1. Thermal damage curve for generator.
 - 2. Time-current characteristic curves for generator protective device.

- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
 2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
 4. Wiring Diagrams: Power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces defined in Section 260548 - Vibration and Seismic Controls for Electrical Systems. Include the following:
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Qualification Data: For manufacturer.
- C. Source quality-control test reports.
1. Certified summary of prototype-unit test report.
 2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
 3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
 4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.

5. Report of sound generation.
 6. Report of exhaust emissions showing compliance with applicable regulations.
 7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.
- D. Field quality-control test reports.
- E. Warranty: Special warranty specified in this Section.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 - Operation and Maintenance Data, include the following:
1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
 2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
 3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

1.08 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
 2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 50 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

- C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with ASME B15.1.
- F. Comply with NFPA 37.
- G. Comply with NFPA 70.
- H. Comply with NFPA 99.
- I. Comply with NFPA 110 requirements for Level 1 emergency power supply system.
- J. Comply with UL 2200.
- K. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
- L. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.09 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.
- B. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 - 1. Ambient Temperature: 5 to 40 deg C.
 - 2. Relative Humidity: 0 to 95 percent.
 - 3. Altitude: Sea level to 1000 feet.

1.10 COORDINATION

- A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 2 years from date of Substantial Completion.

1.12 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Caterpillar; Engine Div.
 2. Onan/Cummins Power Generation; Industrial Business Group.

2.02 ENGINE-GENERATOR SET

- A. Factory-assembled and -tested, engine-generator set.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
 1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.
- C. Capacities and Characteristics:
 1. Power Output Ratings: Nominal ratings as indicated.
 2. Output Connections: Three-phase, four wire.

3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

D. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.03 ENGINE

- A. Fuel: Diesel.
- B. Rated Engine Speed: 1800 rpm.
- C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.
- D. Lubrication System: The following items are mounted on engine or skid:
 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.

2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Engine Fuel System:

1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
3. Remote fill panel: NEMA 3R hinged enclosure with 2" inlet for remote fuel fill.
 - a. Inlet assembly with 2" cam lock, 2" ball valve, 2" check valve and 2"NPT connection.
 - b. Horn alarms and silence switches for 90% and 95% fuel levels.

F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

G. Governor: Mechanical.

H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

- a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and non-collapsible under vacuum.
 - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- I. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
 - 1. Minimum sound attenuation of 25 dB at 500 Hz.
 - 2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 85 dBA or less.
- J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- K. Starting System: 12-V electric, with negative ground.
 - 1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
 - 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
 - 3. Cranking Cycle: As required by NFPA 110 for system level specified.
 - 4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging.
 - 5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
 - 6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
 - 7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
 - 8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:

- a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
- b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
- c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
- d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
- e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
- f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.04 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.
- B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.
- C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.
- D. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:

1. AC voltmeter.
 2. AC ammeter.
 3. AC frequency meter.
 4. DC voltmeter (alternator battery charging).
 5. Engine-coolant temperature gage.
 6. Engine lubricating-oil pressure gage.
 7. Running-time meter.
 8. Ammeter-voltmeter, phase-selector switch(es).
 9. Generator-voltage adjusting rheostat.
 10. Generator overload.
- E. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.
- F. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Section 260913 - Electrical Power Monitoring and Control.
- G. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.
1. Overcrank shutdown.
 2. Coolant low-temperature alarm.
 3. Control switch not in auto position.
 4. Battery-charger malfunction alarm.
 5. Battery low-voltage alarm.
- H. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.
- I. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.05 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100 percent rated; complying with NEMA AB 1 and UL 489.
 - 1. Tripping Characteristic: Designed specifically for generator protection.
 - 2. Trip Rating: Matched to generator rating.
 - 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
 - 4. Mounting: Adjacent to or integrated with control and monitoring panel.
- B. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:
 - 1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
 - 2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
 - 3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
 - 4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.
- C. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.06 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H or Class F.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Enclosure: Drip-proof.
- G. Instrument Transformers: Mounted within generator enclosure.
- H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
 - 1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.
- I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- K. Subtransient Reactance: 12 percent, maximum.

2.07 MOTORS

- A. General requirements for motors are specified in Section 230513 - Common Motor Requirements for HVAC Equipment.
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.

2.08 VIBRATION ISOLATION DEVICES

- A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
 - 1. Material: Standard neoprene.

2.09 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 150. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.
- B. Description: Prefabricated or pre-engineered walk-in enclosure with the following features:

1. Construction: Aluminum, metal-clad, integral structural-steel-framed building erected on concrete foundation.
 2. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
 3. Space Heater: Thermostatically controlled and sized to prevent condensation.
 4. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.
 5. Hinged Doors: With padlocking provisions.
 6. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
 7. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
 8. Muffler Location: Within enclosure.
- C. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain.

2.10 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.11 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.
- B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.

2. Full load run.
3. Maximum power.
4. Voltage regulation.
5. Transient and steady-state governing.
6. Single-step load pickup.
7. Safety shutdown.
8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
9. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.
- B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
- B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- C. Install packaged engine generator with elastomeric isolator pads having a minimum deflection of 1 inch on 4-inch- high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Section 260548 - Vibration and Seismic Controls for Electrical Systems.
- D. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in Section 232113 - Hydronic Piping.

1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Section 232113 - Hydronic Piping.
- E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.03 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
- C. Connect cooling-system water piping to engine-generator set and heat exchanger with flexible connectors.
- D. Connect engine exhaust pipe to engine with flexible connector.
- E. Ground equipment according to Section 260526 - Grounding and Bonding.
- F. Connect wiring according to Section 260519 - Conductors and Cables.
- G. Connect remote fuel fill panel.

3.04 IDENTIFICATION

- A. Identify system components according to Section 230553 - Identification for HVAC Piping and Equipment and Section 260553 - Electrical Identification.

3.05 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
 3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
 - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
 - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
 - c. Verify acceptance of charge for each element of the battery after discharge.
 - d. Verify that measurements are within manufacturer's specifications.
 4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
 5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
 6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
 7. Exhaust Emissions Test: Comply with applicable government test criteria.
 8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
 9. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
 10. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.
- D. Coordinate tests with tests for transfer switches and run them concurrently.
- E. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

- F. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- G. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- I. Remove and replace malfunctioning units and retest as specified above.
- J. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.06 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Section 017900 - Demonstration and Training.

END OF SECTION

SECTION 26 3600

TRANSFER SWITCHES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes transfer switches rated 600 V and less, including the following:
 - 1. Automatic transfer switches.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
 - 1. Single-Line Diagram: Show connections between transfer switch, power sources, and load; and show interlocking provisions for each combined transfer switch.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control test reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 1. Features and operating sequences, both automatic and manual.
 2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.
- B. Source Limitations: Obtain automatic transfer switches through one source from a single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NEMA ICS 1.
- E. Comply with NFPA 70.
- F. Comply with NFPA 99.
- G. Comply with NFPA 110.
- H. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.07 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:
 1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
 2. Do not proceed with interruption of electrical service without Owner's written permission.

1.08 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Contactor Transfer Switches:
 - 2. AC Data Systems, Inc.
 - 3. Caterpillar; Engine Div.
 - 4. Emerson; ASCO Power Technologies, LP.
 - 5. Generac Power Systems, Inc.
 - 6. GE Zenith Controls.
 - 7. Kohler Power Systems; Generator Division.
 - 8. Onan/Cummins Power Generation; Industrial Business Group.
 - 9. Russelectric, Inc.
 - 10. Spectrum Detroit Diesel.

2.02 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
 - 1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
- C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

- D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 - 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
 - 2. Switch Action: Double throw; mechanically held in both directions.
 - 3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
- G. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.
- H. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Section 260553 "Electrical Identification."
 - 1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
 - 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
 - 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- I. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.03 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
- C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

- D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
- E. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
- F. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.
- G. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.
- H. Automatic Transfer-Switch Features:
 - 1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
 - 2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
 - 3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
 - 4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
 - 5. Test Switch: Simulate normal-source failure.
 - 6. Switch-Position Pilot Lights: Indicate source to which load is connected.

7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
 - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
 - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - b. Push-button programming control with digital display of settings.
 - c. Integral battery operation of time switch when normal control power is not available.

2.04 SOURCE QUALITY CONTROL

- A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- B. Floor-Mounting Switch: Anchor to floor by bolting.
 - 1. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Section 260529 "Hangers and Supports for Electrical Systems."
- C. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.
- D. Identify components according to Section 260553 "Electrical Identification."
- E. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.02 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
- B. Ground equipment according to Section 260526 "Grounding and Bonding."
- C. Connect wiring according to Section 260519 "Conductors and Cables."

3.03 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
 - 2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 - a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
5. After energizing circuits, demonstrate interlocking sequence and operation-function for each switch at least three times.
 - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
 - f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
 - a. Verify grounding connections and locations and ratings of sensors.
- C. Coordinate tests with tests of generator and run them concurrently.
- D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- E. Remove and replace malfunctioning units and retest as specified above.

3.04 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Section 017900 "Demonstration and Training."
- B. Coordinate this training with that for generator equipment.

END OF SECTION

SECTION 26 5000

ARCHITECTURAL LIGHTING

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide luminaires and accessories in accordance with the Contract Documents. Furnish and install luminaires as shown on the Drawings and herein specified.

1.02 DEFINITIONS

- A. The term "Architect" refers to the Architect, Interior Designer, Lighting Designer or Owner's Representative individually or collectively.

1.03 GENERAL REQUIREMENTS

- A. Provide all luminaires as shown complete with lamps and accessories, appropriately wired, controlled, and securely attached to supports.
- B. Where a narrative and a catalog number or pictorial description are provided, the written description shall take precedence and prevail.
- C. General Contractor shall provide electrical subcontractor with entire lighting specification (including fixture illustrations and sketches); electrical subcontractor shall provide each specified manufacturer with complete information about the luminaires they will supply.
- D. Type of luminaires shall be as indicated alphanumerically and as specified.
- E. Fixture details shown may be modified by the manufacturer provided all of the following conditions have been met:
 - 1. Fixture performance is equal or improved.
 - 2. Structural, mechanical, electrical, safety, and maintenance characteristics are equal or improved.
 - 3. Cost to the Owner is reduced or equal.
 - 4. Modifications have been reviewed and approved by the Architect in writing.
- F. The contractor shall coordinate dimmable lighting control interface of all light fixtures with approved lighting control system, insuring compatibility across full dimming range of light fixture.

1.04 REFERENCE STANDARDS

- A. The standards and regulating committees referred to in these Specifications, and with which compliance is required, are:
 - 1. ANSI American National Standards Institute
 - 2. ASTM American Society of Testing and Materials
 - 3. CBM Certified Ballast Manufacturers
 - 4. NEC National Electric Code
 - 5. NEMA National Electrical Manufacturers Association
 - 6. NFPA National Fire Protection Association
 - 7. UL Underwriters Laboratories
- B. All luminaires and assembled components shall be new, of good quality, and approved by and bear the label of UL or other approved testing agencies (i.e., CSA, ETL) unless otherwise specified in writing. Documentation of such testing shall be provided upon request.
- C. All luminaires shall meet required local, state and/or national building, electrical and energy codes and regulations.
- D. Luminaires installed in outdoor protected areas (such as building soffits) and indoors in areas subject to water or extreme humidity shall be UL Listed for damp locations. Luminaires in outdoor unprotected areas shall be UL Listed for wet locations.

1.05 BIDDING

- A. Follow bidding procedures as described in General Requirements Section of these Specifications.
- B. Provide unit and alternate prices for the fixture types beginning with Clause A. in Paragraph 2.02, LIGHTING FIXTURE SCHEDULE.

1.06 SUBSTITUTIONS

- A. Bidders' attention is called to the following procedure for submitting alternate fixture manufacturers to those specified:
 - 1. Bidders wishing to obtain approval on manufacturers other than those specified by name and catalog number in Paragraph 2.02, LIGHTING FIXTURE SCHEDULE, shall submit their requests not later than ten (10) business days before the bid opening. Approval will be in the form of an addendum to the specifications issued to all prospective bidders indicating that the additional brand or brands are approved as equals to those specified per the requirements and scope of the project. If the bidders do not elect to obtain prior approval during the time so specified, the Owner has no obligation to review or consider any such article after the contract award.

2. If the bidder wishes to substitute fixtures from alternate manufacturers, bidder's attention is called to Paragraph 2.01, GENERAL MATERIAL REQUIREMENTS of PART 2 - PRODUCTS. Further, note that the dimensions of visible parts of luminaries (for example, the aperture diameters of recessed fixtures) are binding to the bidder and cannot be changed without prior approval by the Architect.
3. Contractor shall pay professional fees (at current standard hourly rates) and reimburse expenses directly to all designers (Architect, Engineer, Lighting Designer, et al.) for time spent reviewing substitutions proposed by the Contractor. If payment by the Contractor is not made within sixty (60) days of invoice date, the Owner shall deduct the amount due from subsequent payments to the Contractor in order to reimburse designers.
4. Request for approval shall be accompanied by working fixture samples (with appropriate lamping, complete photometric, mechanical and electrical data from the manufacturer, list of materials and finishes, and unit cost to the Owner) of both the specified brand and the proposed substitutes as required to make complete comparison and evaluation. These samples shall be in addition to those required by Lighting Fixture Specification. The above data shall be delivered separately to the Architect and the Lighting Designer. The fixture samples shall be furnished and installed, at the bidder's expense, at a location selected by the Architect. In addition, the bidder shall furnish the Architect and the Lighting Designer with the name and location of at least one completed project where each proposed substitute has been in operation for a period of at least six (6) months, as well as the names and addresses of the Owner, the Architect and the Lighting Designer.

1.07 SUBMITTALS

- A. For standard catalog items with no modifications, submit catalog cut sheets, which clearly show all elements to be supplied, and all corresponding product data (including lamping, ballast quantity, ballast manufacturer and model number, voltage, input watts, materials, finishes, accessories and/or options and any miscellaneous items detailed in the written description of the specification). If a cut sheet shows more than one (1) fixture type, all non-applicable information shall be crossed out.
- B. Submittals for solid state lighting luminaires shall include LM-79 report from a laboratory accredited by the National Voluntary Lab Accreditation Program (NVLAP) or one of its Mutual Recognition Arrangement (MRA) signatories. Laboratory tests must be produced using specific module(s)/array(s) and power supply combination that will be used in production. LM-79 report shall include the following minimum information:
 1. Sample and testing description: testing laboratory and date of test, verification LM-79 was used, identification of photometric methods used, and version of product tested including catalog number, ballast or driver information, and accessories.

2. Electrical characteristics: input voltage in volts, input current in amps, input power in watts.
 3. Total light output in lumens, luminaire efficacy in lumens per watt including power supply, thermal, optical, and fixture losses.
 4. Luminous intensity distribution in tabular and polar graph formats.
 5. Color characteristics: chromaticity coordinates (u',v'), correlated color temperature (CCT) in Kelvins, color rendering index (CRI), spectral power distribution graph.
 6. Exterior fixtures shall include BUG rating and isoilluminance plot.
- C. Submittals must be prepared by the manufacturer or manufacturer's local representative agency and clearly indicate the manufacturer's name and representative agency's name on the submittals.
- D. For Standard Cataloged Fixtures:
1. Submit a certificate of compliance with Alzak finish requirements with all requests for approval.
 2. When more than one louver panel occurs in a fixture, submit the dimensioned layout of individual louver panels and supporting "tee" members as a part of shop drawings.
- E. For luminaires such as custom, modified, linear mounted in continuous rows, and solid state lighting systems with remote ballasts and/or controllers submit a reproducible drawing prepared by the manufacturer showing all details of construction, lengths of required runs, lamp layout, power locations, ballast locations, pendant locations where applicable, finishes and list of materials. Drawings must be to scale. Contractor shall provide manufacturer with field dimensions of all architectural coves where continuous runs are to be mounted. If scallop shields, wallwash reflectors or baffles are required, drawings shall indicate relative position to wall or adjacent vertical surface.
- F. For all submittals under Clauses A. through C. above, manufacturer shall provide submittals within two (2) weeks of receipt of order. All submittals shall have project name and fixture type clearly shown.
- G. Fixture cuts and shop drawings shall be submitted in quantities and format as described in the General Conditions Section of these Specifications.
- H. The Architect shall make the final determination as to whether or not the submittal contains sufficient information, and reserves the right to request a shop drawing if the fixture cut is insufficient.

1.08 MOCK-UPS:

1. It shall be the responsibility of the Contractor to provide a mock-up of the lighting fixture or lighting system as indicated in Paragraph 2.02, LIGHTING

FIXTURE SCHEDULE. The mock-up shall be erected within a time period and in a location that is acceptable to the Architect.

2. The mock-up installation shall closely conform to the conditions of the actual installation as to: height, distance from adjacent surfaces, number and type of lamps, material, color, etc. The Contractor shall submit a written description of each proposed mock-up with drawings in order to obtain the Architect's approval prior to commencement of each mock-up.
3. The purpose of the mock-up will be to study the general appearance and performance of the intended lighting systems. At that time, certain minimal test variations may be requested as to lamp location, lamp type, reflector shape, color, etc. Final modifications, if any, shall be considered a part of these Specifications and shall be accomplished with no additional cost to the Owner.
4. Mock-up fixtures may not be used on the project.
5. Full scale mock up is required for the color lighting (Fixture type FE12) at the Phase 1B Parking Structure to determine color specification for the fixture lens based of the approved ceiling finish. Contractor to provide paint finishes of ceiling slab for each level (Level 1A, Level 1B and Level 2), sample of specified light fixture, and color gels of three color options for each finish (Level 1A, Level 1B and Level 2), total 9 color gels. Coordinate with the Architect the location and time of required mockup.

1.09 SAMPLES:

1. It shall be the responsibility of the Contractor to provide sample fixtures as indicated in Paragraph 2.02, LIGHTING FIXTURE SCHEDULE. When samples are called for, the manufacturer shall provide one working samples, unless otherwise noted, complete with specified lamp, ballast (rated for operation on local voltage and frequency) and 96-inch (2000-millimeter) pigtail with grounded plug.
2. The sample(s) shall be shipped to a location determined by the Architect. Shipping and return shipping costs shall be provided as part of the contract.
3. The purpose of the sample is to review manufacturing techniques, detailing, lamping and scale. Sample fixtures must be approved prior to fabrication of fixtures for the project. Minor modifications, if any, shall be considered part of these Specifications and shall be accomplished with no additional cost to the Owner.
4. Sample fixtures may not be used on the project.

1.10 WARRANTIES

- A. All fixtures and workmanship shall be guaranteed free of defects and fully operational for a minimum of one (1) year after installation. Any fixtures or workmanship found to be defective during the warranty period shall either be fixed or replaced to the Owner's approval by the Contractor at no cost to the Owner.

- B. Solid state lighting luminaires, drivers, controllers, and other system components shall be covered by a minimum five (5) year warranty after installation unless otherwise specified against defects in workmanship or material. Warranty shall include in-warranty service program providing for payment of authorized labor charges incurred in replacement of inoperative in-warranty equipment.

PART 2 PRODUCTS

2.01 GENERAL MATERIAL REQUIREMENTS

- A. Luminaires shall be completely factory-assembled and -wired, and equipped with necessary lampholders, ballasts, wiring, shielding, reflectors, channels, lenses, and other parts necessary to complete the luminaire installation.
- B. Luminaire hardware shall be concealed. Exposed metal at joints are to be welded, filled with weld material, ground smooth, and made free of light leaks. Incandescent luminaires shall be gasketed with overlapping trim. Ballast support studs, socket saddle studs, and reflector support studs shall be welded to luminaire body; self-threading screws are not acceptable. Ballast compartments must be adequately ventilated and ballast firmly secured to conducting metal surface.
- C. Luminaires shall be designed for bottom re-lamping, unless otherwise noted.
- D. Luminaires shall be constructed with a minimum number of joints. Unexposed joints shall be welded, screwed or bolted; soldered joints are not acceptable. Self-tapping methods or rivets for fastening removable parts used to gain access to electrical components requiring service or replacement, or for fastening electrical components or their supports, will not be acceptable.
- E. Cast or extruded parts of luminaires shall be close grained, rigid, true to pattern, of ample weight and thickness, and properly fitted, filed, ground, and buffed to provide finished surfaces and joints free of imperfections or discolorations.
- F. Housings for solid state lighting luminaires shall be designed to make electrical components easily accessible and replaceable, without removing the luminaire body from its mounting.

2.02 LIGHTING FIXTURE SCHEDULE

- A. Refer to electrical drawings for WSP Lighting Fixture Schedule.

2.03 LAMPHOLDERS

- A. Incandescent lampholders shall be porcelain bases with copper screw shells.
- B. Lampholders shall be rigidly and securely attached to the luminaire enclosure or husk.

- C. Lampholders shall be suitable for specified lamps, and set to position the lamps in optically correct spacing and relationship to lenses, reflectors, filters, and baffles.
- D. Lampholders shall hold lamps securely against normal vibrations and maintenance handling.

2.04 REFLECTORS

A. Aluminum Reflectors:

1. Reflectors and reflecting cones or baffles shall be fabricated from #12 aluminum reflector sheet, minimum 0.057-inch thick (15 gauge, 1.449-millimeter). Material shall be free of tooling marks, spinning lines, and marks or indentation caused by riveting or other assembly techniques. No rivets, springs, or other hardware shall be visible after installation.
2. The finish of the inner surface of the reflector shall be as described in Paragraph 2.02, LIGHTING FIXTURE SPECIFICATIONS, and produced under the Alzak process. The reflector shall have an anodic coating of not less than four mils thick. The reflector inner surface shall be free of water spotting and shall maintain a reflectivity ratio of not less than 83 percent on clear specular finish. The reflector shall have a low iridescence finish free from multiple colors seen from normal viewing angles. Colors shall be derived from dyes supplied by Sandoz Chemical Company or approved equal.
3. Luminaires provided with tri-phosphor type lamps shall be provided with low iridescence aluminum reflectors to eliminate discoloration on aluminum reflector.
4. Luminaires with Alzak reflector cones, unless otherwise specified, must be furnished by the same manufacturer.
5. The reflecting surface of the cone shall be tested for proper sealing. Test per ASTM B136-63T.

B. Painted Reflectors:

1. Painted reflectors shall be formed before application of primer and paint. Reflectors and reflector bodies for luminaires with baked white enamel finish shall meet the following requirements and tests:
 - a. After 100 hours of exposure to fade-o-meter, reflectance shall be not less than 86 percent, and finish shall show no visible color change.
 - b. After 100 hours of exposure to 100 percent humidity at 100 degrees Fahrenheit (38 degrees Celsius), (cook box test) finish shall show no blistering or other degraded effects.
 - c. After 150 hours of exposure to salt spray (20 percent sodium chloride) shall cause no breakdown of film.

C. Reflector Cones:

1. Provide 45-degrees lamp and lamp image cut-off unless otherwise specified. In fixtures where upper reflector is separate from cone, cut-off shall be 45 degrees unless otherwise specified.
2. Reflector cone retention devices shall not deform the cone in any manner.
3. Submit a certificate of compliance with Alzak finish requirements with all requests for approval.

2.05 LENSES

- A. Lenses, louvers, and other light diffusing components shall be contained in frames. Lenses shall be removable but positively held within the frames so that hinging or other motion of the frame will not cause the diffusing components to drop out.
- B. Fresnel:
 1. Lens shall have uniform brightness throughout the entire visible area at angles from 45 degrees to 90 degrees from vertical, without bright spots or striations.
 2. Lens shall have opaque risers; color shall be as specified in Paragraph 2.02, LIGHTING FIXTURE SCHEDULE.
 3. Finish of visible regress surface of door shall be matte baked enamel paint, special color as selected by Architect.
 4. All fixtures with Fresnel lenses, unless otherwise specified, must be furnished by the same manufacturer.
- C. Glass:
 1. Flat glass lenses shall be heat-tempered borosilicate glass unless otherwise noted.
 2. Glass finishes (i.e. sandblasting, etching, polishing) shall be performed as described in Paragraph 2.02, LIGHTING FIXTURE SCHEDULE.
- D. Acrylic:
 1. Lenses shall be of injection molded crystal clear 100 percent virgin acrylic (except as shown). For lenses with male pattern of pyramids or cones, specified minimum thickness refers to distance from flat surface to base of pyramids (cones), or thickness of undisturbed material. For lenses with female pattern, specified minimum thickness refers to overall thickness of material.
 2. Lenses shall fully eliminate lamp images when viewed from all directions within the 45-degrees to 90-degrees angle from vertical when the ratio of lamp spacing to the distance from lamp underside to top of lens does not exceed 1.50. Within the viewing angle from 0 degrees to 45 degrees the ratio of maximum brightness (under a lamp) to minimum brightness (between lamps) shall not exceed 3 to 1.

3. Finishes (i.e. sandblasting, etching, polishing) shall be performed as described in Paragraph 2.2, LIGHTING FIXTURE SCHEDULE.

2.06 LOUVERS

A. Parabolic:

1. Louvers shall be continuously bound in channel formed frame, finish and color as specified or as selected.
2. Louver shall provide a minimum visual cut-off to the lamp of 45 degrees.
3. The finish of the inner surface of the reflector shall be highly specular as produced under the Alzak process. The reflector shall have an anodic coating of not less than four mils thick. The reflector inner surface shall be free of water spotting and shall maintain a reflectivity ratio of not less than 83 percent on clear specular finish. The reflector shall have a low iridescence finish free from multiple colors seen from normal viewing angles.

B. Flat Blade:

1. Provide flat blade louvers within formed frame, finish and color as specified.
2. Louvers to provide minimum of 45-degrees cut-off from lamp image.
3. Blade thickness to be a minimum of 0.125-inch (3.175-millimeter) flat steel.

2.07 LOW VOLTAGE TRANSFORMERS:

1. Magnetic, integral to light fixture
 - a. Shall be stack laminated or toroidal type.
 - b. Shall have an efficiency greater than 80%
 - c. Shall be inaudible in a 27 dB ambient environment
 - d. Shall include thermal protector on primary with auto-reset.
 - e. Shall have maximum operating temperature of 120 degrees Fahrenheit (49 degrees Celsius) or greater.
 - f. Shall be dimmable with magnetic low voltage dimmers installed on primary side of transformer.
2. Electronic, integral to light fixture
 - a. Shall have an efficiency greater than 95%.
 - b. Shall employ soft start circuitry to extend lamp life by delaying abrupt inrush current to lamp.
 - c. Shall be inaudible in a 27 dB ambient environment
 - d. Shall have a power factor greater than 0.95.
 - e. Shall have total harmonic distortion less than 15%.

- f. Shall include electronic short circuit, overload, and thermal protection with auto-reset once fault is corrected.
 - g. Shall have maximum operating temperature of 120 degrees Fahrenheit (49 degrees Celsius) or greater.
 - h. Shall be dimmable with electronic low voltage dimmers installed on primary side of transformer.
3. Magnetic, remotely located
- a. Shall be stack laminated or toroidal type.
 - b. Shall have an efficiency greater than 90%.
 - c. Shall be inaudible in a 27 dB ambient environment
 - d. Shall include thermal protection on primary and resettable circuit breaker on secondary.
 - e. Shall have multiple primary or secondary taps in order to compensate for voltage drop between transformer and lamp.
 - f. Shall have maximum operating temperature of 140 degrees Fahrenheit (60 degrees Celsius) or greater.
 - g. Shall be dimmable with magnetic low voltage dimmers installed on primary side of transformer.

2.08 SOLID STATE LIGHTING FIXTURES

A. Housing, where applicable:

- 1. Steel bonderized or equal rust protected, or aluminum, rigid construction. Minimum gauge thickness shall be as follows:
 - a. Interior locations: No. 20 gauge (0.812-millimeter) steel, No. 16 gauge (1.291-millimeter) aluminum.
 - b. Exterior locations: No. 18 gauge (1.024-millimeter) steel, No. 14 gauge (1.628-millimeter) aluminum.

B. Finish:

- 1. Baked enamel finish (except when otherwise specified).
- 2. Concealed interior surfaces (this applies to interior hardware, circuit boards, etc.) matte black.
- 3. Concealed exterior surfaces: matte black.
- 4. Visible surfaces: color and texture as specified below for each fixture type or as selected.
- 5. Exterior fixture finish: refer to "Exterior Fixture Finishes".

C. Light Emitting Diode (LED) requirements:

1. Correlated color temperature (CCT) for phosphor-coated white LEDs must have one of the following designated CCT's and fall within the following binning standards:
 - a. 2700K defined as 2725 +/- 145K
 - b. 3000K defined as 3045 +/- 175K
 - c. 3500K defined as 3465 +/- 245K
 - d. 4000K defined as 3985 +/- 275K
 - e. 4500K defined as 4503 +/- 243K
 - f. 5000K defined as 5028 +/- 283K
 - g. 5700K defined as 5665 +/- 355K
 - h. 6500K defined as 6530 +/- 510K
2. Color consistency and stability shall be limited to a maximum change in chromaticity of a 4-step MacAdam ellipse.
3. Color spatial uniformity shall be limited to variations in chromaticity for different directions (i.e. changes in viewing angle) within 0.004 from the weighted average point on the CIE 1976 (u',v') diagram.
4. Color rendering index
 - a. Color rendering index (CRI) to be determined using ANSI C78.377-2008 and applicable IESNA standards. Minimum CRI values shall be as follows:
 - 1) +75 CRI for commercial spaces
 - 2) +85 CRI for residential spaces
5. Lumen depreciation
 - a. Lumen depreciation to be measured using IESNA LM-80-08 standard for IES approved method of measuring lumen maintenance of LED light sources. Projected long term lumen maintenance shall be per IESNA TM-21.
 - b. Phosphor coated white LED module(s)/array(s) shall deliver at least 70% of initial lumens for a minimum of 50,000 hours when installed in-situ and operated at 100% output and the maximum specified operating temperature.
 - c. Colored LED module(s)/array(s) shall deliver at least 50% of initial lumens for a minimum of 35,000 hours when installed in-situ and operated at 100% output and the maximum specified operating temperature.
6. Acceptable LED chip manufacturers shall be as follows:
 - a. Bridgelux
 - b. Citizen Electronics Co., Ltd

- c. CREE
- d. Nichia
- e. Osram Opto Semiconductors
- f. Philips Lumileds
- g. Seoul Semiconductor
- h. Xicato

- 7. All LED arrays / modules and power supplies shall be field serviceable. All internal connections between LED array / module shall utilize quick disconnects, no pigtail or soldered connections shall be used for field serviceable components.

D. Luminaire Efficacy:

- 1. Luminaire efficiency shall be measured using IESNA LM-79-08 standard for electrical and photometric measurements of solid state lighting products.

E. Thermal Management:

- 1. Solid state light fixture shall not exceed LED manufacturer's maximum junction temperature requirements when operated in-situ at fixture manufacturer's maximum ambient operating temperature and 100% light output.
- 2. Solid state light fixtures shall be thermally protected using one of more of the following thermal management techniques:
 - a. Metal core board
 - b. Gap pad
 - c. Internal monitoring firmware
- 3. Solid state lighting fixture housing shall be designed to transfer heat from the LED board to the outside environment.

F. Power Supplies/Drivers:

- 1. Power supply shall have a power factor of 0.90 or greater for primary application.
- 2. Power supply input current shall have Total Harmonic Distortion (THD) of less than 20%.
- 3. Power supply inrush current shall meet or exceed NEMA 410 performance testing for lighting controls and switching devices with electronic drivers and discharge ballasts.
- 4. Power supply shall have a minimum case temperature of minus 4 degrees Fahrenheit (minus 20 degrees Celsius) or below and a maximum case temperature of 176 degrees Fahrenheit (80 degrees Celsius) when used in luminaires intended for outdoor applications.

5. Power supply output operating frequency to be equal to or greater than 120 Hz.
6. Power supply shall operate with sustained input variations of +/- 10% (voltage and frequency) with no damage to the driver or change in light output.
7. Power supply shall tolerate sustained open circuit and short circuit output conditions without damage and without need for external fuses or trip devices.
8. Power supply output shall be regulated to +/- 5% across published load range.
9. Power supply shall have a Class A sound rating.
10. Power supply outputs shall have current limiting protection.
11. Power supply shall have a mean time between failure (MTBF) of 150,000 hours.
12. Power supply to have maximum case temperature of 149 degrees Fahrenheit (65 degrees Celsius).
13. Power supply shall operate LEDs at constant and regulated current levels. LEDs shall not be overdriven beyond the diode manufacturer's specified nominal voltage and current.

G. Solid State Lighting Controls:

1. Control interface to dimmable power supplies shall consist of one of the following:
 - a. Phase Dimming. Controls to be rated for forward phase (also referred to as leading edge or Triac) or reverse phase (also referred to as trailing edge or electronic low voltage) operation.
 - b. Low voltage (0-10V) control. Controls to be compatible with either current sink or current source operation.
 - c. Digital control via DMX, DALI, LonWorks, or Zigbee protocols.
 - d. The contractor shall coordinate solid state lighting control interface with approved dimming system, insuring compatibility across full dimming range of power supply.
2. Dimmable LED power supplies shall use a combination of constant current reduction (CCR) and pulse width modulation (PWM).
 - a. CCR shall be used between 10-100% output.
 - b. PWM shall be used between 0-10% output. Minimum PWM frequency shall be 150 Hz.
 - c. Dimmable power supplies shall have 12-bit or greater resolution.
 - d. Flicker index shall be measured by IES RP-16-10 and shall be less than 5% when operated at all frequencies below 800 Hz. Dimming

shall be free of perceived flicker or visual stroboscopic flicker throughout the dimming range with a natural square law response to control input.

H. System Installation:

1. The Contractor shall furnish a complete solid state lighting system as described in Section 2.2, LIGHTING FIXTURE SPECIFICATIONS.
2. All hardwired connections to solid state lighting fixtures shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.
3. All solid state lighting fixtures (100% of each lot) shall undergo a minimum one-hour burn-in test during manufacturing.
4. In addition to requirements identified in Section 1.04 STANDARDS, solid state lighting installations shall be UL Listed as a low-voltage lighting system including, but not limited to, luminaire, power supply, controller, keypad, and wiring.

2.09 LUMINAIRE WIRING

A. Voltage Rating:

1. For voltages up to 120 volts, fixture wiring shall be rated for 300 volts minimum.
2. For voltages above 120 volts, fixture wiring shall be rated for 600 volts minimum.

B. Temperature Rating – Internal to Fixture:

1. All wiring shall be code-approved for fixture wiring, and shall comply with the following temperature ratings unless fixture design or local codes require higher temperature wire:
2. Incandescent:
 - a. Minimum rating between lampholder(s) and separately mounted junction box or internal transformer.
 - b. Minimum rating between internal transformer and separately mounted junction box.
 - c. Tungsten-halogen lamp seal temperature shall not exceed 660 degrees Fahrenheit (350 degrees Celsius) at ambient of 77 degrees Fahrenheit (25 degrees Celsius) when tested per UL Bulletin 57, Par. 328-334. Submit certified heat test data by independent testing laboratory.

C. Temperature Rating – External to Fixture

1. All flexible cord wiring between fixture components or to electrical receptacle and not in wireway shall have a minimum temperature rating of 220 degrees Fahrenheit (105 degrees Celsius).

2. Cord type shall be suitable for application and shall be fitted with proper strain relief and water-tight entries where required by application.
- D. Splices:
1. Splices internal to fixture shall be made within separate splice compartments and shall utilize nylon insulated crimped connections or insulated quick disconnects.
 2. Splices to branch circuit wiring in separate junction boxes shall utilize flame retardant thermoplastic caps with fully seated helical metal spring and threaded entry.
- E. No internal wiring shall be visible at normal viewing angles (i.e., above 45 degrees from vertical). Use additional wire clamps if necessary. Anticipate increased visibility if fixtures are mounted on or recessed within a sloping surface.
- F. Any fixture fed from more than one panel (i.e., for normal and night or emergency operation) shall have separate neutrals to each panel.
- G. Furnish code-approved wiring in ceiling cavities forming air plenums.

2.10 ACCESSORIES

- A. Recessed incandescent luminaires shall be furnished with thermal protection in accordance with Article 410-65 of the NEC.
- B. Where utilized as raceways, luminaires shall be suitable for use. Provide feed through splice boxes where necessary.
- C. Provide installation and supporting hardware including stems, plates, plaster frames, hangers, and similar items, for support of luminaires for the ceiling construction in which they shall be installed. Provide plaster frames made of non-ferrous metal, or of steel that has been suitably rust-proofed after fabrication. Provide seismic mounting as required.
- D. Air handling luminaires shall have hinged air control vanes within the side slots (bent metal vanes are not acceptable) factory-set at fully open. Provide heat removal slots at luminaire ends.
- E. Provide fastening devices of a positive locking type, which do not require special tools to apply or remove. Do not use tie wires in place of fastening devices.
- F. Attach reflectors to housing by means of safety chains to prevent reflectors from falling. No part of the chain shall be visible after installation.
- G. Provide a ceiling canopy for each stem. Canopy finish shall match stem finish.
- H. Luminaires installed in air plenums shall be enclosed and gasketed.

- I. Install all color, dichroic and imaging lenses and gels as required in Paragraph 2.02, LIGHTING FIXTURE SCHEDULE.

2.11 EXTERIOR LUMINAIRES

- A. Exterior luminaires shall be designed and manufactured specifically for outdoor service. Components including nuts, bolts, rivets, springs, and similar parts, shall be corrosion resistant.
- B. Exterior luminaires shall be suitably and effectively gasketed to prevent entrance of moisture into luminaire. Luminaires that are directly exposed to the elements shall be labeled for wet locations. Luminaires that are exposed to dampness shall be labeled for damp locations.
- C. Aluminum parts of exterior luminaires that are not specified as requiring a painted finish shall be anodized.
- D. Finishes:
 1. Unless otherwise specified, all painted surfaces shall have an outdoor life expectancy of not less than 20 years. Surfaces shall be prepared, primed and material applied in accordance with manufacturer's requirements.
 2. Colors shall be as specified under Paragraph 2.02 LIGHTING FIXTURE SCHEDULE.

2.12 POLE / LUMINAIRE ASSEMBLIES

- A. Supply luminaries, davit arms, brackets, poles hand-hole covers, base components, and all other accessories complete by specified manufacturer who will be responsible for proper fitting of all elements.
- B. Manufacturer will supply assembly to withstand a minimum of 120 mile-per-hour winds with a 1.3 gust factor without permanent deflection or per local wind load requirements.
- C. Manufacturer shall be responsible for design of and structural integrity of complete base (i.e., complete dimensions, rebar requirements, grounding and conduit requirements, drainage and ground compaction requirements).

PART 3 EXECUTION

3.01 SHIPPING AND STORAGE

- A. All fixtures received at the site shall be stored in a clean and dry space until fixtures are installed.
- B. Manufacturer shall clearly mark each box with fixture designation prior to shipping.

- C. Reflector cones, baffles, louvers, aperture plates, and decorative elements of fixtures shall be packed by the manufacturer separate from the housing (body, stem, etc.) of the fixture.

3.02 LOCATION

- A. Luminaire locations as indicated on the Drawings are general and approximate. Verify exact location and spacing of luminaires with Reflected Ceiling Plans and other reference data before ordering of fixtures. Confirm with Architect prior to installation.
- B. Coordinate space conditions with other trades before ordering of fixtures. Prove adequacy of clearance with other equipment such as ducts, pipes, conduit, or structural elements. Bring conflicts to Architect's attention before proceeding with work.
- C. Notify Architect about field conditions at variance with Contract Documents before commencing installation.
- D. Verify ceiling construction and furnish appropriate luminaire mounting supports, hardware, trim, and accessories for each luminaire.
- E. Coordinate length of continuous-run solid state lighting fixtures with adjacent walls, partitions, coffers and other architectural elements as required.

3.03 INSTALLATION

- A. Luminaires shall be installed free of light leaks, warps, dents, or other irregularities. Light leaks are not acceptable.
- B. Install reflector cones, aperture plates, lenses, diffusers, louvers, and decorative elements of luminaires after completion of wet work, plastering, painting, and general clean-up in the area of the luminaires.
- C. Parabolic luminaires shall be installed with Mylar cover over louvers. Cover shall be UL Listed for temporary lighting. Upon completion of work, remove Mylar cover with white gloves.
- D. Visible hanging devices shall be finished to match the luminaire finish, unless otherwise noted. Suspended fixtures shall hang level and aligned when installed in rows.
- E. Provide adequate and sturdy support for each lighting fixture. Contractor shall be responsible for verifying weight and mounting method of all fixtures, and shall furnish and install suitable supports. Fixture mounting assemblies shall comply with all local seismic codes and regulations.
- F. Surface Mounted Fixtures:
 - 1. Support surface-mounted fixtures from structural members other than ceiling tees.
- G. Pendant Mounted Fixtures:

1. Pendant-mounted fixtures shall be supported from structural framework of ceiling or from inserts cast into slab.
 2. All pendants shall have swivel aligners located at the top ends; pendants shall be 0.5-inch (13-millimeter) rigid steel conduits unless specifically indicated otherwise on the Drawings or in specifications.
 3. All solid state lighting pendant- and surface-mounted fixtures shall be supported with two (2) supports per 48-inch (1200-millimeter) section or three (3) per 96-inch (2400-millimeter) section, unless otherwise specified.
- H. Bracket Mounted Fixtures:
1. For each bracket fixture, provide flanged metal stem attached to outlet box, with threaded end suitable for supporting the fixture rigidly in design position. Flanged part of fixture stud shall be of broad base type, secured to outlet box at not fewer than three (3) points.
- I. Recessed Fixtures:
1. Contractor shall be responsible for adjusting aperture rings on all ceiling recessed fixtures to accommodate various ceiling material thicknesses. Contractor shall be responsible for coordinating the cut-out size in ceiling to ensure aperture covers cut-out entirely. The bottom of aperture rings shall be flush with finished ceiling or not more than 0.0625-inch (1.5-millimeter) above. Under no circumstances will the aperture ring extend below the finished ceiling surface.
- J. Top Re-Lamping Fixtures:
1. Fixtures re-lamped from above shall have the necessary top re-lamping screws loosened and moderately tightened, prior to installation, to assure ease of operation when re-lamping.
- K. Plaster Ceilings:
1. Furnish plaster frames for setting under other applicable sections. Direct the setting and be responsible for correct location; make sure the bottom of frame is flush with finished ceiling, forming screed edge for finished plaster.
 2. Fixtures shall be supported by plaster frames utilizing yokes or leveling lugs.
 - a. Fixtures and support elements shall not be mounted to or in contact with ducts or pipes.
 - b. Yoke shall have channel cross-section of sufficient gauge, and shall support a fixture by means of not fewer than two (2) bolts each.
- L. For fixtures with variable position lampholder assemblies, Contractor shall confirm prior to installation proper lampholder (socket) position in field, and shall adjust, if necessary, after coordination with manufacturer.
- M. Equipment requiring access for service and maintenance shall be installed so that components requiring access are readily accessible.

- N. Install luminaires in mechanical equipment rooms after ductwork and piping installation. Locate and mount luminaires as indicated on the Drawings unless mechanical equipment prohibits or makes it impractical to do so. In such cases, chain- or wall-mount luminaires so that serviceable equipment is illuminated.
- O. Provide fire-rated enclosures around recessed luminaires that are installed in fire-rated ceilings.
- P. Install fixtures with vent holes free of air-blocking obstacles.
- Q. Ascertain and ensure that all lamps installed are exactly as specified for each fixture type.
- R. Replace all burned-out or inoperative lamps, and inoperative ballasts, before the building is accepted by the Owner so that all lighting fixtures will be in premium operating condition.
- S. Re-lamp all specified fixtures used as construction work lights with new specified lamps. Solid state lighting (LED) fixtures shall not be used as construction work lights.
- T. At the completion of construction, clean the lenses, baffles, louvers, reflector cones, and bottoms of the trims of all lighting fixtures, so as to render them free of any material, substance or film foreign to the fixture. Use soft, non-abrasive cloth and a cleaning solution recommended by the fixture manufacturer. If the Architect at the completion of the project deems the luminaires dirty, the Contractor shall clean them at no additional cost to the Owner. Luminaire components whose finishes are damaged shall be replaced at no cost to the Owner.

3.04 FOCUSING

- A. Provide labor and materials for final aiming of all adjustable fixtures under the Architect's supervision. Aiming shall take place immediately before building is turned over to Owner, after regular working hours where required.
- B. All aiming of exterior and interior lighting in areas with skylights or windows that cannot be blacked out shall be done after dark.

END OF SECTION

SECTION 27 0501

COMMUNICATIONS GENERAL PROVISIONS

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. Applicable requirements of General Requirements/Provisions shall be considered a part of this section and shall have the same force as if printed herein full. In addition, all information related to communications infrastructure that is documented in the architectural, structural, mechanical, and electrical drawings/documents shall be included as part of the Communications documents.

1.02 QUALITY ASSURANCE

- A. Specifications, Standards and Codes: All work shall be in accordance with the following:
 1. The latest edition of the National Electrical Code (NEC)
 2. American National Standards Institute (ANSI)
 3. National Electrical Manufacturers Association (NEMA)
 4. Telecommunications Industries Association (TIA)
 5. Electronic Industries Association (EIA)
 6. Institute of Electrical & Electronics Engineers (IEEE)
 7. Building Industry Consulting Services International (BICSI)
 8. Underwriters Laboratories (UL)
 9. American Standards Association (ASA)
 10. Federal Communications Commission (FCC)
 11. Occupational Safety and Health Administration (OSHA)
 12. American Society of Testing Material (ASTM)
 13. Americans with Disabilities Act (ADA)
 14. Local city and county ordinances governing electrical work
 15. In the event of conflicts, the more stringent provisions shall apply.

1.03 SCOPE

- A. The work to be done under this section of the Specifications shall include the furnishing of labor, material, equipment and tools required for the complete

installation of the work indicated on the project documentation or as specified herein.

- B. All materials as part of the Communications Infrastructure and necessary to its proper operation, but not specifically mentioned or shown on the Drawings, shall be furnished and installed without additional charge.
- C. The Drawings and Specifications are complementary to each other and what is called for by one shall be as binding as if called for by both. If a discrepancy exists between the Drawing and Specifications the Project and Owner shall be notified of the discrepancy prior to ordering or installing any materials or committing any resources.

1.04 DRAWINGS

- A. Drawings are generally diagrammatic and show the arrangement and location of pathways, outlets, support structures and equipment. The Contractor shall carefully investigate the structural and finish conditions affecting his work and arrange his work accordingly. Should conditions on the job make it necessary to make adjustments to pathways or materials, the Contractor shall so advise the Project and Owner and secure approval before proceeding with such work.
- B. Where exact locations are required by equipment for stubbing-up and terminating conduit concealed in floor slabs, the Contractor shall request shop drawings, equipment location drawings, foundation drawings, and any other data required by him to locate the concealed conduit before the floor slab is poured.
- C. Materials, equipment or labor not indicated but which can be reasonably inferred to be necessary for a complete installation shall be provided. Drawings and Specifications do not undertake to indicate every item of material, equipment, or labor required to produce a complete and properly operating installation.
- D. The right is reserved to make reasonable changes in locations of equipment indicated on Drawings prior to rough-in without increase in contract cost.
- E. The Contractor shall not reduce the size or number of conduit runs indicated on the Drawings without the written approval.
- F. Any work installed contrary to Contract Drawings shall be subject to change, and no extra compensation will be allowed for making these changes.
- G. The location of equipment, support structures, outlets, and similar devices shown on the Drawings are approximate only. Do not scale Drawings. Obtain layout dimensions for equipment from Architectural plans unless indicated on Communications plans.
- H. Schematic diagrams shown on the Drawings indicate the required functions only. The technology of a particular manufacturer may be used to accomplish the functions indicated without exact adherence to the schematic Drawings

shown. Additional labor and materials required for such deviations shall be furnished at the Contractor's expense.

- I. Verify the ceiling type, ceiling suspension systems, and clearance above hung ceilings prior to ordering cabling and associated hardware. Notify the Project and Owner of any discrepancies.
- J. Review all architectural drawings for architectural furnishings and finishes.

1.05 SUBMITTALS

- A. Submit for approval, details of all materials, equipment and systems to be furnished. Work shall not proceed without the Owner and/or the Project Manager's approval of the submitted items. Three (3) copies of the following shall be submitted:
 - 1. Submittals for individual systems and equipment assemblies that consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered, reviewed or stored, and such submittals will not be returned except at the request and expense of the Contractor.
 - 2. Contractor shall generate shop drawings. Modify reviewed and accepted shop drawings to include revisions based upon completion of work. Submit shop drawings with record drawings on hard copy.
 - 3. Shop drawings shall include equipment racks, patch panels, termination blocks, connection details, rack mounting details and any other details not included in the construction drawings.
- B. Any materials and equipment listed that are not in accordance with Specification requirements may be rejected.
- C. The approval of material, equipment, systems and shop drawings is a general approval subject to the Drawings, Specifications and verification of all measurements at the job. Approval does not relieve the Contractor from the responsibility of shop drawing errors. The Contractor shall carefully check and correct all shop drawings prior to submission for approval.

1.06 QUALITY ASSURANCE

- A. Equipment and materials required for installation under these Specifications shall be the current model and new (less than one [1] year from the date of manufacture), unused and without blemish or defect.
- B. Equipment shall bear labels attesting to Underwriters Laboratories, where subject to label service. Manufacturers of equipment and materials pertinent to these items shall have been engaged in the manufacture of said equipment a minimum of three (3) years and, if so directed by the Owner, be able to furnish proof of their ability by submitting affidavits and descriptive data about their product including size and magnitude comparable to requirements specified herein.

1.07 CONTRACTOR QUALIFICATIONS

- A. The Contractor shall have total responsibility for the coordination and installation of the work shown and described in the Drawings and Specifications. The Contractor shall be a company specializing in the design, fabrication and installation of integrated communications systems.
- B. Communications Systems specified shall be installed under the direction of a qualified Contractor. Qualification requirements shall include submittal by the Contractor to the following:
 - 1. List of previous projects of this scope, size and nature; including names and sizes of projects, description of work, time of completion and names of contact persons for reference.
 - 2. Shall certify that they are manufacturer-authorized for work to be performed.
- C. Contractor must employ at least one (1) full-time Registered Communications Distribution Designer (RCDD). The RCDD shall be a W2 employee and not a subcontractor.

1.08 COORDINATION WITH OTHER TRADES

- A. The Contractor shall coordinate communications work with that of other sections as required to ensure that the entire communications work will be carried out in an orderly, complete and coordinated fashion.

1.09 SITE INVESTIGATION

- A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions that may affect the cost of the project. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems, shall be restored to their original condition before the completion of this project.

1.10 PERMITS

- A. Obtain all permits and inspections for the installation of this work and pay all charges incident thereto. Deliver to the Project and Owner all certificates of said inspection issued by authorities having jurisdiction.

1.11 RENOVATIONS AND ADDITIONS

- A. All work that would adversely affect the normal operation of the other portions of the Owner's property shall be done at a time other than normal working hours. Normal working hours shall be considered 8 a.m. to 5 p.m. Monday through Friday.
- B. Prior to submitting bids on the project, visit the site of the work to become aware of existing conditions that may affect the cost of the project.

- C. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems shall be restored to their original and operating condition. Remove all equipment indicated to be demolished, including outlets, devices, raceways and support structures.
- D. Care shall be exercised in the removal and storage of equipment indicated to be relocated or removed and reused. Prior to placing back into service, equipment shall be cleaned, and marred or chipped paint surfaces touched-up.
- E. Provide all coring, cutting and patching to existing walls, floors, etc., required for the removal of existing work or the installation of new work.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

- A. Where equipment is identified by manufacturer and catalog number, it shall be as the base of requirements for quality and performance. Where manufacturers for equipment are identified by name, the Contractor may submit for approval, similar equipment of other manufacturers as substitution. The Owner's Representative decision as to whether the submitted equipment is acceptable shall be final and binding.
- B. All changes necessary to accommodate the substituted equipment shall be made at the Contractor's expense, and shall be as approved by the Owner's Representative. Detailed drawings indicating the required changes shall be submitted for approval at the time the substitution is requested.
- C. If substitutions are made in lieu of device specified; form, dimension, design and profile shall be submitted to the Owner's Representative for approval.
- D. Submit request for approval of substitute materials in writing to the Owner's Representative at least ten days prior to bid opening.

2.02 MATERIALS

- A. All materials used in this work shall be new and shall bear the inspection label of Underwriters' Laboratories Inc. or certification by other recognized laboratory.
- B. The published standards and requirements of the Telecommunications Industries Association (TIA), National Electrical Manufacturers Association (NEMA), the American National Standard Institute (ANSI), the Institute of Electrical and Electronic Engineers (IEEE), and the American Society of Testing Materials (ASTM), are made a part of these Specifications and shall apply wherever applicable.
- C. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.

- D. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer or partner manufacturers that offer a certified solution.
- E. Components of an assembled unit need not be products of the same manufacturer, but must offer a certified end-to-end solution.
- F. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
- G. Components shall be compatible with each other and with the total assembly for the intended service.

PART 3 EXECUTION

3.01 EXAMINATION OF CONDITIONS

- A. Prior to the start of work, the Contractor shall carefully inspect the installed work of other trades and verify that such work is complete to the point where installation may properly commence. Start of work indicates acceptance of conditions.
- B. Install equipment in accordance with applicable codes and regulations, the original design and the referenced standards.
- C. In the event of a discrepancy, immediately notify the Owner's Representative.
- D. Do not proceed with installation until unsatisfactory conditions and discrepancies have been fully resolved.

3.02 PROTECTION OF SYSTEMS AND EQUIPMENT

- A. Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature and rain.
- B. Damage from rain, dirt, sun and ground water shall be prevented by storing the equipment on elevated supports and covering the sides with securely fastened protective rigid or flexible waterproof coverings.
- C. During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum cleaned both inside and outside before testing, operating or painting.
- D. As determined by the Owner's Representative, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the Contract Documents. Decision of the Owner's Representative shall be final.

- E. Damaged paint on equipment and materials shall be repainted with painting equipment and finished with the same quality of paint and workmanship as used by the manufacturer.

3.03 ACCESS TO EQUIPMENT

- A. Equipment shall be installed in location and manner that will allow convenient access for maintenance and inspection.
- B. Working spaces shall be not less than specified in the National Electrical Code (NEC) for voltages specified.
- C. Where the Owner's Representative determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled, one time only, as directed by the Owner's Representative, at no additional cost to the Owner. "Conveniently accessible" is defined as being capable of being reached without the use of ladders or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping and duct work.

3.04 CLEANING

- A. During construction, and prior to Owner acceptance of the building, remove from the premises and dispose of packing material and debris caused by communications work.
- B. Remove dust and debris from interiors and exteriors of electrical equipment. Clean accessible current carrying elements prior to being energized.

3.05 COMPLETION

- A. General: Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and similar items. Leave the premises clean, neat and orderly.
- B. Results Expected: Systems shall be complete and operational and controls shall be set and calibrated. Testing, start-up and cleaning work shall be complete.
- C. Maintenance Materials: Special tools for proper operation and maintenance of the equipment provided under this Specification shall be delivered to the Owner.

3.06 TESTING AND VERIFICATION

- A. See specific Division 27 sections for testing parameters of sub-systems.
- B. The Contractor shall verify that requirements of this Specification are met. Verification shall be through a combination of analyses, inspections, demonstrations and tests, as described below.
- C. Verification by inspection includes examination of items and comparison of pertinent characteristics against the qualitative or quantitative standard set forth in the Specifications. Inspection may require moving or partially disassembling

the item to accomplish the verification, included as part of the work at no additional cost to the Owner.

- D. The Contractor shall verify by formal demonstrations or tests that the requirements of this Specification have been met. The Contractor shall demonstrate that the communications systems, components and subsystems meet Specification requirements in the “as-installed” operating environment during the “System Operation Test.” Even though no formal environmental testing is required, the Contractor shall measure and record temperature, humidity and other environmental parameters and the environmental conditions, which were encountered during the “System Operation Test.”
- E. The Contractor shall carefully plan and coordinate the final acceptance tests so that tests can be satisfactorily completed. The Contractor shall provide necessary instruments, labor and materials required for tests, including the equipment manufacturer’s technical representative and qualified technicians in sufficient numbers to perform the tests within a reasonable time period.
- F. The Contractor shall satisfy all items detailed in the final acceptance check-off list (punch list). The list shall be a complete representation of specified installation requirements. At the time of final acceptance punch list items shall be corrected until the system is found to be acceptable to the Owner and the Project Manager.
- G. After the Contractor systems have been installed and tested, the completed test plan shall be signed by the Communications Contractor Project Manager and submitted for approval.
- H. No additional burden to the Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for reinstallation work shall be coordinated, in writing, with the Owner prior to beginning the work.
- I. All specified Communications systems indicated on the drawings and specifications shall be complete.
- J. Specified shop drawings and product submittals shall have been submitted for review and all review comments and deficiencies shall have been resolved. Final shop drawings and product submittals shall have been submitted, reviewed and found to meet the requirements of the specifications.
- K. Issues and deficiencies identified in field reports and punch lists shall have been resolved. Final as-built drawings shall have been submitted, reviewed and found to meet the requirements of the specifications.
- L. Contractor shall provide written notice of final completion of the telecom infrastructure. Upon receipt, the Owner’s Representative will review/observe the completed installation. Once the Owner’s Representative is satisfied that all work is in accordance with the Contract Documents, the Contractor will be notified in writing.

END OF SECTION 27 0501

SECTION 27 0526

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. Applicable requirements of Division 27 – Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Grounding and Bonding for Communications Systems.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.02 QUALITY ASSURANCE

- A. National Electric Code Compliance: Comply with all NEC articles that apply to construction and installation practices applicable to this section
- B. ANSI/TIA: Comply with all ANSI/TIA articles that apply to construction and installation practices applicable to this section
- C. UL Compliance: Provide products that are UL and or cUL-classified.
- D. NFPA Compliance.
- E. All items of a given type shall be the products of the same manufacturer.
- F. Supply all equipment and accessories new and free from defects.

1.03 SUBMITTALS

- A. Product submittals:
 - 1. Provide an electronic Submittal Log matrix, listing each of the components to be used.
 - a. Submittal Log fields to include referenced specification section, manufacturer, component description and part number.
 - 2. Provide manufacturer's cut sheet of each of the components to be used.
 - a. Specified component to be clearly designated on the manufacturer's cut sheet.
 - b. Manufacturer cut sheets to include detailed component performance parameters.

- B. Shop drawing submittals:
 - 1. Provide shop drawings that have been coordinated with field conditions and the work of other trades.
 - 2. Submit shop drawings for review and acceptance prior to commencement of work.
- C. As-built documentation submittals:
 - 1. Provide as-built documentation of all telecommunications pathway systems under this section utilized throughout the site for review, acceptance and future reference.
 - 2. As-built documentation to include:
 - a. Record Drawings.
 - b. Database matrix of components used.
- D. Warranty documentation:
 - 1. Submit manufacturers extended warranty certification after the warranty acceptance by the manufacturer. It shall be the contractor's responsibility to facilitate the manufacturer specific warranty requirements.

1.04 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 PRODUCTS

2.01 GROUNDING BUSBARS

- A. Grounding busbars
 - 1. Acceptable manufacturers:
 - a. Harger
 - b. Chatsworth
 - c. Or approved equal
 - 2. Copper ground bar, 24 inches long x 4 inches high x 1/4-inch thick.
 - 3. Provide with mounting brackets, insulated stand-offs, and attachment hardware.
 - 4. The grounding busbar shall be made of 1/4" thick solid copper.
 - 5. The grounding busbar shall be installed with minimum clearance, 1" offsets and 1 1/2" insulators.
 - 6. The grounding busbar shall accommodate 2-hole compression lugs.

7. The grounding busbar shall meet or exceed ANSI/TIA-607-B requirements.

2.02 GROUNDING CONDUCTORS AND LUGS

A. Grounding conductors

1. Acceptable manufacturers:
 - a. Harger
 - b. General Cable
 - c. Or approved equal
2. Minimum #6 AWG THHN copper conductors – sized at 2 kcmil per linear foot of conductor length up to a maximum size of 4/0 AWG insulated with heat and moisture resistant PVC over which a UL listed jacket is applied – UL listed
3. Jacket color shall be green or black. Black jacketed cable shall be identified at each termination point with a wrap of green tape.

B. Grounding lugs

1. Acceptable manufacturers:
 - a. Harger
 - b. Panduit
 - c. Or approved equal
2. All stranded copper ground wires shall be terminated with 2-hole, long-barrel compression lugs.
3. Silicon bronze or stainless steel bolts and washers shall be used to install lugs to equipment. Exothermic welding is also allowed
4. 2-hole, long-barrel compression lugs.

2.03 RUNWAY GROUNDING STRAPS

A. Grounding straps

1. Acceptable manufacturers:
 - a. B-line
 - b. Chatsworth
 - c. Or approved equal
2. Flexible tin plated copper wire, #6 AWG, 12" long with crimped lugs on each end and 1/4"-20 mounting hardware.

2.04 SHIELD BOND CONNECTORS

A. Shield bond connector

1. Acceptable manufacturers:

- a. 3M Scotchlok
 - b. Or approved equal
2. Shield bonding assembly, with base and top members made of tin-plated tempered brass, slightly curved to exert a continuous spring force on sheath and shield after clamping, and two securing lock nuts. Designed to make a stable, low resistance electrical connection between the shield of a communications cable and a wire conductor.

2.05 CONDUIT GROUNDING FITTINGS

- A. Conduit grounding fittings
 1. Acceptable manufacturers:
 - a. Steel City
 - b. Or approved equal
 2. Insulated grounding bushing, malleable iron/zinc plated, for copper or aluminum bare ground wire. Size as required.
 3. MT steel set-screw connectors with heavy steel walls, insulated throat, male hub thread NPS, pre-set pre-staked set screws, steel/zinc plated finish. Size as required.

2.06 TELECOM RACK GROUND BAR KIT

- A. Vertical ground bar kit for telecom rack
 1. The rack ground bar kit includes a thin strip of tinned copper that attaches to the rack's equipment mounting rail to provide direct ground contact for rack-mount equipment.
 2. Sized to fit a rack with an EIA-310-D Universal, hole pattern.
 3. Minimum 0.05" thick tinned copper strip
 4. Width is 0.68" and length is sized to fit rack height and RU.
 5. Accommodate 2-hole compression lugs.
 6. UL listed

PART 3 EXECUTION

3.01 GROUNDING

- A. The facility shall be equipped with a communications grounding system used to ground all communications cable shields, equipment, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current carrying conductor. The communications grounding system shall be installed independent of the building's electrical and building ground and shall be designed in accordance with the recommendations contained in the ANSI/TIA-607-B Telecommunications Bonding and Ground Standard.

3.02 GROUNDING BUSBAR INSTALLATION

- A. The Contractor shall install a ground bars in communications spaces to which all ground wires, grounding terminal points within the room, and bonding conductors will terminate.
- B. The ground bar shall be installed in a horizontal orientation at a height above finished floor and at the location indicated on the enlarged floor plan drawings.
- C. The main entrance facility/equipment room in each building shall be equipped with a telecommunications main grounding busbar (TMGB). The TMGB shall be connected to the building electrical entrance grounding facility.
- D. Each communications space/room/closet shall be provided with a telecommunications ground busbar (TGB).
- E. Provide the full complement of grounding busbars for communications spaces to meet the number of grounding and bonding connections required per space.

3.03 GROUNDING CONDUCTORS AND LUGS INSTALLATION

- A. Contractor shall install and bond a 4/0 gauge ground wire using a 2-hole, long-barrel compression lug from the TMGB ground bar in the MDF room to the main ground bar at the main building electrical service.
- B. There shall be no splices or mechanical couplers installed between the wire points of origin and termination.
- C. Place copper ground conductor in minimum 1" size EMT conduit when routing outside of the communications spaces to existing ground bars in electrical distribution panels or to existing building steel connections outside the communications spaces.
- D. Grounding of the conduit should be done at the electrical distribution panels or building steel connections only (not on ground bar) unless otherwise required by code.
- E. All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, etc. entering or residing in the MC/IC/TC shall be grounded to the respective TGB or TMGB using a minimum #6 AWG stranded copper bonding conductor and compression lugs.
- F. The Contractor shall install a continuous bonding conductor (wire) as an uninterrupted conductor section bonded to each layer of cable runway. There shall be no splices or mechanical couplers installed between the wire points of origin and termination except as specified herein.
- G. Unless otherwise noted, all bonding and ground wires on telecom cable trays and runways shall be routed on the outer edge of the cable trays and cable runways.
- H. Contractor shall utilize the lug-crimping tool designed to work specifically with the specified lugs. Use of tools not specifically designed for lug crimping, or

other methods of crimping shall be deemed unacceptable. Lugs installed in an unacceptable manner shall be replaced at no cost to the Owner.

- I. All wires used for communications grounding purposes shall be identified with a green insulation. Non-insulated wires shall be identified at each termination point with a wrap or green tape. All cables and busbars shall be identified and labeled in accordance with the ANSI/TIA-606-A.

3.04 RUNWAY GROUNDING STRAP INSTALLATION

- A. The Contractor shall provide a grounding strap between cable runway sections in order to provide a continuous ground path throughout the cable runway assembly.

3.05 CONDUIT GROUND FITTINGS INSTALLATION

- A. EMT or rigid conduit used for routing of ground cables between communications spaces and the main electrical ground bar shall have a threaded grounding bushing with set screws to ensure electrical and mechanical connection.
- B. EMT conduit used for routing of station cables into the communications spaces shall have a threaded grounding bushing with set screws to ensure electrical and mechanical connection.
- C. The EMT conduit shall have a steel set screw coupling with a threaded insulated grounding bushing securely connected to the point of termination within the communications spaces or the Main Electrical closet.
- D. Rigid conduit shall use threaded insulated grounding bushing securely connected directly to the threaded end of the conduit.
- E. The bonding jumper shall be stripped and tightened securely on the set screw connection at the grounding bushing. The other end of the bonding jumper shall be properly connected in a two-hole long barrel lug and secured to the pre-drilled insulated ground bar
- F. Banks of conduits providing entry of communications cable into a communications spaces may be grounded by either of the following methods:
 1. Each individual conduit shall have an insulated grounding bushing with a continuous bonding jumper in a daisy chain configuration, bonded to a predrilled insulated ground bar in the communications space
 2. Or the individual conduits shall be securely clamped in an approved manner to a strut trapeze assembly, which shall be bonded to a predrilled insulated ground bar in the communications space.

3.06 TELECOM RACK GROUND BAR KIT INSTALLATION

- A. Provide and install a telecom rack ground bar kit that attaches to the rack's equipment mounting rail to provide direct ground contact for rack-mount equipment.

- B. Provide bonding of the telecom rack ground bar kit to the communications space TGB.

3.07 CLOSEOUT AND ACCEPTANCE

- A. No additional burden to the Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for reinstallation work shall be coordinated, in writing, with the Owner prior to beginning the work.
- B. All specified Communications systems indicated on the drawings and specifications shall be complete.
- C. Specified shop drawings and product submittals shall have been submitted for review and all review comments and deficiencies shall have been resolved. Final shop drawings and product submittals shall have been submitted, reviewed and found to meet the requirements of the specifications.
- D. Issues and deficiencies identified in field reports and punch lists shall have been resolved. Final as-built drawings shall have been submitted, reviewed and found to meet the requirements of the specifications.
- E. Contractor shall provide written notice of final completion of the telecom infrastructure. Upon receipt, the Owner's Representative will review/observe the completed installation. Once the Owner's Representative is satisfied that all work is in accordance with the Contract Documents, the Contractor will be notified in writing.

END OF SECTION 27 0526

SECTION 27 0528

PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Metal conduits and fittings.
 - 2. Nonmetallic conduits and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Boxes, enclosures, and cabinets.
- B. Related Requirements:
 - 1. Section 260533 "Raceways and Boxes" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.

1.03 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. IMC: Intermediate metal conduit.

PART 2 - PRODUCTS

2.01 METAL CONDUITS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Allied Tube & Conduit; a Tyco International Ltd. Co.

3. Alpha Wire Company.
 4. Anamet Electrical, Inc.
 5. Electri-Flex Company.
 6. O-Z/Gedney; a brand of EGS Electrical Group.
 7. Picoma Industries; Subsidiary of Mueller Water Products, Inc.
 8. Republic Conduit.
 9. Robroy Industries.
 10. Southwire Company.
 11. Thomas & Betts Corporation.
 12. Western Tube and Conduit Corporation.
 13. Wheatland Tube Company; a division of John Maneely Company.
- B. General Requirements for Metal Conduits and Fittings:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Comply with TIA-569-B.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. ARC: Comply with ANSI C80.5 and UL 6A.
- E. IMC: Comply with ANSI C80.6 and UL 1242.
- F. EMT: Comply with ANSI C80.3 and UL 797.
- G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Setscrew or compression.
 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

- H. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.02 NONMETALLIC CONDUITS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 3. Anamet Electrical, Inc.
 - 4. Arnco Corporation.
 - 5. CANTEX Inc.
 - 6. CertainTeed Corp.
 - 7. Condux International, Inc.
 - 8. Electri-Flex Company.
 - 9. Kraloy.
 - 10. Lamson & Sessions; Carlon Electrical Products.
 - 11. Niedax-Kleinhuis USA, Inc.
 - 12. RACO; a Hubbell company.
 - 13. Thomas & Betts Corporation.
- B. General Requirements for Nonmetallic Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.
- C. RNC: Type EPC-80-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- D. Rigid HDPE: Comply with UL 651A.
- E. Continuous HDPE: Comply with UL 651B.
- F. RTRC: Comply with UL 1684A and NEMA TC 14.

- G. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- H. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- I. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.03 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman; a Pentair company.
 - 3. Mono-Systems, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 or Type 3R stainless steel unless otherwise indicated, and sized according to NFPA 70.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Screw-cover type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.04 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Adalet.
 - 2. Cooper Technologies Company; Cooper Crouse-Hinds.

3. EGS/Appleton Electric.
 4. Erickson Electrical Equipment Company.
 5. Hoffman; a Pentair company.
 6. Hubbell Incorporated; Killark Division.
 7. Lamson & Sessions; Carlon Electrical Products.
 8. Milbank Manufacturing Co.
 9. Molex; Woodhead Brand.
 10. Mono-Systems, Inc.
 11. O-Z/Gedney; a brand of EGS Electrical Group.
 12. RACO; a Hubbell company.
 13. Robroy Industries.
 14. Spring City Electrical Manufacturing Company.
 15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
 16. Thomas & Betts Corporation.
 17. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets:
1. Comply with TIA-569-B.
 2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- F. Metal Floor Boxes:
1. Material: Cast metal.
 2. Type: Fully adjustable.
 3. Shape: Rectangular.

4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
 - H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
 - I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
 - J. Gangable boxes are prohibited.
 - K. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
 - L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 or Type 3R stainless steel with continuous-hinge cover with flush latch unless otherwise indicated.
 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
 - M. Cabinets:
 1. NEMA 250, Type 1 or Type 3R, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 2. Hinged door in front cover with flush latch and concealed hinge.
 3. Key latch to match panelboards.
 4. Metal barriers to separate wiring of different systems and voltage.
 5. Accessory feet where required for freestanding equipment.
 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.01 PATHWAY APPLICATION

- A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
 1. Exposed Conduit, Damp Location: GRC.
 2. Exposed Conduit, Wet Location: GRC.

3. Concealed Conduit, Aboveground: EMT.
 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R stainless steel.
- B. Indoors: Apply pathway products as specified below 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: GRC. Pathway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 5. Damp or Wet Locations: GRC.
 6. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250 Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Pathway Size: 3/4-inch trade size. Minimum size for optical-fiber cables is 1 inch.
- D. Pathway Fittings: Compatible with pathways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 3. EMT: Use setscrew or compression, steel or cast-metal fittings. Comply with NEMA FB 2.10.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface pathways only where indicated on Drawings.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.02 INSTALLATION

- A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- B. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- C. Complete pathway installation before starting conductor installation.
- D. Comply with requirements in Section 16073 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches of enclosures to which attached.
- I. Pathways 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. Secure pathways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange pathways to keep a minimum of 1 inch of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 - 5. Change from ENT to GRC or IMC before rising above floor.
- J. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for pathways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- N. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- P. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- Q. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lbtensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.
- R. Surface Pathways:
 - 1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
 - 2. Install surface pathway with a minimum 2-inch radius control at bend points.
 - 3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- S. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
 - 1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
 - 2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
 - 3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

- T. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.
- U. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where otherwise required by NFPA 70.
- V. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- W. Expansion-Joint Fittings:
 - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
 - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 - 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 - 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 - 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

- X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- Y. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- Z. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- AA. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- BB. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- CC. Set metal floor boxes level and flush with finished floor surface.
- DD. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.03 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260500 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.04 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.05 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 27 0529

HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. Applicable requirements of Division 27 – Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Hangers and Supports for Communications Systems.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.02 QUALITY ASSURANCE

- A. National Electric Code Compliance: Comply with all NEC articles that apply to construction and installation practices applicable to this section
- B. ANSI/TIA: Comply with all ANSI/TIA articles that apply to construction and installation practices applicable to this section
- C. UL Compliance: Provide products that are UL and or cUL-classified.
- D. All items of a given type shall be the products of the same manufacturer.
- E. Supply all equipment and accessories new and free from defects.

1.03 SUBMITTALS

- A. Product submittals:
 - 1. Provide an electronic Submittal Log matrix, listing each of the components to be used.
 - a. Submittal Log fields to include referenced specification section, manufacturer, component description and part number.
 - 2. Provide manufacturer's cut sheet of each of the components to be used.
 - a. Specified component to be clearly designated on the manufacturer's cut sheet.
 - b. Manufacturer cut sheets to include detailed component performance parameters.
- B. Shop drawing submittals:

1. Provide shop drawings that have been coordinated with field conditions and the work of other trades.
 2. Submit shop drawings for review and acceptance prior to commencement of work.
- C. Seismic and bracing documentation for the structural bracing and support of telecommunications equipment:
1. Refer to Structural design documents for seismic requirements for non-structural components for all structural bracing and support of telecommunications equipment.
 2. Provide seismic design calculations and seismic design sketches prepared by the Contractor's California Certified structural engineer for coordination and approval by the Owner's Representative prior to fabricating or installing any supports. Any proposed reinforcement to be the responsibility of the Contractor. Coordinate seismic design with other trades, fire protection and site conditions.
- D. As-built documentation submittals:
1. Provide as-built documentation of all telecommunications pathway systems under this section utilized throughout the site for review, acceptance and future reference.
 2. As-built documentation to include:
 - a. Record Drawings.
 - b. Database matrix of components used.
- E. Warranty documentation:
1. Submit manufacturers extended warranty certification after the warranty acceptance by the manufacturer. It shall be the contractor's responsibility to facilitate the manufacturer specific warranty requirements.

1.04 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 PRODUCTS

2.01 NON-CONTINUOUS CABLE SUPPORT SYSTEMS

- A. Acceptable Manufacturers
1. B-line
 2. Erico
 3. Or approved equal
- B. Non-continuous cable supports

1. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables.
 2. cULus listed.
 3. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
 4. Non-continuous cable supports sized 1⁵/₁₆" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.
 5. Non-continuous cable supports shall be rated for indoor use in non-corrosive environments.
 6. Provide manufacturer recommended specialty fasteners including threaded rod assemblies, beam clamps, flange clips, C and Z purlin clips.
- C. Multi-tiered non-continuous cable support assemblies
1. Multi-tiered non-continuous cable support assemblies shall be used where separate cabling compartments are required. Assemblies may be factory assembled or assembled from pre-packaged kits.
 2. Assemblies shall consist of a hanger bracket holding up to six non-continuous cable supports.
 3. Multi-tiered non-continuous cable support assemblies shall be rated for indoor use in non-corrosive environments.
 4. cULus listed.
 5. Provide manufacturer recommended specialty fasteners including threaded rod assemblies, beam clamps, flange clips, C and Z purlin clips.
- D. Adjustable Non-Continuous Cable Support Sling
1. Constructed from steel and woven laminate; sling length can be adjusted to hold up to 425 4-pair UTP.
 2. Rated to support Category 5 and higher cable and optical fiber cable.
 3. cULus listed.
 4. Adjustable non-continuous cable support sling shall have a static load limit of 100 lbs.
 5. Adjustable non-continuous cable support sling shall be suitable for use in air handling spaces.
 6. Adjustable Non-Continuous Cable Support Sling shall be rated for indoor use in non-corrosive environments
 7. Provide manufacturer recommended specialty fasteners including threaded rod assemblies, beam clamps, flange clips, C and Z purlin clips.

2.02 FABRIC INNERDUCT

- A. Acceptable Manufacturers
1. Maxcell
 2. Or approved equal
- B. Fabric innerduct
1. Flexible textile communications raceway

2. Use: Provide wire management in a building for copper and fiber optic communications cabling.
 3. Material: White Polyester and Nylon resin polymer.
- C. Self-supporting indoor plenum rated textile innerduct:
1. Micro (33mm), 2-inch and 3-inch single or multi-cell nylon textile innerduct.
 2. Fire resistant nylon monofilament fabric
 3. High tenacity polyester 500 lbs.or 1,250 lbs. rated pull tape
 4. Plenum rated OFCR FT6
 5. Pre-installed galvanized support wire.
 - a. Galvanized 7x7 Stranded Steel
 - b. $\frac{3}{32}$ " diameter
 6. Load Rating: 920 lbs.
 7. Weight: 1.6 lbs. per 100 ft.
- D. Indoor plenum rated textile innerduct:
1. Micro (33mm), 2-inch and 3-inch single or multi-cell nylon textile
 2. Innerduct.
 3. Fire Resistant Nylon Monofilament fabric
 4. High Tenacity Polyester 500 lbs.or 1,250 lbs. rated pull tape
 5. Plenum Rated OFCR FT6
- E. Indoor riser rated textile innerduct:
1. Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell nylon textile innerduct
 2. 1,250 lb. polyester flat woven pull tape which meets UL2024A for flame propagation and smoke density values for general applications.
- F. Standard outdoor textile innerduct
1. Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell polyester/nylon textile innerduct
 2. 1,250 lb. polyester flat woven pull tape.
- G. Detectable outdoor textile innerduct
1. Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell polyester/nylon textile innerduct
 2. 1,250 lb. polyester flat woven pull tape, and a solid copper, polyvinyl color coated conductor (19AWG minimum) for tracing and rated for a minimum of 6 amps and 600 volts. Conductor shall be placed in the sidewall edge fold of the textile sleeve.

H. Fabric innerduct fittings

1. Conduit Plugs: Compression-type conduit plugs with locking nuts for sealing and securing one or more textile innerducts within a 4-inch inside diameter conduit,
2. Termination Bags: Inflation-type bags for sealing and securing around one or more textile innerducts and cables within 2-inch outside diameter or larger conduit.
3. Pull tape:: measuring and pulling tape constructed of synthetic fiber, printed with accurate sequential footage marks. Color-coded.
4. Penetration sealing materials: Duct Water Seal: products suitable for closing underground and entrance conduit openings where innerduct or cable is installed, to prevent entry of gases, liquids, or rodents into the structure.

2.03 STRUCTURAL SUPPORT SYSTEMS

A. Slotted strut supports

1. Acceptable manufacturers:
 - a. B-line
 - b. Unistrut
 - c. Or approved equal
2. Provide continuous slotted strut and all associated fittings and hardware.
3. Use:
 - a. Post and grid support system inside communications spaces.
 - b. Trapeze and bracing type supports.
4. Slotted struts and fittings shall have the manufacturer's name, part number, and material heat code identification number stamped in the part itself for identification.
5. Material certification sheets and test reports must be publically available by the manufacturer.
6. Single slotted strut shall be 1 $\frac{5}{8}$ " wide in varying heights and welded combinations as required to meet load capacities and designs indicated on the drawings.
7. Materials and Finish: Material and finish specifications for each strut type are as follows:
 - a. Aluminum: Strut shall be manufactured of extruded aluminum alloy 6063-T6. All fittings and hardware shall be zinc plated according to ASTM B633 (SC3 for fittings, SC1 for threaded hardware) for indoor use only. For outdoor use, all fittings and hardware shall be stainless steel type 316. Fittings shall be hot dip galvanized after fabrication in accordance with ASTM 123 with stainless steel Type 316 or chromium zinc ASTM F1136 Gr. 3.

- b. Epoxy Painted: Strut shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS Grade 33, then painted with water born epoxy applied by a cathodic electro-deposition process. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A907 SS, Grade 33. All fittings and hardware shall be zinc plated in accordance with ASTM B633 (SC3 for fittings, SC1 for threaded hardware).
 - c. Pre-galvanized Steel: Strut shall be made from steel meeting the minimum mechanical properties of ASTM A653 SS, Grade 33, and mill galvanized in accordance with coating designation G90. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A907 SS, Grade 33. All fittings and hardware shall be zinc plated in accordance with ASTM B633 (SC3 for fittings, SC1 for threaded hardware).
 - d. Hot-dip Galvanized Steel: Strut shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A907 SS, Grade 33, and hot-dip galvanized after fabrication in accordance with ASTM A123. All hardware shall be stainless steel type 316 or chromium zinc ASTM F1136 Gr. 3. All hot-dip galvanized after fabrication products must be returned to point of manufacture after coating for inspection and removal of all sharp burrs.
 - e. Stainless Steel: All strut, fittings and hardware shall be made of AISI type 316 stainless steel as indicated.
- B. Plywood backboards
- 1. Communication rooms interior wall surfaces will be covered with $\frac{3}{4}$ " A/C plywood from 1'-0" to 9'-0" AFF (unless noted differently on drawings), with the A side mounted out.
 - 2. Backboards shall be $\frac{3}{4}$ " void free plywood. Size of backboard shall be 4' x 8' (unless noted differently on drawings).
 - 3. The wall partitions to which the plywood is to be attached shall be structurally configured by the Architect to provide a surface to which the plywood can be safely mounted.

PART 3 EXECUTION

3.01 NON-CONTINUOUS CABLE SUPPORT SYSTEMS

- A. Follow manufacturer's instructions and recommended industry standards and guidelines for installation.
- B. The installed non-continuous support system must be an independent support structure for the communications system.

- C. Draping cables over other structures in the ceiling is unacceptable. Water pipes, ceiling grid, sprinkler system, electrical supports, air ducts or any other in-ceiling structure may not be used for cable support.
- D. Non-continuous supports shall be used to supplement the main cable support system when any cabling leaves the main support system or is unsupported for more than three and one half feet (3½'-0").
- E. Non-continuous supports shall be installed with ceiling wire or threaded rod secured to the slab above to support the communications cable infrastructure parallel to the slab throughout the cable plant, unless site conditions dictate a non-parallel installation.
- F. Non-continuous supports must be routed to follow existing corridors and parallel or 90 degree angles from all walls and the cable tray whenever possible.
- G. Non-continuous support system is a method of supporting horizontal network cabling between the communications intermediate distribution rooms (IDFs) and the work area outlet where cable tray assemblies are not installed.
- H. Non-continuous support system shall consist of a scalable pathway system able to accommodate a 50% increase in future cable counts.
- I. Under no circumstances shall the non-continuous support pathway be obstructed by other structural obstructions for example, fire sprinkler pipes, mechanical ductwork, structural beams, electrical junction boxes and/or conduits, ceilings etc.
- J. Under no circumstances shall the non-continuous supports be spaced further than the allowed 4' or at such intervals as to allow cable bundles supported to rest on any structural obstructions for example, fire sprinkler pipes, mechanical ductwork, structural beams, electrical junction boxes and/or conduits, ceilings etc.
- K. The non-continuous support system shall at all times allow for EIA/TIA standards compliant cable bend radii to accommodate copper and fiber station cabling.
- L. The non-continuous supports system shall be installed in a structured grid pattern perpendicular to the existing cable tray pathways and shall make use of a modular assembly method to support a scalable pathway system for future needs.
- M. Cable bundles inside the non-continuous supports system shall at all times be bundled neatly to lay inside the hook system with no excessive cable slack or loop overhang.
- N. The non-continuous supports system shall be suspended off ¼" threaded rod supported off the slab above with approved anchors. Provide bracing wires and steel straps at minimum every 25', at all directional changes in the non-continuous support system pathway and at all intersections of the non-continuous support system pathways.
- O. Other approved methods of supporting the non-continuous supports are with structural beam clamps, flange clips, C and Z purlin clips.

- P. Installation and configuration shall conform to the requirements of ANSI/TIA-568-C.0, ANSI/TIA-568-C.1 & ANSI/TIA-569-B, NFPA 70 (National Electrical Code), applicable local codes, and to the manufacturer's installation instructions.
- Q. Install cables using techniques, practices, and methods that are consistent with Category 5e or higher requirements and that supports Category 5e or higher performance of completed and linked signal paths, end to end.
- R. Install cables without damaging conductors, shield, or jacket.
- S. Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by manufacturer.
- T. Pull cables without exceeding cable manufacturer's recommended pulling tensions. Use pulling means that will not damage media.
- U. Do not exceed load ratings specified by manufacturer.
- V. Adjustable non-continuous support sling shall have a static load limit of 100 lbs.
- W. To avoid electromagnetic interference (EMI), pathways shall provide minimum clearances of four feet from motors or transformers, one foot from conduit and cables used for electrical power distribution, and five inches from fluorescent lighting. Pathways shall cross perpendicular to fluorescent lighting and electrical power cables or conduits.

3.02 FABRIC INNERDUCT SYSTEMS

- A. Follow manufacturer's instructions and recommended industry standards and guidelines for installation.
- B. Protection of products during onstruction from the effects of moisture, UV exposure, corrosion and physical damage during construction.
- C. Provide textile innerduct in conduit and wire ways, and place textile innerduct within and under cable trays using continuous unspliced lengths of textile innerduct between maintenance holes, pull boxes, and/or termination points as indicated on the drawings.
- D. Install textile innerduct ensuring that no twist is introduced to the innerduct.
- E. Provide suitable textile innerduct slack in the maintenance holes, hand holes, pull boxes, and at turns to ensure there is no kinking or binding of the product.
- F. Textile Innerduct Mountings, Hangers and Attachments:
 - 1. When exposed indoors or in maintenance holes, hold firmly in place using independent support.
 - 2. Design & install hangers and other similar fittings adequate to support loads and so as to not damage innerduct.
 - 3. Do not fasten textile innerduct to steam, water, or other piping, ductwork, mechanical equipment, electrical equipment, electrical raceways, or wires.

G. Maintenance Hole and Hand Hole Installation:

1. At locations where textile innerduct will be continuous through a manhole or hand hole, allow sufficient slack so that the innerduct may be secured to the side of the vault maintaining the minimum bend radius.
2. At maintenance holes serving as the junction location, pull the exposed end of the innerduct to the far end of the vault, install termination bag, and secure to the vault.

H. Cable Tray and Runway Installation:

1. Cut incisions every 24 inches into the edge of the textile innerduct and cable wrap to one side of vertical ladder rack or horizontal ladder-type cable tray at each incision.

I. Penetrations:

1. Seal all conduit and textile innerduct entering structures at the first box or outlet to prevent entrance into the structure of gases, liquids or rodents.
2. Inspect fire stopping installation by others between building structure and conduit, wire way, and cable tray to verify integrity of installation.
3. Exposed Textile Innerduct Penetrations: Install conduit sleeves or fire barrier sealing systems in all openings where open and exposed textile innerduct passes through fire-rated walls and floors. After installation, install intumescent fire barrier penetration sealing material between textile innerduct and sleeves or fire barrier system.

J. Raceway Penetrations:

1. After textile innerduct installation, install intumescent fire barrier penetration sealing material between textile innerduct and conduit or wire way at all exposed penetration locations.
2. Protect adjacent surfaces from damage during water seal or fire stop installation. Repair any damage.

K. Document entire installation process for future referral.

3.03 STRUCTURAL SUPPORT SYSTEMS

A. Slotted strut supports

1. Leftover construction dust, metal filings and debris from drilling, cutting, sawing and any other construction activity can be detrimental to electronic equipment in production communications room environments. The Contractor shall be required to place dust protective plastic covers at all times over HVAC systems, UPS power systems and any other equipment or furniture that is occupying the space during construction when the Contractor is doing construction work in the immediate vicinity of this equipment. This will prevent dust, metal filings and debris collection in the equipment during construction. Dust protection covers to be approved by the Owner prior to installation.

2. The Contractor shall do vacuuming, mopping and cleaning of immediate environment around any area where drilling, cutting, and sawing and any other construction activity is taking place at the same time of the construction activity.
3. The Contractor shall do vacuuming, mopping and cleaning of the entire communications room environment prior to termination of cabling and prior to electronic hardware being installed inside the technology rooms.
4. Install cable trays as indicated on the drawings, in accordance with the manufacturer's instructions, and with recognized industry practices to ensure compliance with requirements of NEC.
5. Drawings are for assistance and guidance, but exact routing, locations, distances and levels will be governed by actual field conditions. Verify exact location of slotted strut support system with installed utilities and other existing obstructions.
6. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the communications system is accurate and complete before proceeding with installation or use of products specified in this section.
7. Installation of slotted strut support systems shall provide minimum workable space clearances to the following:
 - a. Ensure that slotted strut support system do not interfere with or restrict access to lighting fixtures, other structural supports, air ducts, conduits, piping, cable trays or raceways and other trades installations.
8. Installation of slotted strut support systems must at all times provide a clear cable pathway to accommodate the installation of communications cable types and conform to the telecommunications industry standard bend radii for these cables.
9. Openings through fire partitions, fire walls or walls and floors shall be laid out in advance and fully coordinated with other trades.
10. All field-cut struts shall be de-burred prior to placement.
11. Provide external grounding straps locations where strut continuity is interrupted.
12. Install trapeze, post and grid strut support systems level and straight.
13. Provide all hardware, accessories, fasteners, anchors, threaded rods and strut supports required to provide a complete system.
14. The installed slotted strut support system must be an independent support structure for the communications system.
15. The slotted strut support grid & post system shall be bonded and grounded to the telecom ground bar with a continuous #6 AWG cable and the terminal ground support.

B. Plywood backboards

1. The plywood shall be fastened through the sheet rock wall surface to the structural members of the walls and not to the wall surfacing material.
2. Approved metal screws shall be used to fasten the plywood to the wall. The screws shall be recessed to provide a smooth non-interrupted surface.
3. The plywood shall be primed and painted with (2) coats of semi-white fire-retardant paint to match the room color.

3.04 CLOSEOUT AND ACCEPTANCE

- A. No additional burden to the Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for reinstallation work shall be coordinated, in writing, with the Owner prior to beginning the work.
- B. All specified Communications systems indicated on the drawings and specifications shall be complete.
- C. Specified shop drawings and product submittals shall have been submitted for review and all review comments and deficiencies shall have been resolved. Final shop drawings and product submittals shall have been submitted, reviewed and found to meet the requirements of the specifications.
- D. Issues and deficiencies identified in field reports and punch lists shall have been resolved. Final as-built drawings shall have been submitted, reviewed and found to meet the requirements of the specifications.
- E. Contractor shall provide written notice of final completion of the telecom infrastructure. Upon receipt, the Owner's Representative will review/observe the completed installation. Once the Owner's Representative is satisfied that all work is in accordance with the Contract Documents, the Contractor will be notified in writing.

END OF SECTION 27 0529

SECTION 27 0533

CONDUITS, PULLBOXES AND BACKBOXES FOR COMMUNICATIONS SYSTEM

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. Applicable requirements of Division 27 – Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Conduits, Pull boxes and Back boxes for Communications Systems.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.02 QUALITY ASSURANCE

- A. National Electric Code Compliance: Comply with all NEC articles that apply to construction and installation practices applicable to this section
- B. American National Standards Institute: Comply with all ANSI articles that apply to construction and installation practices applicable to this section
- C. UL Compliance: Provide products that are UL and or cUL-classified.

1.03 SUBMITTALS

- A. Product submittals:
 - 1. Provide an electronic Submittal Log matrix, listing each of the components to be used.
 - a. Submittal Log fields to include referenced specification section, manufacturer, component description and part number.
 - 2. Provide manufacturer's cut sheet of each of the components to be used.
 - a. Specified component to be clearly designated on the manufacturer's cut sheet.
 - b. Manufacturer cut sheets to include detailed component performance parameters.
- B. Shop drawing submittals:
 - 1. Provide shop drawings that have been coordinated with field conditions and the work of other trades.
 - 2. Submit shop drawings for review and acceptance prior to commencement of work.

- C. Seismic and bracing documentation for the structural bracing and support of telecommunications equipment:
 - 1. Refer to Structural design documents for seismic requirements for non-structural components for all structural bracing and support of telecommunications equipment.
 - 2. Contractor's California Certified structural engineer for coordination and approval by the Owner's Representative prior to fabricating or installing any supports. Any proposed reinforcement to be the responsibility of the Contractor. Coordinate seismic design with other trades, fire protection and site conditions.
- D. As-built documentation submittals:
 - 1. Provide as-built documentation of all telecommunications pathway systems under this section utilized throughout the site for review, acceptance and future reference.
 - 2. As-built documentation to include:
 - a. Record Drawings.
 - b. Database matrix of components used.
- E. Warranty documentation:
 - 1. Submit manufacturers extended warranty certification after the warranty acceptance by the manufacturer. It shall be the contractor's responsibility to facilitate the manufacturer specific warranty requirements.

1.04 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 PRODUCTS

2.01 CONDUIT

- A. Rigid Steel Conduit
 - 1. Acceptable manufacturers:
 - a. Allied Tube and Conduit
 - b. Cal Pipe Industries
 - c. Wheatland Tube Company
 - d. Or approved equal

2. Rigid steel conduit shall be hot dipped galvanized inside and outside conforming to ANSI and UL. Conduit shall have standard threaded type couplings and fittings.
3. Threads on the uncoupled ends shall be covered by industry color-coded thread protectors.
4. Teflon tape shall be used on all galvanized rigid steel conduit thread joints.

B. Non-Metallic (PVC) Conduit

1. Acceptable PVC conduit and fitting manufacturers:
 - a. Carlon
 - b. PW Pipe
 - c. Georgia Pipe Company
 - d. Or Approved Equal
2. Non-metallic conduit shall be heavy wall, Schedule 40 PVC.
3. Couplings and connectors for non-metallic conduit shall be of the same material and be the product of the same manufacturer of the conduit furnished.
4. Colored primer and solvent cement designed to be used with Schedule 40 PVC conduit shall be utilized in the assembly of all PVC conduit joints.
5. Straight Schedule 40 PVC conduit shall have an expanded bell on one end and an insertion depth line on the spigot end to facilitate inspection for completeness of joint. All bell end joints shall be interference types.
6. Schedule 40 PVC conduit couplings and rigid bends:
 - a. Molded couplings with an internal stop as required for the joining of two non-bell end Schedule 40 PVC conduits,
 - b. Sleeve couplings without an internal stop,
 - c. Factory-made bends with bell or coupling ends with minimum radius and curvature to meet communications bend radii standards.

C. Electrical Metallic Tubing (EMT)

1. Acceptable EMT conduit and fitting manufacturers:
 - a. Allied Tube and Conduit
 - b. Cal Pipe Industries
 - c. Wheatland Tube Company
 - d. Or approved equal
2. Additional acceptable EMT conduit fitting manufacturers:
 - a. Thomas & Betts
 - b. Steel City

- c. Or Approved Equal
 - 3. EMT shall be hot galvanized steel O.D. with an organic corrosion resistant I.D. coating, and shall be listed and manufactured in accordance with UL Safety Standard 797 and ANSI C80.3.
 - 4. Electrical metallic tubing (EMT), couplings and connectors shall be steel. Malleable iron, pressure-cast or die-cast fittings are not permitted.
 - 5. Fittings for 2" EMT and smaller shall be steel set screw type, except where otherwise noted. Fittings for 2.5" and larger shall be steel set screw type with two (2) screws for connectors and four (4) screws for couplings. All connectors shall be insulated throat type.
- D. Non-Metallic Fiberglass Conduit
- 1. Acceptable Fiberglass conduit and fitting manufacturers:
 - a. FRE Composite,
 - b. Champion Fiberglass,
 - c. Or approved equal.
 - 2. Shall be manufactured from E or E-CR glass and epoxy resin with no fillers.
 - 3. Shall have a resin content of 32%, plus or minus 3%.
 - 4. All joints shall be adhesive bonded inside a bell end of even socket depth through-out the raceway.
 - 5. Two part adhesive epoxy resin designed to be used fiberglass conduit shall be utilized to assemble the tight lock-style of joint.
 - 6. Conduit couplings and rigid bends:
 - a. Sleeve couplings without an internal stop
 - b. Factory-made bends with bell or coupling ends with minimum radius and curvature to meet communications bend radii standards.
 - 7. Fiberglass conduit and fittings:
 - a. FRE Composite
 - b. Champion Fiberglass
 - c. Or approved equal
- E. Electrical Non-Metallic Tubing (ENT)
- 1. Acceptable ENT and fitting manufacturers:
 - a. Carlon
 - b. Or approved equal
 - 2. ENT shall be a pliable, non-metallic raceway manufactured of the same PVC material used for rigid non-metallic conduit.

3. Fittings and outlet boxes shall be designed for use with ENT and listed by Underwriters Laboratories.

F. Conduit Support

1. Acceptable manufacturers:
 - a. B-line
 - b. Unistrut
 - c. Or approved equal
2. Supporting devices: Strut trapeze assemblies sized for the amount of conduit to be supported with minimum $\frac{3}{8}$ " threaded rods, clamps, conduit straps, C-clamps and retainers.
3. Provide fittings and accessories that match with the strut of the same manufacturer.

2.02 METALLIC BACKBOXES

- A. Acceptable manufacturers:
 1. Randl Industries
 2. Or Approved Equal
- B. Provide 5" H X 5" W X 2- $\frac{7}{8}$ " D outlet back boxes with integrated cable management at all communications outlet locations shown on drawings.
- C. Metallic outlet boxes and device covers shall be galvanized steel not less than $\frac{1}{16}$ " thick.
- D. Provide single gang plaster ring on all communications outlet back boxes, unless indicated otherwise.
- E. Plaster ring on all communications outlet back boxes shall be raised to compensate for the thickness of the wall finish.
- F. Provide (1) 1 $\frac{1}{4}$ " conduit from back box to cable tray, except as otherwise noted. Provide bushing on ends of all conduits.
- G. Provide pull string in all conduits.
- H. Bond conduits to cable tray pathways.
- I. All connectors and couplings shall be zinc-plated steel set screw type.
- J. Blank coverplates shall be provided for all metallic backboxes slated for future use.
- K. Blank coverplates shall be provided for all locations where surface mount outlet housings will be located inside metallic backboxes.

2.03 METALLIC BACKBOXES

- A. Acceptable manufacturers:
 - 1. Steel City
 - 2. Raco
 - 3. Or Approved Equal
- B. Provide 4^{11/16}" H X 4^{11/16}" W X 2^{1/8}" D outlet back boxes at all communications outlet locations shown on drawings.
- C. Metallic outlet boxes and device covers shall be galvanized steel not less than 1/16" thick.
- D. Provide single gang plaster ring on all communications outlet back boxes, unless indicated otherwise.
- E. Plaster ring on all communications outlet back boxes shall be raised to compensate for the thickness of the wall finish.
- F. Provide (1) 1" conduit from back box to cable tray, except as otherwise noted. Provide bushing on ends of all conduits.
- G. Provide pull string in all conduits.
- H. Bond conduits to cable tray pathways.
- I. All connectors and couplings shall be zinc-plated steel set screw type.
- J. Blank coverplates shall be provided for all metallic backboxes slated for future use.
- K. Blank coverplates shall be provided for all locations where surface mount outlet housings will be located inside metallic backboxes.

2.04 PLASTIC BACKBOXES

- A. Acceptable manufacturers:
 - 1. Ortronics
 - 2. Leviton
 - 3. Siemon
 - 4. Or approved equal
- B. Surface mount backboxes shall accept NEMA compliant flush-mount plates.
- C. Side and rear cable entry must be provided, with rear cable knockout sized to facilitate cable bend-radius.
- D. Backboxes shall have removable base and accommodate two sizes of raceway on sides, top and bottom.

- E. Backboxes shall be constructed of high-impact, fire-retardant plastic, UL Listed and compliant with TIA/EIA-568-B specifications.
- F. Available in single- and double-gang format.
- G. The surface mount box shall be deep enough to provide for connector modularity and flexibility in configuring multimedia outlets that respond to various network media needs such as audio, video, coaxial and optical fiber applications.
- H. The surface mount box shall have the option for internal storage space for slack cabling and a built-in spool for controlling optical fiber cable bend radius. Internal slack spool option shall be provided at all locations where optical fiber horizontal cables are present.
- I. Provide screws and NEMA compliant screw openings for mechanical fastening to building structures.
- J. Match the faceplate and outlet housing supplier.
- K. Color and material finish shall match architectural finish requirements be same as electrical faceplates.

2.05 PULL BOXES

- A. Acceptable manufacturers:
 - 1. B-line
 - 2. Hoffman
 - 3. Or Approved Equal
- B. Indoor NEMA Type 1:
 - 1. Enclosure and cover are fabricated from galvanized steel
 - 2. Enclosure body has mounting holes on the back
 - 3. Enclosures are available with knockouts on the sides, top and bottom ends
 - 4. Cover is secured to the body with plated screws
 - 5. Keyhole slots provided in the cover allow easy access to the inside without removing the screws
 - 6. #10-32 tapped hole provision for ground lug kit
 - 7. Gray acrylic electro coat finish inside and out.
- C. Indoor/Outdoor NEMA Type 3R (IP66 rated) pullbox for protection against windblown dust, rain, sleet, external ice formation and dripping noncorrosive liquids:
 - 1. Enclosure and cover are fabricated from code gauge G-90 grade galvanized steel

2. All continuous welded seams are finished smooth
 3. Cover is attached with gasketed screws
 4. Cover has a fixed, oil and water resistant gasket
 5. #10-32 tapped hole provision for ground lug kit.
- D. Indoor/Outdoor NEMA Type 4X (IP66 rated) intended for use where a corrosive environment exists:
1. Enclosure and door are fabricated from code gauge Type 304 or Type 316L stainless steel
 2. All continuous welded seams are finished smooth
 3. Hardware kit provided contains grounding hardware, flanged hex nuts for panel mounting and sealing washers for body mounting holes
 4. Body flange trough design, formed around body opening
 5. Ground stud provided in enclosure body
 6. Enclosure mounting holes in body provided for direct mounting
 7. Utility bracket provides wire management and accessory mounting
 8. Doors are secured to the body with a spring-loaded hinge design on one side and slotted quarter turn flush latch(es) on the opposite side
 9. Doors are easily removed and interchangeable
 10. Door has a fixed, oil and water-resistant, seamless foam in place gasket
 11. Door opens 170° for easy access
 12. Utility rail provides grounding, rigidity and wire management
 13. Door stiffeners are provided on larger enclosures for added rigidity
 14. Outer surface of enclosure and cover has a smooth brushed stainless steel finish
- E. Pull boxes to be sized per NEC code to accommodate the number of EMT conduits as shown on drawings with adequate clearances, access and cable management space.
- F. Pull boxes shall have provisions for grounding.

PART 3 EXECUTION

3.01 CONCRETE PENETRATIONS

- A. Holes through concrete and masonry in new and existing structures shall be cut with a diamond core drill or concrete saw upon approval of the structural engineer of record for the project. Pneumatic hammer, impact electric, hand or manual hammer type drills shall not be allowed, except where permitted by the

Project Manager as required by limited working space. X-ray all floor penetrations accordingly.

- B. Holes shall be located so as not to affect structural sections such as re-bar or beams.
- C. Openings through structural bearing walls, fire partitions, fire walls or walls and floors shall be laid out in advance and fully coordinated with other trades.
- D. Fire rated penetrations: Where openings pass through fire partitions, fire walls or walls and floors provide a code compliant effective barrier against the spread of fire, smoke and gases.
- E. No gaps or rough edges shall be allowed between concrete wall or slab and conduit/sleeve.

3.02 CONDUIT INSTALLATION

- A. Install individual and multiple trapeze hangers and riser clamps as necessary to support the conduits. Provide U-bolts, clamp attachments and other necessary hardware for hanger assemblies and for securing hanger rods and conduits. Space supports for conduits on maximum 10-foot centers. Support individual conduits 1½ inch and smaller with ¼ inch threaded steel rods and use ⅜ inch rods for 2 inch and larger.
- B. Conceal all conduits, except in unfinished spaces such as equipment rooms or as indicated by symbol on the Drawings.
- C. Conduits shall be clearly labeled at both ends designating the opposite locations(s) served. The numbering scheme shall be room number plus a suffix to guarantee uniqueness, e.g., 143-1. Labeling must be machine generated.
- D. Leave all empty conduits with a 200 pound test nylon cord pull line.
- E. Flattened, dented, or deformed conduits are not permitted and shall be removed and replaced.
- F. Conduit shall be run parallel or at right angles to walls, ceilings, and structural members.
- G. Provide appropriate fittings, flex conduit with slack for minimum movement as required and any expansion and deflection couplings needed where conduit passes over a building expansion joint.
- H. Service entrance conduit elbows shall be galvanized rigid steel. Service entrance conduits installed exposed or concealed in walls or above ceilings shall be galvanized rigid steel (G.R.S.). Service entrance conduits shall be installed in outdoor ductbanks, trenches or direct buried as defined by the N.E.C.
- I. Communications cables shall not occupy conduits with power cables.

- J. Metallic conduits shall be grounded in accordance with ANSI/TIA-607-B and the NEC.
- K. Article 344 of the National Electrical Code® (NEC) Rigid metal conduit (RMC) shall be used for entrance conduits that exceed 50 feet into the building.
- L. Bond conduits to cable tray sections where conduits terminate to meet up with cable tray sections. Provide grounding and bonding for conduits and pull boxes as indicated by NEC code and instructed by manufacturer.
- M. Conduit installations within concrete walls or floor slabs:
 - 1. Conduit shall be run following the most direct route between points.
 - 2. Conduit shall not be installed in concrete where the outside diameter is larger than $\frac{1}{3}$ of the slab thickness.
 - 3. Conduits shall not be installed within shear walls unless specifically indicated on the Drawings. Conduit shall not be run directly below and parallel with load bearing walls.
 - 4. Protect each metallic conduit installed in concrete wall or slab or conduits $1\frac{1}{2}$ inch and smaller passing through a concrete slab against corrosion where conduit enters and leaves concrete by wrapping conduit with vinyl all-weather electrical tape.
 - 5. Protect all conduits entering and leaving concrete walls or floor slabs from physical damage during construction.
- N. Conduit routing, bends and radius guidelines
 - 1. If the conduit has an internal diameter of 2 inches or less the bend radius must be at least 6 times the internal conduit diameter.
 - 2. If the conduit has an internal diameter of more than 2 inches the bend radius must be at least 10 times the internal conduit diameter.
 - 3. Conduit bends should be smooth, even, and free of kinks or other discontinuities that may have detrimental effects on pulling tension or cable integrity during or after installation.
 - 4. Communications conduit system shall contain no condulets (also known as an LB).
 - 5. If a conduit run requires more than two 90 degree bends then provide a pull box between sections with two bends or less.
 - 6. If a conduit run requires a reverse bend (between 100 degrees and 180 degrees) then insert a pull point or pull box at each bend having an angle from 100 degrees to 180 degrees.
 - 7. Consider an offset as equivalent to a 90 degree bend.
 - 8. Achieve the best direct route with no bend greater than 90 degrees or an aggregate of bends in excess of 180 degrees between pull points or pull boxes.

9. Contain no continuous sections longer than 100 ft.
10. For runs that total more than 100 ft. in length, pull points or pull boxes should be inserted so that no segment between points/boxes exceeds the 100 ft. limit.
11. Rated to withstand the environment to which they will be exposed.
12. Conduits should not be routed through areas in which flammable material may be stored or over or adjacent to boilers, incinerators, hot-water lines and steam lines.
13. Keep conduits at least 6' away from parallel runs of steam, hot water pipes or mechanical ductwork.
14. Provide firestopping according to UL-listing in openings between conduits and fire-rated floors or walls.

O. Conduit termination guidelines

1. Join conduits with fittings designed and approved for the purpose. Make the joints tight without protruding lips that can snag cable pulling inside the conduits.
2. Where conduits are terminated with locknuts and bushings align the conduit to enter squarely and install the locknuts with dished part against the box. Use two locknuts, one inside and one outside the box.
3. Ream all conduit ends and fit them with an insulated bushing to eliminate sharp edges that can damage cables during installation or service.
4. Conduits that enter a telecom room should terminate near the corners to allow for proper cable racking.
5. Terminate conduit penetrations through the floor slabs a minimum of 3-inches above the surface.

P. Conduit protection guidelines

1. Remove burrs, dirt and construction debris from conduits and pull boxes.
2. Conduits should be left capped for protection.
3. Provide final protection and maintain conditions in a manner acceptable to the Owners Representative to ensure that coatings and finishes are without damage or deterioration at completion. Repair damage to galvanized finishes with zinc-rich paint recommended by the manufacturer.

3.03 BACK BOXES

- A. Exact locations of the outlet boxes shall be coordinated with the architectural drawings and other trades.
- B. The approximate locations of the outlets are indicated on the Drawings. The exact locations shall be determined on site. The right is reserved to change, without additional cost, the exact location of any outlet, a maximum of 10' before it is permanently installed.

- C. Orientation of outlet boxes (horizontal or vertical) shall be as indicated on the architectural elevations.
- D. Install all outlet boxes in finished areas flush with the wall.
- E. Outlet boxes shall be firmly anchored in place and shall not depend on the coverplate to hold it secure to the wall.
- F. Outlet boxes installed back-to-back in fire-rated walls shall be separated horizontally by a minimum of 24”.

3.04 PULL BOXES

- A. Pull box support guidelines:
 - 1. Secure pull boxes independent of the conduit entries into the box.
 - 2. Pull boxes shall be secured to the building structure.
 - 3. Structural braces and/or reinforcements are to be attached directly to structural framework and secondary structural members; do not attach braces and/or reinforcements to elements other than structural framework and secondary structural members.
 - 4. Pull boxes shall not be supported with ceiling wires.
 - 5. Install pull boxes level and square at proper elevations.
- B. Conduits entering pull box guidelines:
 - 1. Conduits entering pull boxes shall connect to pull boxes using die-cast zinc connectors.
 - 2. Conduits should enter the pull boxes on the opposite short ends of a rectangular pull box.
 - 3. Conduits that enter the pull box from opposite ends with each other should be aligned.
 - 4. A pull box should not be used in lieu of a conduit bend.
- C. Install pull boxes in easily accessible locations at heights to provide access to pull boxes for cable access. Ensure adequate working clearances and cable management.
- D. Install pull boxes above suspended ceilings with no obstructions between the opening of the pull box and the ceiling system.
- E. For direct access to a pull box located above inaccessible ceilings provide a suitable, marked, hinged access panel (or equivalent) in the ceiling. This access panel can also serve as the cover for the box.
- F. Pull boxes should be rated to withstand the environment to which they will be exposed.
- G. Pull boxes shall be free from burrs, dirt and debris.

- H. Pull boxes shall be installed in accordance with ANSI/TIA-569-B.
- I. Pull boxes shall be grounded in accordance with ANSI/TIA-607-B.
- J. Table for pull box sizing:

Conduit Trade Size (in.)	Pull box Width (in.)	Pull box length (in.)	Pull box Depth (in.)	Increase for Additional Conduit (in.)
1	4	16	3	2
1 ¼	6	20	3	3
1 ½	8	27	4	4
2	8	36	4	5
2 ½	10	42	5	6
3	12	48	5	6
3 ½	12	54	6	6
4	15	60	8	8

3.05 CLOSEOUT AND ACCEPTANCE

- A. No additional burden to the Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for reinstallation work shall be coordinated, in writing, with the Owner prior to beginning the work.
- B. All specified Communications systems indicated on the drawings and specifications shall be complete.
- C. Specified shop drawings and product submittals shall have been submitted for review and all review comments and deficiencies shall have been resolved. Final shop drawings and product submittals shall have been submitted, reviewed and found to meet the requirements of the specifications.
- D. Issues and deficiencies identified in field reports and punch lists shall have been resolved. Final as-built drawings shall have been submitted, reviewed and found to meet the requirements of the specifications.
- E. Contractor shall provide written notice of final completion of the telecom infrastructure. Upon receipt, the Owner's Representative will review/observe the completed installation. Once the Owner's Representative is satisfied that all work is in accordance with the Contract Documents, the Contractor will be notified in writing.

END OF SECTION 27 0533

SECTION 27 0543

UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. Applicable requirements of Division 27 – Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Underground ducts and raceways for Communications Systems.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.02 QUALITY ASSURANCE

- A. National Electric Code Compliance: Comply with all NEC articles that apply to construction and installation practices applicable to this section
- B. ANSI/TIA: Comply with all ANSI/TIA articles that apply to construction and installation practices applicable to this section
- C. UL Compliance: Provide products that are UL and or cUL-classified.
- D. All items of a given type shall be the products of the same manufacturer.
- E. Supply all equipment and accessories new and free from defects.

1.03 SUBMITTALS

- A. Product submittals:
 - 1. Provide an electronic Submittal Log matrix, listing each of the components to be used.
 - a. Submittal Log fields to include referenced specification section, manufacturer, component description and part number.
 - 2. Provide manufacturer's cut sheet of each of the components to be used.
 - a. Specified component to be clearly designated on the manufacturer's cut sheet.
 - b. Manufacturer cut sheets to include detailed component performance parameters.
- B. Shop drawing submittals:

1. Provide shop drawings that have been coordinated with field conditions and the work of other trades.
 2. Submit shop drawings for review and acceptance prior to commencement of work.
- C. As-built documentation submittals:
1. Provide as-built documentation of all telecommunications pathway systems under this section utilized throughout the site for review, acceptance and future reference.
 2. As-built documentation to include:
 - a. Record Drawings.
 - b. Database matrix of components used.
- D. Warranty documentation:
1. Submit manufacturers extended warranty certification after the warranty acceptance by the manufacturer. It shall be the contractor's responsibility to facilitate the manufacturer specific requirements.

1.04 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 PRODUCTS

2.01 CONDUIT SYSTEM

- A. Rigid Steel Conduit and fittings
1. Acceptable manufacturers:
 - a. Allied Tube and Conduit
 - b. Cal Pipe Industries
 - c. Wheatland Tube Company
 - d. Or approved equal
 2. Rigid steel conduit shall be smooth wall, single bore, hot dipped galvanized inside and outside conforming to ANSI and UL. Conduit shall have standard threaded type couplings and fittings.
 3. Threads on the uncoupled ends shall be covered by industry color-coded thread protectors.
 4. Teflon tape shall be used on all galvanized rigid steel conduit thread joints.

5. Exposed conduit rising more than one foot above the adjacent grade shall be galvanized rigid steel conduit.
6. Underground concrete encased conduits that have twelve inches or less of cover shall be galvanized rigid steel.
7. Threaded joints and unions shall be encased with a heat shrink tube prior to placing concrete encasement.
8. All joints in galvanized rigid steel shall be the straight thread style of joint and shall be evaluated visually.
9. Use only factory-made bends with bell or coupling ends with minimum radius and curvature to meet communications bend radii standards.

B. Non-Metallic (PVC) Conduit and fittings

1. Acceptable PVC conduit and fitting manufacturers:
 - a. Carlon
 - b. PW Pipe
 - c. Georgia Pipe Company
 - d. Or Approved Equal
2. Non-metallic conduit shall be heavy wall, Schedule 40 PVC.
3. Couplings and connectors for non-metallic conduit shall be of the same material and be the product of the same manufacturer of the conduit furnished.
4. Colored primer and solvent cement designed to be used with Schedule 40 PVC conduit shall be utilized in the assembly of all PVC conduit joints.
5. Straight Schedule 40 PVC conduit shall have an expanded bell on one end and an insertion depth line on the spigot end to facilitate inspection for completeness of joint. All bell end joints shall be interference types.
6. Schedule 40 PVC conduit couplings and rigid bends:
 - a. Molded couplings with an internal stop as required for the joining of two non-bell end Schedule 40 PVC conduits,
 - b. Sleeve couplings without an internal stop,
 - c. Use only factory-made bends with bell or coupling ends with minimum radius and curvature to meet communications bend radii standards.

C. Fiberglass Conduit and fittings

1. Acceptable PVC conduit and fitting manufacturers:
 - a. FRE Composite
 - b. Champion Fiberglass
 - c. Or Approved Equal

2. The fiberglass conduit and fittings shall be used as single bore, factory extruded conduit and meet the requirements of NEMA.
3. Two part adhesive epoxy resin designed to be used fiberglass conduit shall be utilized to assemble the tight lock-style of joint.
4. The applicable two part adhesive epoxy resin and the tight lock style interference joint are required to pass the air pressure testing.
5. All fiberglass joints shall be the interference-style and shall be evaluated visually and with the low pressure air test. All joint and attached conduit segments that do not pass the visual and/or low-pressure air test shall be replaced.
6. Straight sections of fiberglass conduit shall have an expanded bell on one end and an insertion depth line on the spigot end to facilitate inspection for completeness of joint.
7. Use only couplings with an internal stop designed for use with fiberglass.
8. One slip style union may be utilized on a single conduit bore between two communications vaults.
9. Fiberglass conduit couplings and bends:
 - a. Use fiberglass molded couplings with an internal stop as required for the joining of two non-bell end fiberglass conduits. One sleeve couplings without an internal stop may be used in a single manhole to manhole conduit run only.
 - b. Use only factory-made bends with bell or coupling ends with minimum radius and curvature to meet communications bend radii standards.

D. Conduit system accessories

1. Duct bank conduit spacers
 - a. Acceptable Manufacturers
 - 1) Old Castle
 - 2) Or approved equal
2. Pulling Tape
 - a. Acceptable Manufacturers
 - 1) Carlon
 - 2) Or approved equal
 - b. Prelubricated, woven polyester tape made from low friction, high abrasion resistant yarns providing a low coefficient of friction. Tape is printed with sequential footage markings for accurate measurements.
 - c. Pulling tape with minimum 1,250-pound tensile strength.
3. Duct plugs

- a. Acceptable Manufacturers
 - 1) Carlon
 - 2) Or approved equal
 - b. Conduit plugs shall provide a watertight seal at expose ends of conduits.
 - c. Conduit plugs shall be conduit size specific.
 - d. Triplex and Quadplex duct plugs shall provide a watertight seal between the conduit and innerduct(s).
 - e. Simplex duct plugs shall provide a watertight seal between the innerduct and the cable that occupies it.
4. Concrete seal at conduit penetrations
- a. Acceptable Manufacturers
 - 1) PSI Thunderline Linkseal
 - 2) Or approved equal
 - b. Conduit entrances into existing concrete structures shall use a modular, mechanical seal, consisting of rubber links shaped to continuously fill the annular space between the pipe and the wall opening. Pressure plates shall be molded of glass reinforced nylon. Hardware shall be mild steel with a 60,000 psi minimum tensile strength and 2-part Zinc Dichromate coating per ASTM B633 and Organic Coating, tested in accordance with ASTM B117 to pass a 1,500-hour salt spray test (or 316 Stainless Steel). Coloration shall be throughout elastomer for positive field inspection. Each link shall have permanent identification of the size and manufacturer's name molded into the pressure plate and sealing element.

2.02 MANHOLES AND HANDHOLES

- A. Acceptable Manufacturers
 - 1. Old Castle
 - 2. Quazite (Handholes Only)
 - 3. Or approved equal
- B. Manholes
 - 1. Acceptable Manufacturers
 - a. Old Castle
 - b. Or approved equal
 - 2. Communications manholes shall be precast concrete, specifically designed for telecommunications applications.
 - 3. Manholes are to be equipped with the following:

- a. Hot-dipped galvanized steel channels cast into the walls for mounting cable racks
 - b. Hot-dipped galvanized cable racking and attaching hook hardware
 - c. Securing equipment used to lift and place the manhole section
 - d. Twelve inch sump designed for the installation of a B-type submersible pump
 - e. Cast iron frame with round cast iron cover lid
 - f. Hot dipped galvanized frames that can be used in concrete work or landscaped areas
 - g. Hot-dipped galvanized tilt up covers.
 - h. Hot dipped galvanized steel ladder
 - i. Hot dipped galvanized pulling eyes embedded in the concrete opposite each duct entrance and in the floor beneath the cover.
 - j. Manholes shall be equipped with grounding busbar. Ground splices and connections at manholes shall be exothermic welds, copper or bronze compression ground fittings, or bolted compression ring lugs.
 - k. Four-inch Schedule 40 PVC conduit terminators cast into all conduit entrance locations during the manufacturing of the manhole,
 - l. Bright white epoxy-based paint on the interior surfaces and black polymer-based waterproofing on exterior surfaces provided by the manufacturer,
4. Designed for traffic HS20 loading. The concrete compressive strength shall be 4,500 psi at 28 days from manufacture of the manhole. Steel reinforcement bars shall meet ASTM 615 or ASTM 706, Grade 60 requirements.
 5. Manufacturers' design specifications:
 - a. Designed for traffic HS20 loading.
 - b. The concrete compressive strength shall be 4,500 psi at 28 days from manufacture of the manhole. Steel reinforcement bars shall meet ASTM 615 or ASTM 706, Grade 60 requirements.
 - c. The exterior dimensions shall be determined by the wall, floor and roof thickness required to meet ACI 318.
 - d. Designed to meet the requirements of the latest edition of the AASHTO code and to be installed in either firm or fluid soils within specific depth limitations.
 6. The cover for manholes shall have the identification and lettering as noted on the drawings, but at a minimum a permanent identification label designating it as a communications manhole.

C. Handholes

1. Acceptable Manufacturers
 - a. Quazite (Handholes Only)
 - b. Or approved equal
2. Communications handholes shall be precast polymer concrete made from selectively-graded aggregates in combination with a polymer resin system, reinforced with fiberglass for strength and rigidity.
3. Manholes are to be equipped with the following:
 - a. Hot-dipped galvanized cable racking and attaching hook hardware,
 - b. Securing equipment used to lift and place the manhole section
 - c. Gasketed Heavy Duty covers with bolts designed for driveways, parking lots and off-road-way applications where subject to occasional non-deliberate vehicular traffic.
4. Manufacturers' design specifications:
 - a. Loadings: comply with ANSI/SCTE 77.
 - b. Meet ANSI Tier 22 test provisions with design load of 22,500 lbs. and a test load of 33,750 lbs.
5. The cover for handholes shall have the identification and lettering as noted on the drawings, but at a minimum a permanent identification label designating it as a communications manhole.
6. Handholes shall be non-conductive and shall not require grounding for safety.
7. Handholes shall be bottomless.

PART 3 EXECUTION

3.01 CONDUIT SYSTEM

- A. Schedule 40 PVC conduit and fittings:
 1. Primer and solvent cement designed to be used in the temperatures and humidity ranges at the actual installation site shall be used. The applicable primer and solvent cement are required in order for the assembled PVC conduit to pass the air pressure testing.
 2. All Schedule 40 PVC conduit joints shall be evaluated visually and with the low-pressure air test described in the Specifications. All joint and attached conduit segments that do not pass the visual and low pressure air test shall be replaced.
 3. Schedule 40 PVC conduits shall be encased in steel reinforced concrete.
 4. Schedule 40 PVC should not be used where cover is less than 12 inches from top of conduit to ground surface.

5. Each length shall be marked "Schedule 40 PVC Conduit" as applicable. In addition, all bends are marked with the degree of bend and the radius in feet.
6. Straight Schedule 40 PVC conduit shall have an expanded bell on one end and an insertion depth line on the spigot end to facilitate inspection for completeness of joint. All bell end joints shall be interference types.
7. Use only couplings with an internal stop designed for use with Schedule 40 PVC conduit. One slip style union may be utilized on a single conduit bore between 2 communications vaults. The slip union must provide a minimum of 5 inches of solvent weld joint surface on each side of the pipe joint. The slip union must be at least 10 inches in length.
8. The Contractor shall use only factory-made degree bends with bell or coupling ends of minimum radius and curvature as required for directional changes in conduit.
9. Each bend or coupling shall be marked "Schedule 40 PVC Conduit" as applicable and shall meet the requirements of NEMA TC3 for EPC-40 conduit.

B. Laying conduit:

1. At the trench site, examine each conduit length and remove all mud and other debris such as lath, paper, stones, etc., from the ducts before placing them in the trench.
2. Underground ducts may not exceed, cumulatively, 180 degrees of horizontal bends and 90 degrees of vertical bend in any manhole to manhole segment. This basically allows for 2 major 90-degree bends and splaying at the manhole structures.
3. Flattened, dented, or deformed conduits are not permitted and shall be removed and replaced.
4. Service entrance conduits and feeder conduits in direct contact with earth shall be Schedule 40, heavy wall PVC/HDPE.
5. Service entrance conduit elbows penetrating into the building shall be galvanized rigid steel (GRS).
6. Service entrance conduits installed exposed or concealed in walls or above ceilings shall be galvanized rigid steel (GRS).
7. Conduit runs shall not exceed 400 feet without a manhole or handhole to provide a pullpoint.

C. Ductbanks:

1. Schedule 40 PVC, 4-inch conduit shall be encased in reinforced concrete in straight sections, bends, sweeps or grade changes from 1 to 6 tiers high, and greater than 20 feet in length shall be installed as follows:
 - a. A monolithic (single pour) concrete encasement shall be made in duct formations up to and including 6 tiers high.

- b. Separations in ducts shall be obtained by using approved permanent, commercially available, plastic duct spacers.
 - 1) The base spacers should be placed along the trench bottom at intervals of 4 to 6 feet. Set the first tier of ducts into the spacer grooves. Then place a tier of intermediate spacers, then the second tier of ducts, etc., and finally the spacer over the top tier, making certain that each tier of spacers is securely locked to the next lower tier.
 - 2) The duct bank encasement shall be secured to the manhole wall with 12 inch rebar dowels 3 inches into the manhole wall with epoxy grout.
2. The Contractor shall insure the mix flows to the bottom and between the layers of duct formation.
3. The Contractor shall vibrate the concrete sufficiently to be assured of a good flow of concrete around the individual ducts and rebar. Place sufficient concrete to provide the minimum top cover required.
4. Duct banks shall be sloped downward toward manholes/handholes and away from buildings a minimum of 6 inches per 100 feet. Duct banks shall not route water from manholes/handholes into buildings. Duct banks shall not contain traps between manholes/handholes where water may accumulate.
5. Duct banks and direct buried ducts shall be supported on undisturbed soil or on piers extending down to undisturbed soil.
6. Where power and communications duct banks run in parallel, they shall be separated by a minimum of 12 inches.
7. Duct banks shall have a minimum of 3 inches of concrete cover on all sides.
8. Direct buried ducts and fittings shall have bend radii greater than the minimum bend radii of the cables enclosed, and shall not be smaller than the radii of standard manufactured elbows.
9. Direct buried ducts shall be installed parallel to or at right angles to building lines and site features, and as close to curbs and sidewalks as possible to avoid interferences with future landscaping.
10. Where direct buried PVC ducts cannot be buried deep enough to meet the NEC minimum cover requirements, rigid steel conduits shall be installed instead, or a concrete cover shall be poured over the ducts.
11. An orange detectable marker tape (for communications) shall be buried in the backfill approximately 12 inches above duct banks or direct buried cables for the entire length of the duct run.
12. Ducts shall be identified in the manholes/handholes at both ends and at building entrances.

D. Cleaning:

1. Prior to any testing, the Contractor shall clean conduits by pulling an acceptable 4-inch washer duct cleaner through all of the conduits. If debris is encountered the Contractor shall make a minimum of 2 passes until the conduit is free and clear of debris before passing a mandrel through the conduit. (Rock and debris that catches between the mandrel and the conduit can damage Schedule 40 PVC conduit.)

E. Testing:

1. After backfilling, but before any finished surfacing begins, the Contractor shall pull a 3⁵/₈-inch diameter and 12¹/₄-inch long solid mandrel through all Schedule 40 PVC conduits.
2. If the mandrel fails to pass through the duct being tested, either the duct is obstructed or misaligned, or the curve has too small a radius. The Contractor shall either unblock the duct without damaging the Schedule 40 PVC conduit or remove and repair the impassable section at the Contractor's expense. The conduit in question as well as the conduits immediately adjacent shall be re-mandrelled by the Contractor.
3. Identify and label the conduits as specified.
4. Where conduit is being stubbed horizontally for future connection, leave a minimum of 2 feet of conduit exposed beyond the concrete encasement. Prior to capping the conduit, test the conduit in accordance with this Specification. Pulling tape shall not be required conduits that are to be stubbed horizontally for future connection. After testing, place end caps on the end of the conduit and seal to prevent leakage. During backfilling, leave one locator ball at 1 foot above stubbed conduit and metallic locator tape at 1 foot from the surface as shown on the Drawings. Stake the location of the stubbed conduit using a sign post and sign labeled "Telecom Conduit" for future reference.
5. Where conduit is being stubbed vertically, leave a minimum of 2 feet of conduit exposed above the finished grade to allow for concrete pads to be placed around the conduit. Prior to capping the conduit, test the conduit in accordance with this Specification. After testing, place blank 4-inch duct plugs in the conduit. Pulling tape shall be required in conduit to be stubbed vertically. Label the stubbed conduit "Telecom Conduit" for future reference.

F. Excavation and Backfill

1. Contractor shall call underground utilities locator company before digging.
2. Barricades shall be provided around open holes and trenches. Temporary bridges shall be provided over trenches cut through major sidewalk routes. Major sidewalk routes shall not be closed to pedestrian traffic.
3. Barriers shall be provided to protect landscaping adjacent to the excavation area.
4. When rocks, concrete or other debris are encountered during excavation, remove completely.

5. Where sidewalk sections must be removed for installation of underground ducts, remove the sidewalk sections completely from joint to joint.
6. Where asphalt must be removed for installation of underground ducts, saw cut the asphalt in two, straight, parallel lines.
7. Backfill excavations in 6-inch layers and mechanically compact to 98 percent compaction.
8. Excavated materials may be used as backfill only if the backfill is sand or clean dirt that is free of rocks and debris over $\frac{3}{4}$ " in diameter.
9. In landscaped areas, backfill and mechanically compact to a depth of 6 inches below grade.
10. Backfill the last 6 inches with clean topsoil. Reseed lawn areas.
11. Restore concrete sidewalks and asphalt.
12. The Contractor shall perform all excavation to install the work herein specified and as indicated on Drawings. During excavation, material for backfilling shall be piled back from the banks of the trench to avoid overloading and to prevent slides and cave-ins. All excavated materials not to be used for backfill shall be removed and disposed of by the Contractor. Grading shall be done to prevent surface water from flowing into trenches and others excavation and any water accumulating therein shall be removed by pumping. All excavation shall be made by open cut.
13. The bottom of the trenches shall be graded to provide uniform bearing and support for conduits, cables, or duct bank on undisturbed soil at every point along its entire length. Overdepths shall be backfilled with loose, granular, moist earth, tamped. Remove unstable soil that is not capable of supporting equipment or installation and replace with specified material for a minimum of 12" below invert of equipment or installation.
14. The trenches shall be backfilled with the excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel or soft shale, free from large clods of earth and stones, deposited in 6" layers and rammed until the installation has a cover of not less than the adjacent ground but not greater than 2" above existing ground. The backfilling shall be carried on simultaneously on both sides of the trench so that injurious pressures do not occur. The compaction of the filled trench shall be at least equal to 95% of the maximum density as determined by the Standard Proctor Test. Settling the backfill with water will not be permitted. Reopen any trenches not meeting compaction requirements or where settlement occurs, refill, compact, and restore the surface to the grade and compaction indicated, mounded over and smoothed off.
15. A warning tape capable of being detected by a metal detector from the surface shall be placed, as shown on trench details, maximum 12 inches below subgrade. The warning tape shall be orange and provide written indication of the presence of communication cables.

3.02 MANHOLES/HANDHOLES

- A. The Contractor shall place a minimum of 6 inches or a maximum of 12 inches of drain rock from the bottom of the excavation to the bottom of the manhole. The standard vaults are designed to be installed in either firm or fluid soils within specific depth limitations. The stated depth limitations should be observed within 1 inch, or as reasonable construction practice will permit.
- B. A gasket material designed to seal precast concrete components at joints must be placed in the joint between the manhole sections to make the joint watertight. An acceptable plastic or mastic gasket material shall be provided by the manhole manufacturer for installation at the time the manhole is placed. The joint seal shall be used in joints between all concrete components including extension rings and manhole sections as well as between the top extension ring and the cover frame.
- C. The manholes are to be set plumb and level with lids flush with rough grade.
- D. The manhole shall be provided with the 4-inch Schedule 40 PVC conduit terminators cast into all conduit entrance locations.
- E. A sump shall be provided in the floor of the manholes. It is used to facilitate the removal of water from the vaults. Contractor shall provide a cover grate for the sump.
- F. Provide cable rack hooks and brackets for racking cable. Hook length as required to allow for minimum 1/2-inch spacing between cables.
- G. The Contractor shall touch up all chips in the waterproofing prior to backfilling.
- H. Inside of the manhole shall be stenciled with the correct manhole number (for example, "MH-01"). These should be placed in a location that can be seen by a worker standing on the floor of the manhole.
- I. The Contractor shall confirm, that the manholes are in the correct location, properly assembled, and that proper depth is maintained, the excavation bottom is level, all joints are properly made, horizontal and vertical alignment is maintained.
- J. Manholes shall be grounded with four 3/4 inch diameter by 8 foot long ground rods, one driven inside of the manhole at each corner. Connect the ground rods and any duct bank ground conductors together with a No. 4/0 AWG bare, stranded copper ground wire loop. A No. 2 AWG bare stranded copper pigtail from the ground wire loop shall be used to ground the maintenance hole cover frame, ladder support bracket, any metallic concrete inserts and metallic cable racks, and the shields of any cables that are spliced in the maintenance hole.

3.03 CONDUIT PLUGS/CAPS

- A. After completion of the testing, the Contractor shall place pulling tape with sequential printed footage marking in each of the conduits.

- B. The Contractor shall extend the pulling tape 6 feet beyond the termination at each end of the conduits. The tapes shall be tied to the tab on the duct plug.

3.04 CONDUIT PLUGS/CAPS

- A. Upon completion of conduit testing and placement of the measured pulling tape, the Contractor shall place a temporary 4-inch universal duct plug in each of the ducts and attach the measured pulling tape to the duct plug by running the tape through the hole in the plug's tab and tying the tape to the tab.
- B. At the close of each work day, or when it is necessary to stop construction in a section, a temporary 4-inch universal duct plugs shall be used to temporarily seal the ducts against mud, dirt, etc.
- C. Telecommunication Duct Plugs shall be for permanent duct plugs to be provided by the Contractor upon completion of the conduit, innerduct and cabling placement.
- D. Protect conduits against dirt, plaster, and foreign debris with conduit plugs. Plugs shall remain in place until ready for use.

3.05 CLOSEOUT AND ACCEPTANCE

- A. No additional burden to the Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for reinstallation work shall be coordinated, in writing, with the Owner prior to beginning the work.
- B. All specified Communications systems indicated on the drawings and specifications shall be complete.
- C. Specified shop drawings and product submittals shall have been submitted for review and all review comments and deficiencies shall have been resolved. Final shop drawings and product submittals shall have been submitted, reviewed and found to meet the requirements of the specifications.
- D. Issues and deficiencies identified in field reports and punch lists shall have been resolved. Final as-built drawings shall have been submitted, reviewed and found to meet the requirements of the specifications.
- E. Contractor shall provide written notice of final completion of the telecom infrastructure. Upon receipt, the Owner's Representative will review/observe the completed installation. Once the Owner's Representative is satisfied that all work is in accordance with the Contract Documents, the Contractor will be notified in writing.

END OF SECTION 27 0543

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SECTION 27 0553

IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. Applicable requirements of Division 27 – Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Identification for Communications Systems.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.02 QUALITY ASSURANCE

- A. National Electric Code Compliance: Comply with all NEC articles that apply to construction and installation practices applicable to this section
- B. ANSI/TIA: Comply with all ANSI/TIA articles that apply to construction and installation practices applicable to this section
- C. UL Compliance: Provide products that are UL and or cUL-classified.
- D. NFPA Compliance.
- E. All items of a given type shall be the products of the same manufacturer.
- F. Supply all equipment and accessories new and free from defects.

1.03 SUBMITTALS

- A. Product submittals:
 - 1. Provide an electronic Submittal Log matrix, listing each of the components to be used.
 - a. Submittal Log fields to include referenced specification section, manufacturer, component description and part number.
 - 2. Provide manufacturer's cut sheet of each of the components to be used.
 - a. Specified component to be clearly designated on the manufacturer's cut sheet.
 - b. Manufacturer cut sheets to include detailed component performance parameters.

- B. Shop drawing submittals:
 - 1. Provide shop drawings that have been coordinated with field conditions and the work of other trades.
 - 2. Submit shop drawings for review and acceptance prior to commencement of work.
- C. As-built documentation submittals:
 - 1. Provide as-built documentation of all telecommunications pathway systems under this section utilized throughout the site for review, acceptance and future reference.
 - 2. As-built documentation to include:
 - a. Record Drawings.
 - b. Database matrix of components used.
- D. Warranty documentation:
 - 1. Submit manufacturers extended warranty certification after the warranty acceptance by the manufacturer. It shall be the contractor's responsibility to facilitate the manufacturer specific warranty requirements.

1.04 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 LABELING

2.01 UNDERGROUND DUCT AND RACEWAY IDENTIFICATION

- A. Underground duct identification at manholes and vaults.
 - 1. Acceptable manufacturers
 - a. 3M Scotchlite
 - b. Tech Products, Everlast series
 - c. Or approved equal
 - 2. Underground ducts entering manholes and vaults shall be labeled with large reflective lettering on decal holders.
 - a. The polyethylene decal holders shall be at least be sized to match the numbering sequence with two holes punched at each end.
 - b. The decal holders shall be mechanically attached to the manhole/vault wall above the duct.
 - c. The reflective lettering shall be screen-printed on a vinyl base with aluminum backing plate that can easily slide into the decal holders.

- d. Labels shall be individual letters and numbers.
 - e. Individual characters shall be self-spacing by simply butting the individual characters against each other in a row.
 - f. Characters shall be black on a reflective safety orange background.
 - g. Characters shall be minimum 1" x 1.5".
 - h. Labels shall be designed for exposed outdoor applications.
- B. Underground duct route marking for surveying identification.
- 1. Acceptable manufacturers
 - a. 3M
 - b. Tech Products
 - c. Or approved equal
 - 2. Underground duct routes shall be marked with a detectable warning tape containing message of communication conduit buried below.
 - a. Shall be designed for exposed outdoor applications.
- C. Underground duct identification at stubbed location.
- 1. Acceptable manufacturers
 - a. 3M
 - b. Tech Products
 - c. Or approved equal
 - 2. Underground ducts stubbed for future connections shall be marked with a utility warning sign post.
 - a. The sign post marker is made from high impact fiberglass.
 - b. Capable of flex upon impact and return to its original upright position
 - c. Shall be designed for exposed outdoor applications.

2.02 PULL BOX, CONDUIT, CABLE TRAY AND SURFACE RACEWAY IDENTIFICATION

- A. Pull box identification
- 1. Acceptable manufacturers
 - a. 3M Scotchlite
 - b. Tech Products, Everlast series
 - c. Or approved equal
 - 2. Pull boxes shall be labeled with large reflective lettering.
 - a. The reflective lettering shall be screen-printed on a vinyl base with adhesive backing.

- b. Labels shall be individual letters and numbers.
- c. Individual characters shall be self-spacing by simply butting the individual characters against each other in a row.
- d. Characters shall be black on a reflective safety orange background.
- e. Characters shall be minimum 1" x 1.5".

B. Conduit identification

- 1. Acceptable manufacturers
 - a. Panduit
 - b. Hellermann Tyton
 - c. Or approved equal
- 2. Larger sized conduits (2" to 4") shall be labeled with large decal tags.
 - a. Decal tags shall be of a non-adhesive polyester and polyolefin combination.
 - b. The decal tags shall be at least be 2" x 1" with two holes punched at each end.
 - c. The decal tags shall be attached to conduits with tie wraps.
 - d. Tags shall be labeled using thermal transfer.
- 3. Horizontal cabling conduits between outlets and cable trays in corridors shall be hand marked underneath at the point of attachment to the cable tray or at the ceiling stub end with a permanent marker indicating the room of origin.

C. Cable tray identification

- 1. Acceptable manufacturers
 - a. 3M Scotchlite
 - b. Tech Products, Everlast series
 - c. Or approved equal
- 2. Cable trays shall be labeled with large reflective lettering.
 - a. The reflective lettering shall be screen-printed on a vinyl base with adhesive backing.
 - b. Labels shall be individual letters and numbers.
 - c. Individual characters shall be self-spacing by simply butting the individual characters against each other in a row.
 - d. Characters shall be black on a reflective safety orange background.
 - e. Characters shall be minimum 1" x 1.5".

D. Surface raceway (sizes larger than 6" x 6") identification

1. Acceptable manufacturers
 - a. 3M Scotchlite
 - b. Tech Products, Everlast series
 - c. Or approved equal
2. Surface raceway shall be labeled with large reflective lettering.
 - a. The reflective lettering shall be screen-printed on a vinyl base with adhesive backing.
 - b. Labels shall be individual letters and numbers.
 - c. Individual characters shall be self-spacing by simply butting the individual characters against each other in a row.
 - d. Characters shall be black on a reflective safety orange background.
 - e. Characters shall be minimum 1" x 1.5".

2.03 CABINET, RACK, FRAME AND ENCLOSURE IDENTIFICATION

- A. Equipment cabinet identification.
 1. Acceptable manufacturers
 - a. 3M Scotchlite
 - b. Tech Products, Everlast series
 - c. Or approved equal
 2. Equipment cabinets shall be labeled with large reflective lettering.
 - a. The reflective lettering shall be screen-printed on a vinyl base with adhesive backing.
 - b. Labels shall be individual letters and numbers.
 - c. Individual characters shall be self-spacing by simply butting the individual characters against each other in a row.
 - d. Characters shall be black on a reflective safety orange background.
 - e. Characters shall be minimum 1" x 1.5".
- B. Telecom rack identification.
 1. Acceptable manufacturers
 - a. NorCal Metal Fabricators
 - b. Or approved equal
 2. Telecom racks shall be identified by a labeling assembly bracket consisting of the following:
 - a. An angled "T" shaped metal card holder bracket with mounting slots to attach to struts on the long end of the "T" shape.

- b. The short angled end the “T” shape shall attach to the label metal card holder.
 - c. The label metal card holder shall be 2”W x 12.75”L provided with a cardboard label card and clear plastic cover.
 - 3. Metal hardware shall be finished in black powder coat.
- C. Enclosure identification.
 - 1. Acceptable manufacturers
 - a. 3M Scotchlite
 - b. Tech Products, Everlast series
 - c. Or approved equal
 - 2. Surface mount enclosures shall be labeled with large reflective lettering.
 - a. The reflective lettering shall be screen-printed on a vinyl base with adhesive backing.
 - b. Labels shall be individual letters and numbers.
 - c. Individual characters shall be self-spacing by simply butting the individual characters against each other in a row.
 - d. Characters shall be black on a reflective safety orange background.
 - e. Characters shall be minimum 1” x 1.5”.
 - f. Labels shall be designed for exposed outdoor applications.

2.04 CABLE IDENTIFICATION

- A. Copper, optical fiber and coaxial horizontal cable identification
 - 1. Acceptable manufacturers
 - a. Panduit
 - b. Hellermann Tyton
 - c. Or approved equal
 - 2. Horizontal cable sheaths shall be vinyl based with the capability to rotate for visibility from any angle.
 - 3. Labels shall be white in color.
 - 4. Labels shall be at least 1” x 2.25” with a 0.75-inch high printable area.
 - 5. Labels shall be printed with thermal transfer printers.
- B. Indoor copper, optical fiber and coaxial backbone cable identification.
 - 1. Acceptable manufacturers
 - a. Panduit
 - b. Hellermann Tyton

- c. Or approved equal
 - 2. Indoor optical fiber backbone cables shall be fitted with optical fiber warning tags:
 - a. Warning tags shall be black and yellow in color.
 - b. Warning tags shall be a minimum of 3.5" x 2" in size.
 - 3. Indoor copper, optical fiber and coaxial backbone cable sheaths larger than 1½" shall be labeled with large decal tags that shall be tie wrapped to the cable sheath.
 - a. Decal tags shall be of a non-adhesive polyester and polyolefin combination.
 - b. The decal tags shall be at least be 2" x 1" with two holes punched at each end.
 - c. The decal tags shall be attached to cable sheaths with tie wraps with neoprene rubber cushion sleeves.
 - d. Tags shall be labeled using thermal transfer.
 - 4. Indoor copper, optical fiber and coaxial backbone cable sheaths smaller than 1½" shall be labeled with laser-printed polyester self-laminating wrap-around labels.
 - a. Horizontal cable sheaths shall be vinyl based.
 - b. Labels shall be white in color.
 - c. Labels shall be at least 1" x 2.25" with a 0.75-inch high printable area.
 - d. Labels shall have an adhesive backing.
 - e. Labels shall be attached to cable sheaths by wrapping around the sheath with the adhesive back self-laminating portion.
 - f. Labels shall be printed with thermal transfer printers.
- C. Outdoor copper, optical fiber and coaxial backbone cable identification.
- 1. Acceptable manufacturers
 - a. 3M Scotchlite
 - b. Tech Products, Everlast series
 - c. Or approved equal
 - 2. Outdoor optical fiber backbone cables shall be fitted with optical fiber warning tags:
 - a. Warning tags shall be black and yellow in color.
 - b. Warning tags shall be a minimum of 3.5" x 2" in size.

3. Outdoor copper, optical fiber and coaxial backbone cable sheaths shall be labeled with large reflective lettering on decal holders that shall be tie wrapped to the cable sheath.
 - a. The polyethylene decal holders shall be at least be sized to match the numbering sequence with two holes punched at each end.
 - b. The decal holders shall be attached to cable sheaths with tie wraps with neoprene rubber cushion sleeves.
 - c. The reflective lettering shall be screen-printed on a vinyl base with aluminum backing plate that can easily slide into the decal holders.
 - d. Labels shall be individual letters and numbers.
 - e. Individual characters shall be self-spacing by simply butting the individual characters against each other in a row.
 - f. Characters shall be black on a reflective safety orange background.
 - g. Characters shall be minimum 1" x 1.5".
 - h. Labels shall be designed for exposed outdoor applications.

D. Copper patch cord identification

1. Acceptable manufacturers
 - a. Panduit
 - b. Hellermann Tyon
 - c. Or approved equal
2. Copper patch cord labels shall be vinyl based with the capability to rotate for visibility from any angle.
3. Labels shall be white in color.
4. Labels shall be at least 1" x 2.25", with a 0.75" high printable area.
5. Labels shall be printed with thermal transfer printers.

E. Optical fiber patch cord identification

1. Acceptable manufacturers
 - a. Panduit
 - b. Hellermann Tyon
 - c. Or approved equal
2. Optical fiber patch cord labels shall be vinyl based in flag style.
3. Labels shall be white in color.
4. Labels shall be at least 1" x 1.5", with a 0.75" high printable area.
5. Labels shall be printed with thermal transfer printers.

2.05 SPLICE CLOSURE IDENTIFICATION

- A. Splice closure identification.
 - 1. Acceptable manufacturers
 - a. 3M Scotchlite
 - b. Tech Products, Everlast series
 - c. Or approved equal
 - 2. Splice closures shall be labeled with large reflective lettering on decal holders that shall be tie wrapped.
 - a. The polyethylene decal holders shall be at least be sized to match the numbering sequence with two holes punched at each end.
 - b. The decal holders shall be attached to either ends of the splice closure with tie wraps.
 - c. The reflective lettering shall be screen-printed on a vinyl base with aluminum backing plate that can easily slide into the decal holders.
 - d. Labels shall be individual letters and numbers.
 - e. Individual characters shall be self-spacing by simply butting the individual characters against each other in a row.
 - f. Characters shall be black on a reflective safety orange background.
 - g. Characters shall be minimum 1" x 1.5".
 - h. Labels shall be designed for exposed outdoor applications.

2.06 BUILDING ENTRANCE PROTECTOR TERMINAL IDENTIFICATION

- A. Protector terminal identification.
 - 1. Acceptable manufacturers
 - a. Panduit
 - b. Hellermann Tyon
 - c. Or approved equal
 - 2. Labels shall be polyester and white in color.
 - 3. Labels shall be at least 1" x 0.75".
 - 4. Labels shall be attached to the terminal by adhesive backing.
 - 5. Labels shall be printed with thermal transfer printer.

2.07 TERMINATION PANEL, BLOCK AND PATCH PANEL IDENTIFICATION

- A. Termination block (110-style) identification.
 - 1. Acceptable manufacturers

- a. Panduit
 - b. Hellermann Tyon
 - c. Or approved equal
2. Termination block designation strip labels shall be polyester.
 3. Labels shall be BLUE in color for 4-pair station cable terminations.
 4. Labels shall be GREY in color for copper tie cable terminations.
 5. Labels shall be attached to the designation strip provided.
 6. All labels shall be minimum 7.88 inches in width and 0.50-inch in length.
 7. Labels shall have an adhesive backing.
 8. Labels shall be laser-printed.
- B. Patch panel identification.
1. Acceptable manufacturers
 2. Panduit
 3. Hellermann Tyon
 4. Or approved equal
 5. Labels shall be polyester and white in color.
 6. Labels shall be at least 0.9" x 0.25".
 7. Labels shall be attached to the patch panel by adhesive backing.
 8. Labels shall be printed with thermal transfer printer.
- C. Optical fiber termination panel identification.
1. Acceptable manufacturers
 - a. 3M Scotchlite
 - b. Tech Products, Everlast series
 - c. Or approved equal
 2. Optical fiber termination panels shall be labeled on the outside with large non-reflective lettering.
 - a. The lettering shall be screen-printed on a vinyl base with adhesive backing.
 - b. Labels shall be individual letters and numbers.
 - c. Individual characters shall be self-spacing by simply butting the individual characters against each other in a row.
 - d. Characters shall be white on black background.
 - e. Characters shall be minimum 0.75" x 1".

3. Optical fiber termination panels shall be labeled on the inside using the label card behind the plastic panel provided by the termination panel manufacturer. The plastic panel shall be overlaid with a one-piece adhesive-backed sheet. Contractor shall cut the sheet to size.

2.08 FACEPLATE AND OUTLET HOUSING IDENTIFICATION

- A. Faceplate and outlet housing identification.
 1. Acceptable manufacturers
 - a. Panduit
 - b. Hellermann Tyon
 - c. Or approved equal
 2. Labels shall be polyester and white in color.
 3. Labels shall be at least 1.8" x 0.375".
 4. Labels shall be attached to the faceplate by adhesive behind the snap in clear plastic cover.
 5. Labels shall printed with thermal transfer printer.

2.09 GROUNDING AND BONDING HARDWARE IDENTIFICATION

- A. Grounding cable identification.
 1. Acceptable manufacturers
 - a. Panduit
 - b. Hellermann Tyon
 - c. Or approved equal
 2. Ground cable identification labels inside the telecommunications rooms shall be vinyl based with the capability to rotate for visibility from any angle.
 3. Labels shall be white in color.
 4. Labels shall be at least 1" x 2.25", with a 0.75" high printable area.
 5. Labels shall be printed with thermal transfer printers.

PART 3 EXECUTION

3.01 GENERAL IDENTIFICATION REQUIREMENTS

- A. Labeling shall be done in accordance with the recommendations made in the ANSI/TIA-606-A document, manufacturer's recommendations and best industry practices.
- B. Furnish materials shown and called for in the specifications, which are necessary for the complete identification, labeling, installation, and operation of

components, equipment, and systems of the telecommunications structured cabling system.

- C. Provide such labeling materials and labor as required to completely label components of the telecommunications system, whether specifically called for or not, and whether provided by the Contractor, the Owner or others, which are used or are intended to be used in the structured cabling system.
- D. Provide incidental equipment, labor and materials required for the completion of systems included in this contract whether or not specified or shown on the Drawings.
- E. All labels shall be machine-manufactured by a labeling machine. Handwritten labels will not be accepted for final labeling.
- F. It is the responsibility of the contractor to acquire, understand, and utilize the owner's labeling scheme for all component of the voice data communications system.
- G. It is the responsibility of the contractor to provide labels sized to show the Owner's labeling scheme in readable font size while still matching the specified hardware identification dimensions.
- H. The intent of the final labeling is to allow the Owner or persons contracted by the Owner to identify any part of the structured cabling system through physical identification of the components and their related components at the specified access point without the use of electrical, electronic or mechanical means of identification.
- I. It is the responsibility of the Contractor to be familiar with the location of components of the structured cabling system locations involved under the work of this Section and provided by other trades for use in the telecommunications system to eliminate conflicts between the labeling installation and the work of others.
- J. Each label shall be firmly affixed to the item being identified. Provide all painting, sanding, cleaning required to permanently affix and fasten the labels.
- K. Where indicated, use both mechanical and adhesive fasteners.
- L. Apply adhesives and adhesive-backed labels according to the manufacturers' recommendations and instructions. Replace any labels that are wrinkled, chipped, buckled, not level, or out of plumb and true.
- M. Where adhesive is used to affix the labels, the adhesive shall cover a minimum of 90% of the contact/bonding surface of the label.
- N. Adhesive used to affix labels shall not be visible from the front of the label and shall not extend beyond edge of the label.

3.02 UNDERGROUND DUCT AND RACEWAY IDENTIFICATION

- A. Underground duct identification at manholes, vaults and building entrances.

1. Each conduit shall be identified with its individual conduit identifier at the vault or building entrance penetration with the reflective lettering and decal holders.
 2. The decal holders shall be mechanically attached to the manhole, vault or building entrance walls.
- B. Underground duct route marking for surveying identification.
1. Underground duct routes shall be marked with a detectable warning tape containing message of communication conduit buried below.
- C. Underground duct identification at stubbed location.
1. Underground ducts stubbed for future connections shall be marked with a utility warning sign post.

3.03 PULL BOX, CONDUIT, CABLE TRAY AND SURFACE RACEWAY IDENTIFICATION

- A. Pull box identification
1. Labels shall be attached on the cover and interior of pullbox with the adhesive backed large reflective lettering.
- B. Conduit identification
1. Larger sized conduits (2" to 4") shall be labeled with large decal tags.
 2. Horizontal cabling conduits between outlets and cable trays in corridors shall be hand marked underneath at the point of attachment to the cable tray or at the ceiling stub end with a permanent marker indicating the room of origin.
- C. Cable tray identification
1. Cable trays shall be labeled with large reflective lettering.
 - a. The reflective lettering shall be screen-printed on a vinyl base with adhesive backing.
 - b. Labels shall be individual letters and numbers.
 - c. Individual characters shall be self-spacing by simply butting the individual characters against each other in a row.
 - d. Characters shall be black on a reflective safety orange background.
 - e. Characters shall be minimum 1" x 1.5".
- D. Surface raceway (sizes larger than 6" x 6") identification
1. Surface raceway shall be labeled with large reflective lettering.
 - a. The reflective lettering shall be screen-printed on a vinyl base with adhesive backing.
 - b. Labels shall be individual letters and numbers.

- c. Individual characters shall be self-spacing by simply butting the individual characters against each other in a row.
- d. Characters shall be black on a reflective safety orange background.
- e. Characters shall be minimum 1" x 1.5".

3.04 CABINET, RACK, FRAME AND ENCLOSURE IDENTIFICATION

A. Equipment cabinet identification

- 1. Identify each cabinet on the left hand corner surface of the front and rear frame.
- 2. Identify each cabinet on the ends of cabinet rows on the left hand corner surface of the side panel.

B. Telecom rack identification

- 1. Identify each rack using the labeling assembly bracket mounted in the front center of the rack.

C. Enclosure identification

- 1. Identify each enclosure on the left hand corner surface of the front and rear panels.

3.05 CABLE IDENTIFICATION

A. Copper, optical fiber and coaxial horizontal cable identification

- 1. Identify each horizontal cable sheaths at all termination ends, enclosures, and pull boxes with the specified labels.
- 2. The labels shall be positioned to be accessible and readable without re-arranging cable bundles.
- 3. Identify horizontal cable sheaths with labels within 2" of the termination point at the termination panel, termination block and connector end.
- 4. Identify horizontal cable sheaths with labels within 12 inches of the point that the cable enters or exits wall and floor sleeves and conduit pathways.
- 5. Fiber optic warning tags shall be affixed to the innerduct and to fiber optic cable sheaths within 12 inches of the point that the cable enters or exits wall and floor sleeves, conduit pathways and at 40-foot intervals on cable trays.

B. Indoor copper, optical fiber and coaxial backbone cable identification.

- 1. Identify indoor backbone cable sheaths with labels within 12" of the point that the cable enters a splice enclosure, termination panel or termination block.
- 2. Identify indoor backbone cable sheaths with labels within 12 inches of the point that the cable enters or exits wall and floor sleeves and conduit pathways.

3. Identify outdoor backbone cable sheaths with labels at 40-foot intervals on cable trays or surface duct ways.
 4. Fiber optic warning tags shall be affixed to the innerduct and to fiber optic cable sheaths within 12 inches of the point that the cable enters or exits wall and floor sleeves, conduit pathways and at 40-foot intervals on cable trays.
- C. Outdoor copper, optical fiber and coaxial backbone cable identification
1. Identify outdoor backbone cable sheaths with labels within 12” of the point that the cable enters a splice closure, termination panel or termination block.
 2. Identify outdoor backbone cable sheaths with labels within 12 inches of the point that the cable enters or exits handholes/manholes/vaults and conduit pathways.
 3. Identify outdoor backbone cable sheaths with labels at 40-foot intervals on cable trays or surface duct ways.
 4. Fiber optic warning tags shall be affixed to the innerduct and to fiber optic cable sheaths within 12 inches of the point that the cable enters or exits wall and floor sleeves, conduit pathways and at 40-foot intervals on cable trays.

3.06 SPLICE CLOSURE IDENTIFICATION

- A. Place the large reflective lettering decal holders on the outer splice closure cover so that the label is clearly visible without moving the splice closure or other objects near the splice.

3.07 BUILDING ENTRANCE PROTECTOR TERMINAL IDENTIFICATION

- A. Identify building entrance protector blocks using an identification label at the upper top/left corner of the protector block.
- B. Copper protector blocks shall also be labeled using the labeling card inside the plastic panel provided by the manufacturer for cable labeling.

3.08 TERMINATION PANEL, BLOCK AND PATCH PANEL IDENTIFICATION

- A. Optical fiber termination panel identification.
 1. Identify the termination panel using an identification label at the top/left corner of the panel door/tray on the outside of the panel.
 2. Termination panels shall also be labeled using the insert identification card provided by the manufacturer for cables and individual connector labeling.
- B. Copper termination block identification.
 1. Identify the termination block using the colored identification labels included in the block kits.

2. Identify each punch down port with the corresponding cable labeling and identification scheme.
- C. Copper patch panel identification.
1. Identify the patch panel using an identification label at the top/left corner of the patch panel.
 2. Identify each patch panel port with the corresponding cable labeling and identification scheme.

3.09 FACEPLATE AND OUTLET HOUSING IDENTIFICATION

- A. Faceplate and outlet housing identification.
1. Identify the faceplate and outlet housing using the identification labels specified and placed in the appropriate label housing.
 2. Identify each cable port on the label with the corresponding cable labeling and identification scheme.
 3. The cable port numbers should be printed in legible font size and spaced on the label matching the cable port sequence of the faceplate or outlet housing.

3.10 GROUNDING AND BONDING HARDWARE IDENTIFICATION

- A. Grounding cable identification
- B. Identify each cable sheath at all termination ends with the specified labels.
- C. Identify cable sheaths with labels within 3" of the ground lug on both ends.
- D. Identify each cable with the corresponding cable labeling and identification scheme.

3.11 CLOSEOUT AND ACCEPTANCE

- A. No additional burden to the Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for reinstallation work shall be coordinated, in writing, with the Owner prior to beginning the work.
- B. All specified Communications systems indicated on the drawings and specifications shall be complete.
- C. Specified shop drawings and product submittals shall have been submitted for review and all review comments and deficiencies shall have been resolved. Final shop drawings and product submittals shall have been submitted, reviewed and found to meet the requirements of the specifications.
- D. Issues and deficiencies identified in field reports and punch lists shall have been resolved. Final as-built drawings shall have been submitted, reviewed and found to meet the requirements of the specifications.

- E. Contractor shall provide written notice of final completion of the telecom infrastructure. Upon receipt, the Owner's Representative will review/observe the completed installation. Once the Owner's Representative is satisfied that all work is in accordance with the Contract Documents, the Contractor will be notified in writing.

END OF SECTION 27 0553

SECTION 27 0800

TESTING OF COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. Applicable requirements of Division 27 – Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Testing and Commissioning of Communications.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.02 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 TESTING

2.01 TESTING REQUIREMENTS

- A. General
 - 1. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA-568-C.0, ANSI/TIA-568-C.1, and/or ANSI/TIA-1152. All conductors of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.
- B. Copper Testing
 - 1. All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category 6A performance. Horizontal balanced twisted pair cabling shall be tested using a level IIe, III, or IV test unit for Category 6A performance compliance.

2. Continuity – Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. The test shall be recorded as pass/fail as indicated by the test unit and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.
3. Length – Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA-568-C.2 Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the shortest pair length shall be recorded as the length for the cable.
4. Approved copper test equipment manufacturers are as follows:
 - a. Copper Twisted Pair Testers
 - 1) Fluke – DTX-5000

C. Optical Fiber Testing

1. All fiber testing shall be performed on all fibers in the completed end-to-end system. There shall be no splices unless clearly indicated in the project documents. These tests also include continuity checking of each fiber.
2. Multimode
 - a. Test the optical fiber cable bi-directionally with an OTDR and uni-directionally with a power meter/light source. Fiber must be tested at both 850 nm and 1,300 nm. Maximum attenuation dB/Km @ 850 nm/1,300 nm shall be 3.5/1.5. Maximum attenuation per connector pair shall be 0.75 dB. Attenuation testing shall be performed with a stable launch condition using a one-meter or two-meter jumper, wrapped around a mandrel sized according to fiber type, to attach the light source to the cable plant. Fiber jumper shall be wrapped around mandrel no less than five (5) times. The jumper-mandrel assembly shall remain connected to the light source after calibration and the power meter moved to the far end using a new jumper to take measurements. Test set-up and performance shall be conducted in accordance with ANSI/TIA-568-C.3, and to the manufacturer's application guides.
3. Single mode
 - a. Test the optical fiber cable bi-directionally with an OTDR and uni-directionally with a power meter/light source. Fiber must be tested at both 1,310 nm and 1,550 nm. Maximum attenuation dB/Km @ 1,310 nm/ 1,550 nm shall be 0.5/0.5 for outside plant and 1.0/1.0 for inside plant. Maximum attenuation per connector pair shall be 0.75 dB. Attenuation testing shall be performed with a stable launch condition using one-meter or two-meter jumpers to attach the test equipment to the cable plant. The light source shall be left in place

after calibration and the power meter moved to the far end to take measurements. Test set-up and performance shall be conducted in accordance with ANSI/TIA-568-C.3, and to the manufacturer's application guides.

4. Approved optical fiber test equipment manufacturers are as follows:

- a. Power Meters & Light Sources
 - 1) Optical Wavelength Laboratories (OWL)
 - 2) Noyes
 - 3) Photonix
 - 4) Fluke
 - 5) Agilent
- b. Optical Time Domain Reflectometers (OTDR)
 - 1) GN Nettest
 - 2) Agilent
 - 3) Fluke
 - 4) Anritsu
 - 5) Tektronix

D. Test Results

- 1. Test documentation shall be provided on disk as part of the as-built package. The disk shall be clearly marked on the outside front cover with the words "Project Test Documentation," the project name, and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair (or strand) and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.
- 2. The field test equipment shall meet the requirements of ANSI/TIA-568-C.2, ANSI/TIA-568-C.3, and/or ANSI/TIA-1152.
- 3. Printouts generated for each cable by the wire (or fiber) test instrument shall be submitted as part of the documentation package. Alternately, the Contractor may furnish this information in electronic form (CD). These CDs shall contain the electronic equivalent of the test results as defined by the Specification and be of a format readable from Microsoft Word.

4. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.

PART 3 DOCUMENTATION, AS-BUILTS, TRAINING AND RECORDS

3.01 DOCUMENTATION & AS-BUILTS

- A. As-Built record documentation for communications work shall include:
 1. Cable routing and identification
 2. System function diagrams
 3. Manufacturers' description literature for equipment
 4. Connection and programming schedules as appropriate
 5. Equipment material list including quantities
 6. Spare parts list with quantities
 7. Details not on original Contract Documents
 8. Test results
 9. Warranties
 10. Release of liens
- B. The Contractor shall provide and maintain at the site a set of prints on which shall be accurately shown the actual installation of all work under this section, indicating any variation from contract drawings, including changes in pathways, sizes, locations and dimensions. All changes shall be clearly and completely indicated as the work progresses.
- C. Progress prints shall be available for inspection by the Owner or any of his representatives and may be used to determine the progress of communications infrastructure work.
- D. At the completion of the work, prepare a new set of as-built drawings, of the work as actually noted on the marked-up prints, including the dimensioned location of all pathways.
- E. Furnish as-built drawings and documentation. As-built drawings shall be generated in AutoCad 2008 or later. Submit as-built drawings electronically on CD and hard copy.

3.02 OPERATIONS AND MAINTENANCE MANUAL

- A. After completion of the work, the Contractor shall furnish and deliver to the Engineer three (3) copies of a complete Operations & Maintenance Manual. A system wiring diagram shall be furnished for each separate system.

- B. The manual shall be subdivided into separate sections with tab dividers to identify subsystems of the integrated system. Reference appropriate Specification sections.
- C. Provide the following additional information for each electronic system. Information shall be edited for this project where applicable.
 - 1. Operations manuals for components and for systems as a whole
 - 2. Maintenance manuals for components and for system as a whole
 - 3. Point-to-point diagrams, cabling diagrams, construction details and cabling labeling details
 - 4. List of spare parts, materials and suppliers of components. Provide name, address and telephone number for each supplier.
 - 5. Emergency instructions for operational and maintenance requirements
 - 6. Delivery time frame for replacement of component parts from suppliers
 - 7. Recommended inspection schedule and procedures for components and for system as a whole
 - 8. List of spare parts, materials and suppliers of components. Provide name, address and telephone number for each supplier.
 - 9. Complete "reviewed" shop drawings and product data for components and system as a whole
 - 10. Troubleshooting procedures for each system and for each major system component

3.03 TRAINING

- A. The Contractor shall be responsible for training of facility personnel. Training shall take place after occupancy and before acceptance and shall include programs for on-site operations and maintenance of technology and communications systems. Training shall be for not more than ten (10) people, shall be held at the Owner's site and shall be of sufficient duration and depth to ensure that the trained personnel can operate the installed systems and can perform usual and customary maintenance actions.

3.04 WARRANTY

- A. General
 - 1. All equipment is to be new and warranted free of faulty workmanship and damage.
 - 2. Replacement of defective equipment and materials and repair of faulty workmanship within 24 hours of notification, except emergency conditions (system failures), which must be placed back in service within eight (8) hours of notification, all at no cost to the Owner.
 - 3. The minimum warranty provisions specified shall not diminish the terms of individual equipment manufacturer's warranties.

B. Voice & Data Structured Cabling

1. Manufacturer(s) shall provide a minimum 25-year warranty for components used in the installed Voice & Data Structured Cabling System. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.

C. Pathway & Support Infrastructure

1. Manufacturer(s) shall provide a minimum 1-year warranty for components used in the installed Pathway & Support Infrastructure. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.

END OF SECTION 27 0800

SECTION

STRUCTURED CABLING

PART 1 GENERAL

1.01 SUMMARY

- A. General requirements for Communications work.
- B. The general conditions for contracts of construction, referred to in the contract documents as the General Conditions, together with the following articles of the Telecommunications Structured Cabling Specification, which amend, modify and supplement various articles and provisions of the General Conditions, are made part of the Contract and shall apply to all work under the Contract.
- C. The Contractor represents that it has expertise in the Work described in the contract documents. The Contractor further agrees that it shall provide all labor and materials required to provide a fully functional installation meeting the specifications, drawings, and design intent. The NIC and OFE equipment and materials are specifically exempted from this requirement.
- D. The Contractor scope of work includes project specifications and drawings. Contractor is obligated to identify conflicts between the drawings and specs at the time of bid submission.
- E. Contractor shall comply with all applicable governmental regulations and with all Federal, State, City, and other applicable codes and ordinances. If the contractor performs any work which is contrary to such regulations, codes, and ordinances, contractor shall make all changes to comply therewith and bear all costs arising there from.

1.02 RELATED SECTIONS

- A. Section 27 0501 Communications General Provisions
- B. Section Bonding and Grounding for Communications Systems
- C. Section 27 0529 Hangers and Supports for Communications Systems
- D. Section 27 0533 Conduits, Pullboxes and Backboxes for Communications Systems
- E. Section 27 0536 Cable Trays for Communications Systems
- F. Section 27 0543 Underground Ducts and Raceways for Communications Systems

- G. Section 27 0553 Identification for Communications Systems
- H. Section 27 0800 Testing of Communications Systems
- I. Section 27 1000 Structured Cabling
- J. Section 27 1119 Communications Termination Blocks and Patch Panels
- K. Section Communications Cable Management and Ladder Rack
- L. Section 27 1126 Communications Rack Mounted Power Distribution
- M. Section Communications Copper Backbone Cabling
- N. Section Communications Optical Fiber Backbone Cabling
- O. Section Communications Copper Horizontal Cabling
- P. Section Communications Faceplates and Connectors
- Q. Section Communications Patch Cords and Station Cords

1.03 WORK INCLUDED

- A. The Owner seeks to identify a qualified telecommunication cabling contractor capable of performing the scope of work as identified in the Contract Documents.
- B. It is the intent of these Specifications to create a fully functional structured cabling system.
- C. The work covered by this specification includes the installation of a complete cabling system, including all labor necessary to perform and complete such installation, all materials and equipment incorporated or to be incorporated in such installation, and all services, supervision, consumable items, fees, licenses, facilities, tools, and equipment necessary or used to perform and complete such installation.
- D. The Work Included is defined by the following and further defined in the drawings and Sections of Division 27:
 - 1. Provide project management and oversight for the installation of a complete structured cabling system.
 - 2. Prepare and submit
 - a. shop drawings and product data
 - b. cable termination and pull schedules
 - c. cable test results

- d. as-built drawings

1.04 DEFINITIONS

- A. NEC National Electrical Code.
- B. OSHA Occupational Safety & Health Administration.
- C. ANSI American National Standards Institute.
- D. BICSI Building Industry Consulting Service International
- E. NFPA National Fire Protection Association
- F. ASA American Standards Association
- G. IEEE Institute of Electrical & Electronics Engineers
- H. NEMA National Electrical Manufacturers Association
- I. UL Underwriters' Laboratories, Inc
- J. IES Illuminating Engineering Society
- K. IPCEA International Power Cable Engineers Association
- L. ASTM American Society of Testing Materials
- M. ETL Electrical Testing Laboratories, Inc
- N. TIA Telecommunication Industries Association
- O. FCC Federal Communications Commission
- P. NRTL Nationally Recognized Testing Laboratory
- Q. FM Factory Mutual
- R. NIC Not in Contract
- S. OFE Owner Furnished Equipment
- T. "PROVIDE" or "FURNISH" means to supply, purchase, transport, place, erect, connect, label, test and turn over to Owner, complete and ready for regular operation, all materials, labor, equipment, testing apparatus, controls, tests, accessories and all other items customarily required for some telecommunications cabling system.
- U. "SUPPLY" means to purchase, procure, acquire, and deliver complete with related accessories.

- V. "INSTALL" means to move from property line, set in place, join, unite, fasten, link, attach, set up or otherwise connect before testing and turning over to Owner of equipment and/or components. It means the installation is to be complete and ready for regular operation, except as otherwise noted.
- W. "WIRING" or "CABLING" includes furnishing, unless otherwise noted, of all fittings, hangers, supports, sleeves, etc.
- X. "CONDUIT" and "CABLE TRAY" includes furnishing, unless otherwise noted, of all fittings, hangers, supports, sleeves, etc.
- Y. "AS DIRECTED" means as instructed by the IT Project Manager or his representative.
- Z. "CONCEALED" means embedded in masonry or other construction, installed behind wall furring or within double partitions, installed beneath raised floor within appropriate support system or installed within hung ceilings.
- AA. "EXPOSED" means not installed underground or "CONCEALED" as defined above.
- BB. "PERMANENT LINK" means the end-to-end test configuration for a link excluding test cords and patch cords, but including the mated connection with the link. The permanent link shall not exceed 295 feet (90 meters)
- CC. "CHANNEL LINK" means the permanent link plus patch cords (of 24 AWG or greater). The channel link shall not exceed 328 feet (100 meters)
- DD. "TECHNOLOGY ROOM" includes IDF, MDF, and TSER rooms, or any other rooms or spaces containing equipment associated with Division 27 work and/or where an enlarged equipment plan drawing is included the Division 27 drawings.

1.05 CODES, REGULATIONS, AND STANDARDS

- A. The installation shall comply fully with all applicable local, county and state laws and ordinances, regulations and codes.
- B. Should any change in plans or specifications be required to comply with governmental regulations, the contractor shall notify the Construction Manager and the IT Project Manager at the time of submitting the construction schedule.
- C. All products, services and materials provided and performed under the scope of this specification shall conform to the latest edition of the following codes and standards:
 - 1. BICSI Information Technology Systems Installation Methods Manual (ITSIMM)
 - 2. BICSI Telecommunications Distribution Methods Manual (TDMM).

3. ANSI/TIA-568 Telecommunications Standards
4. ANSI/TIA-569 Telecommunications Pathways and Spaces Standards.
5. ANSI/TIA-606 Administration Standard for Telecommunications Infrastructure
6. ANSI/TIA-607 Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
7. NFPA 70 National Electrical Code

1.06 SITE VISIT, PRE-BID

- A. The contractor is encouraged to visit the site of the work and become familiar with the conditions affecting the installations. Submission of a proposal shall presuppose knowledge of such conditions and no additional compensation shall be allowed where extra labor or hours are required because of ignorance of such conditions.
- B. The contractor shall verify all dimensions in the field, confirm the locations and types of cabling to be used in completing the job, document the lengths of new cable to be furnished and installed, and verify capacity and condition of conduits, raceways, sleeves, and ducts.

1.07 SPECIAL CONDITIONS

- A. All work that would adversely affect the normal operation of the other portions of the Owner's facility shall be coordinated with the Owner.
- B. Prior to submitting bids on the project, visit the site of the work to become aware of existing conditions that may affect the cost and scope of the project.

1.08 PROPOSAL REQUIREMENTS

- A. Each proposal must include complete unit pricing for the system as defined in this document. The bidders must include in their pricing all overtime labor, shift work, etc., if any, required to complete the installation as specified within this document. The Owner will not accept liability for any additional charges for work specified herein unless the scope of the work is in addition to this document. Pricing should be for installed systems working on a turnkey basis. Proposals must include the information requested in the following sections, in the order and detail needed to satisfy each item shown. The quotations submitted in reply to this request will be considered binding.
- B. To facilitate the evaluation of bid responses, each proposal shall be constructed in the format prescribed by these guidelines.
- C. Specifically identify all components, products, services or functions described in this section that are not being included by the bidder in their Proposal. If such

components, products, services or functions are not specifically identified, they are understood to be included within the scope and price proposed by the bidder.

- D. Include product cut sheets for all materials, components, products, and hardware included in the proposal.
- E. Compliance with Requirements:
 - 1. Requests for substitutions of equipment or materials outside of the approved manufacturer list must be made and approved prior to the bid submittal. Unapproved substitutions shall constitute a non-compliant bid return.
 - 2. The bidder shall confirm that in all respects the bidder's quotation conforms to all specifications, terms and conditions incorporated and made a part of this bid package. The bidder will ensure that responses will be made in the same order and using the same numbering conventions as used in this specification to facilitate the evaluation process. The bidder shall ensure that all required information is included in this response and state acceptance of conformance requirements, to each point in this specification. Neutral comments such as "noted" will not be accepted as a compliant statement. Any failure and/ or incompleteness in this respect may result in disqualification.
 - 3. By virtue of its submission of a response to this RFP, the bidder warrants that the requirements of this RFP have been read and understood and represents that the delivery and implementation of the products and services specified in this RFP shall in no way obligate The Owner to pay any additional costs to the Contractor for the provision of the services, other than those so noted and presented in the response to this RFP.
 - 4. The contractor shall include the cost (initial purchase and one year of ongoing support) of all required software and hardware licensing agreements in their bid submission. The contractor shall coordinate the purchase and registration of all required software with The Owner. Any proprietary software developed for use in the recommended system shall be considered work for hire and will become the property of The Owner.

1.09 QUALITY ASSURANCE

- A. Select and submit cable and cable termination hardware manufacturers to comply with the warrantee requirements of 27 10 00.
- B. All materials furnished shall be new, unused, clean and free from damage, defects or corrosion.
- C. Materials shall be purchased directly from distributors authorized by the manufacturer for resale of same.

- D. Equipment and materials of the same type shall be a product of the same manufacturer throughout unless specifically exempted in advance.
- E. The Contractor, upon receiving notice from The Owner that the Contractor has furnished inferior, improper or unsound Work or materials (including equipment, whether operational or unused) or Work or materials at variance with that which is specified will, within twenty-four (24) hours, proceed to remove such Work or materials and make good all other Work or materials damaged thereby, and, at the option of The Owner, the Contractor shall immediately replace such Work or materials with Work or materials as specified. The removal, replacement and repair shall be performed at such times and with manpower sufficient, in the judgment of The Owner, to avoid disturbance to occupants, or other ongoing work.
- F. If the Contractor does not remove such unsound Work within twenty (20) working days, The Owner may remove it and may store the material at the expense of the Contractor.
- G. The Owner shall have full authority always, until completion and acceptance of the Work, to inspect and reject Work and materials which in its sole judgment are not in conformity with the Drawings and Specifications, and its decision regarding character and value of Work shall be final and conclusive on both contracting parties.
- H. Any expense incurred by The Owner in connection with the foregoing shall be reimbursed by the Contractor, and The Owner may withhold money due to the Contractor or recover money already paid to the Contractor, to the extent of such expense.

1.10 SUBMITTALS

- A. Within two (2) weeks after date of execution of contract documents, submit for review and acceptance a list of all material and equipment manufacturers whose products are proposed.
- B. A submittal list must be submitted prior to the submission of shop drawings and/or product data submittals. The submittal list shall include all materials necessary to provide a fully functional structured cabling system and be reviewed and accepted prior to submittal of shop drawings. The submittal list must indicate of the submitted equipment if a specified manufacturer or a product substitution. No shop drawings will be processed without an accepted submittal list. Data of a general nature will not be accepted.
- C. The materials, equipment, and software submittals will include:
 - 1. All material, systems, software, and equipment as listed herein:
 - 2. Mark each copy of the product data sheets to show applicable choices and options.

3. Where product data includes information on several products, some of which are not required, mark copies to indicate the applicable information.
- D. Installation of telecommunications systems shall be performed under the direct supervision of a RCCD specialist trained and currently certified by the manufacturer. Within two working (2) days after date of execution of contract documents, submit for review and acceptance the following information:
1. Field superintendent's name.
 2. Telephone number and address.
 3. A list of three projects of equivalent in size and complexity to that specified herein that were directly supervised by the proposed superintendent-specialist.
 4. Project List for each project detailing; the name of the project; location; project description; construction cost; name and telephone number of The Owner's representative; date installation started; and date installation was completed.
 5. Company's certifications and professional designations within the telecommunications industry.
- E. Labor force shall have certified technicians trained by the manufacturer and shall provide with the bid response copies of certifications for all technicians who are expected to install the system and execute the tests. Amend this submission at time of actual installation with updated data on all technicians assigned. Within two (2) days after date of execution of contract documents, submit for review and acceptance the following information for each technician:
1. Optical Fiber Terminator: Certifications for training on the approved manufacturers' connectors and in the splicing methodologies.
 2. UTP Cable Testers: Certifications for use of the required UTP cable testers to be used on the project.
 3. Optical Fiber Cable Testers: Certifications for use of optical loss power meters and OTDR testing equipment to be used on the project.
- F. Product data submittals:
1. For products installed under Division 27 work submit the following:
 - a. Manufacturer's cut-sheets and/or specification sheet for all products installed under division 27.
 - b. Each product data submittal shall include the individual product identified by a check mark. Product data submittals that do not have specific products indicated will be returned without review.
 - c. Each product data submittal shall indicate the applicable specification section as part of the submittal identification number. Product data

submittals that do not indicate the applicable specification section shall be returned without review.

G. Other information submittals:

1. In addition to the specific requirements of the individual division 27 sections, at a minimum, shop drawings shall include the following:
 - a. Cable termination/pull schedules for each horizontal and riser cable segment that includes at a minimum:
 - 1) Floor number
 - 2) Room number
 - 3) Work area outlet ID
 - 4) Work area port number/letter
 - 5) IDF Room name/number
 - 6) Rack number
 - 7) Patch panel RU position
 - 8) Patch Panel Port number

H. Shop Drawings:

1. All drawings shall be submitted 2 weeks in advance of field requirements to allow ample time for review and resubmitted as may be required. All submittals shall be complete and contain all required and detailed information.
2. Shop drawings shall consist of two (2) sets of prints of drawings, diagrams, schedules, and other data specially prepared for the work by the contractor or any subcontractor, manufacturer, supplier or distributor to illustrate some portion of the work as required.
3. The contractor shall submit three (3) copies of the floor plan, with station information outlets numbered, at the start of construction
4. Acceptance of any submitted data or shop drawings for material, equipment apparatus, devices, arrangement, and layout shall not relieve the contractor from responsibility of furnishing same of proper dimensions and weight, capacities, sizes, quantity, quality, and installation details to perform efficiently the requirements and intent of the contract. Such acceptance shall not relieve contractor from responsibility for errors, omissions, or inadequacies of any sort on submitted data or shop drawings
5. Each shop drawing shall contain drawing title and reference to the applicable drawing and specification article

6. Individual shop drawing submittals shall be provided for each specific material, system or equipment as identified herein. Submittals provided other than in this manner will be returned without review.
7. In addition to the specific requirements of the individual division 27 sections, at a minimum, shop drawings shall include the following:
 - a. Schematic diagrams indicating type and quantities of riser and tie cabling.
 - b. Plan drawings of each floor indicating cable pathways, outlet locations, and each outlet ID.
 - c. Technology room equipment plans indicating dimensioned locations of division 27 equipment.
 - d. Technology room reflected ceiling plans indicating dimensioned locations of division 27 equipment.
 - e. Technology room elevations where div 27 work exists on walls indicating dimensioned locations of division 27 equipment.
 - f. Elevation drawings depicting each rack and division 27 equipment.

1.11 COORDINATION OF WORK

- A. Carefully check space requirements and the physical confines of the areas of work to ensure that all material can be installed in the technology rooms.
- B. Transmit to Project Manager all information necessary for any work required by other trades and/or equipment vendors to ensure that all trades/vendors have the information necessary to properly install all the necessary connections and equipment.
- C. The contractor shall arrange and coordinate all access to the job site and to the floors as well as the receipt, staging, marshaling, and safe storage of all materials, tools and supplies with a person specified by the Project Manager and inform the Project Manager of the arrangements. All material deliveries, either before or after normal working hours shall be included in this pricing.
- D. Provide immediate notification to the Project Manager of construction sequencing delays that will prevent contractor(s) from meeting the construction schedule.
- E. Contractor will attend all required construction meetings, at the project site or other location, as requested.
- F. Without additional cost, Contractor shall accommodate reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper compliance with the design intent.

- G. The contractor will be held accountable for any damage done to the property or work of other trades (i.e. ceiling tile, painted walls, etc.) and will be back charged for any required repairs to restore damaged area(s) to original finish and functionality.
- H. Cleanup and removal of debris is the responsibility of the contractor. If the contractor does not cleanup and remove debris, the Owner will contract another party to perform this function and the contractor will be back charged for this work.

1.12 DELIVERY, STORAGE, AND HANDLING

- A. Ship all products and materials in a manner that will protect them from damage, weather, and entry of debris. If items are damaged, do not install, but take immediate steps to obtain replacement.
- B. Deliver materials (except bulk materials) in manufacturer's unopened container, fully identified with the manufacturer's name, trade name, type, class, grade, size and color.
- C. Store materials suitably sheltered from the elements, but readily accessible for inspection until installed. Store all items subject to moisture damage in dry spaces. Identify space requirements for storage with the submittals.
- D. Costs of all shipping to the site and all unusual storage requirements shall be borne by the Contractor. It shall be the responsibility of the Contractor to make appropriate arrangements and to coordinate with authorized personnel at the site for the proper acceptance, handling, protection and storage of equipment so delivered.
- E. Movement of material, either at the time of delivery or subsequently, shall be the sole responsibility of the Contractor. All costs associated with this movement shall also be the responsibility of the Contractor.
- F. The Contractor shall be responsible for the safe storage of all equipment. In the event of equipment damage or disappearance from the site, the Contractor shall bear full responsibility and all costs associated with equipment replacement at no additional cost to The Owner.
- G. The Contractor shall maintain and protect all equipment, materials, and tools from loss or damage from all causes until final acceptance by The Owner.

1.13 PROJECT CLOSEOUT

- A. Final project acceptance shall include, but is not limited to:
 - 1. Successful resolution of punch list items
 - 2. Completion of required testing
 - 3. Completion of Consultant's construction administration site visits

4. Submittal, review and acceptance of required As Built drawings, test results, cable pull schedules and documentation
 5. Issuance of 20-year cabling Warranty by cable manufacturer
- B. The Contractor shall provide, in writing, a minimum of a one-year (1-year) no-cost warranty policy against materials and workmanship supplied under this contract.
- C. Provide final cable termination schedules for all cables installed under the Work. Schedules shall be stored on a compact disk (CD-ROM) in Microsoft Excel format.

1.14 APPLICATION MANUFACTURER'S EXTENDED WARRANTIES

- A. Provide twenty (20) year cable manufacturer's extended warranty to The Owner.
- B. A copy of certification by the manufacturer for all products listed in this specification is to be provided as an attachment to the bid response.
- C. Prior to commencement of the work, the contractor shall submit documentation demonstrating the project has been registered with the cable manufacturer.
- D. Upon completion of the work, the contractor shall coordinate with the manufacturer the issuance of a full Warranty on the entire copper and fiber optic cable plant including the horizontal cabling for both parts and labor. The cabling contractor at his sole expense will correct any deficiencies determined by the manufacturer. Per the contract documents, the Owner may elect to withhold final payment until the full extended warranty is received.
- E. Contractor shall transmit to the owner instructions for processing a warranty claim for years 2 through 20 of the extended warranty.

PART 2 PRODUCTS

2.01 GENERAL

- A. Refer to the Specific Sections of the Specifications for Equipment Requirements

PART 3 EXECUTION

3.01 STAFFING

- A. The contractor shall provide a supervisory work force sufficient to maintain efficient performance of the contractor's responsibilities. The contractor shall designate in writing to the Construction Manager a dedicated, full time foreman as contact for resolution of problems, job coordination, additions, changes, etc., who shall be present in the field at all times during the performance of the work.

The contractor's foreman shall have full authority to represent the contractor in making decisions and executing the work in an acceptable manner. The contractor as part of this bid response shall supply a resume of the foreman and, if a project manager is to be assigned, a copy of his resume as well.

- B. The contractor shall use only a skilled, experienced and reliable work force and shall discontinue the services of anyone employed on this project upon written request by The Owner or its designated Project Manager.
- C. Craft personnel will be required to provide and use the proper tools and test equipment in the performance of each activity. The tools must be in good working order, and the test equipment must have current calibration certificates, as applicable. The Owner reserves the right to review the tool and test equipment lists and maintenance procedures of the contractor.
- D. Use of Site – Refer to the Division 01 Requirements.
- E. Organization of Work:
 - 1. Where and when applicable, the work called for under this contract shall be carried on simultaneously with the work of other trades in such a manner as to not delay the overall progress of the construction project. This practice shall apply to all the trades on the project in general and to the electrical, furniture, and carpeting contractors in particular. Contractors should take into consideration any additional costs that may be incurred to complete this project within the tight time frames. This cost, if any, should be included in your response. The contractor shall furnish promptly to the Construction Manager, and to any other trades involved in the project, all information and measurements relating to the work which they may require and cooperate with them in order to secure the harmony necessary to the best interest of the project as a whole.
 - 2. The contractor shall provide all work necessary to meet all construction schedules.
 - 3. The contractor shall maintain a complete file of shop drawings at all times available to The Owner, Construction Manager, and/or the IT Project Manager.
 - 4. All work shall remain accessible so as to permit The Owner, Construction Manager, and/or the IT Project Manager observation of the work during the course of construction.

3.02 INSTALLATION, GENERAL

- A. Follow manufacturer's instructions for installing, connecting, and adjusting all telecommunications riser and horizontal cabling and associated supporting, termination and splicing equipment, conduits, poke throughs, ladder rack and all other Division 27 hardware and/or equipment. Provide a copy of such instructions at the equipment during any work on the equipment.

- B. Keep all items protected before and after installation. Provide protection for exposed cables roughed onto the floor prior to their installation into the furniture systems. Clean up and remove all debris at the end of each work day.
- C. If products and materials are specified herein for a specific item or system, use those products or materials. If products and materials are not listed, use products and materials suitable for the application and environment and subject to acceptance of shop drawings.
- D. Examine and compare the telecommunications cabling drawings and specifications with the drawings and specifications of other trades; report any discrepancies between them to the IT Project Manager; and obtain from him written instructions for changes necessary in the work.
- E. The locations of structural and architectural features, sleeves, floor slots, termination and cross connect fields, panels, racks and other equipment indicated on the drawings are approximate. The contractor shall verify the existence, locations, and suitability of all such items, and shall present, with bid response, required modifications to contract documents necessary to complete this work.
- F. At time of bid, the most stringent requirements must be included in the bid. Install and coordinate the telecommunications cabling work, including conduit, ladder rack, and poke throughs in cooperation with other trades and with vendors installing interrelated work. Before installation, make proper provisions to avoid interferences in a manner accepted by the Construction Manager. All repairs or changes required in the work of the contractor, caused by his neglect, shall be made by the contractor, at the contractor's expense.
- G. Only site surveys and take-offs of the architectural drawings are to be used by the contractor to determine cable, conduit, and ladder rack lengths and distances between floors and closets that form the basis of the contractor's bid. The Owner accepts no responsibility as to the accuracy of the preceding distances.
- H. Any deviation from the contract drawings shall require the Contractor to submit a shop drawing for review and approval prior to installation. Where shop drawings are not submitted and approved, the Contractor shall be solely responsible for the coordination and correction as well as any additional incurred expense that may result from deviation.

3.03 INSTALLATION

- A. Contractor shall take necessary precautions to assure that the maximum tensile load and minimum bend radius of all cables (fiber and copper) are not exceeded. Velcro tie wraps are to be hand tightened on cables to prevent crimping cable sheath. Plastic tie wraps are not to be used on lateral cables.

- B. The contractor is responsible for protecting all cables from damage by other contractors at the information outlet before and after installation of the outlet faceplates.

3.04 FIRE-RATED PENETRATIONS

- A. Fire rated penetrations for Division 27 pathways shall be re-enterable and List by a NTRL recognized by the AHJ.
- B. Fire rated pathways shall be Listed for use from 0% to 100% fill without the use of any ancillary materials unless noted otherwise.

3.05 REPLACEMENT

- A. Any cable or termination hardware that fail to meet testing requirements shall be removed and replaced at no additional cost to The Owner. The replacement cable and termination hardware, shall be re-certified after installation to verify compliance. Only equipment that meets the installation requirements stated herein shall meet The Owner's acceptance requirements.

3.06 POST INSTALLATION INSPECTION

- A. Notify consultant for visual inspection of structured cabling installation prior to the termination of cabling but after cables have been physically installed. Following the physical installation of the cabling but before the consultant's inspection, the contractor will conduct visual inspections that include:
 - 1. Verify that cables subject to inspection have been installed to full compliance with the Contract Documents and the design intent.
 - 2. Check for physical damage to cable and termination hardware.
 - 3. Verify that cable bends are within the manufacturer's specified bend radius
 - 4. Verify that cabinets and racks (which require grounding) are properly grounded and comply with the National and Local Electrical Codes for grounding.
 - 5. Verify that the requirements of the AHJ have been satisfied.

3.07 SOURCE MANUFACTURING AND QUALITY CONTROL

- A. Cables that are supplied by the contractor, and test outside of the factory test data by a margin of 10 percent on loss, may, at The Owner's option, be deemed non-usable and returned to the manufacturer for replacement.

END OF SECTION

SECTION 27 1116

COMMUNICATIONS CABINETS, RACKS, FRAMES, AND ENCLOSURES

PART 1 GENERAL

1.01 GENERAL CONDITIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 27 10 00 shall be considered a part of this section and shall have the same force as if printed herein full.
- C. References and standards listed herein are to be the latest edition available.

1.02 SUMMARY

- A. Rack, cabinet, and enclosure specification.

1.03 RELATED SECTIONS

- A. Division 01 – General Requirements
- B. Section 27 10 00 – Structured Cabling

1.04 WORK INCLUDED

- A. Furnish and install racks, cabinets, and enclosures.

1.05 SUBMITTALS

- A. Product Data:
 - 1. Warranty information in accordance with Section 27 1000.
 - 2. Submit all product data in accordance with Division 01 and Section 27 1000.
- B. Shop drawings
 - 1. Provide shop drawings that have been coordinated with field conditions and the work of other trades depicting dimensioned rack and cabinet positions for each location where racks, cabinets, frame, and/or enclosures are installed.

PART 2 PRODUCTS

2.01 2-POST 19" EQUIPMENT RACK

A. Description

1. Manufactured to support 19" EIA-310-D compliant rack-mount equipment.
2. Racks shall be equipped with Vertical Cable Management channels, refer to Section 27 1123.
3. Rack unit marking in a color contrasting with the frame.
4. Integrated bonding attachment point to comply with ANS/TIA-607
5. Aluminum construction with powder coat finish. Color: black.
6. Top and bottom L-angles for rigidity.
7. Pre-punched to allow attachment of vertical cable managers for rack-to-rack ganging.
8. Standard EIA/ECA-310-E hole pattern.
9. Minimum 1,200 lb. Load rating.

B. Required Product Options:

1. Accessory mounting brackets to accept mounting installation of vertical plug strips, offset as required, so as not to conflict with the installation and access to IT equipment.

C. Manufacturers

1. CPI Chatsworth
2. Cooper B-Line
3. Hubbell
4. Approved equivalent

2.02 WALL-MOUNTED IT ENCLOSURE

A. Description

1. 19" EIA-310-E compliant.
2. 2-pair of #12-24 rails, fully adjustable; includes rack manufacturer's hardware.
3. Keyed locks with dust covers.
4. Front and rear sections lock independently.
5. 2" conduit knock-outs on back panel.
6. 14-gauge main body and rear section.
7. NEMA 12k rated.

8. Shall accept integral side-mounted air conditioner unit.
9. Shall include integral side-mounted 1300 BTU air conditioner unit.

B. Manufacturers

1. Great Lakes Case & Cabinet GL360N12A Wall Mount Cabinet
2. Great Lakes Case and Cabinet GL1300MMR AC Unit
3. Approved equivalent

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install all racks and cabinets per the manufacturer's recommended instructions.
- B. Anchor all racks and cabinets to the concrete floor and cross brace to building structure above.
- C. Seismically brace the products indicated in this specification adhering to construction regulations relative to the buildings seismic zone.
- D. Cables within racks, cabinets, and enclosures shall be dressed and terminated in accordance with the recommendations made in BICSI Information Technology Systems Installation Methods Manual (ITSIMM), manufacturer's recommendations and best industry practices.
- E. Cable raceways within racks, cabinets, and enclosures shall not be filled greater than the ANSI/TIA 568/569 maximum fill allowed for the raceway type.
- F. All cables within racks, cabinets, and enclosures shall be visually inspected by contractor for damage or improper installation and shall be replaced at no additional cost to the Owner.
- G. Provide slack loop in accordance with ANSI/TIA 569.
- H. Cables within racks, cabinets, and enclosures shall be neatly dressed in bundles with hook-and-loop ties in all areas where the telecom pathways are exposed.
- I. Mounting screws not used shall be turned over to The Owner.

END OF SECTION 27 1116

SECTION 27 1119

COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Communications Termination Blocks and Patch Panels.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.02 QUALITY ASSURANCE

- A. National Electric Code Compliance: Comply with all NEC articles that apply to construction and installation practices applicable to this section
- B. ANSI/TIA: Comply with all ANSI/TIA articles that apply to construction and installation practices applicable to this section
- C. UL Compliance: Provide products that are UL and or cUL-classified.
- D. NFPA Compliance.
- E. All items of a given type shall be the products of the same manufacturer.
- F. Supply all equipment and accessories new and free from defects.

1.03 SUBMITTALS

- A. Product submittals:
 - 1. Provide an electronic Submittal Log matrix, listing each of the components to be used.
 - a. Submittal Log fields to include referenced specification section, manufacturer, component description and part number.
 - 2. Provide manufacturer's cut sheet of each of the components to be used.
 - a. Specified component to be clearly designated on the manufacturer's cut sheet.
 - b. Manufacturer cut sheets to include detailed component performance parameters.

- B. Shop drawing submittals:
 - 1. Provide shop drawings that have been coordinated with field conditions and the work of other trades.
 - 2. Submit shop drawings for review and acceptance prior to commencement of work.
- C. As-built documentation submittals:
 - 1. Provide as-built documentation of all telecommunications pathway systems under this section utilized throughout the site for review, acceptance and future reference.
 - 2. As-built documentation to include:
 - a. Record Drawings.
 - b. Database matrix of components used.
- D. Warranty documentation:
 - 1. Submit manufacturers extended warranty certification after the warranty acceptance by the manufacturer. It shall be the contractor's responsibility to facilitate the manufacturer specific warranty requirements.

1.04 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 PRODUCTS

2.01 COPPER PATCH PANELS

- A. Acceptable manufacturers
 - 1. Ortronics
 - 2. Leviton
 - 3. Siemon
 - 4. Or approved equal
- B. Category 5e UTP patch panel
 - 1. The patch panel shall be compatible with 19" equipment racks, cabinets or wall mount brackets.
 - 2. The patch panel should be flat
 - 3. The patch panel shall be equipped with 8-position modular ports and shall allow for termination using both T568A and T568B wiring schemes.

4. The patch panel shall be equipped with front labeling space to facilitate port identification.
 5. The connector module shall meet or exceed the Category 5e performance criteria per ANSI/TIA-568-C.2.
- C. Category 6 UTP patch panel
1. The patch panel shall be compatible with 19" equipment racks, cabinets or wall mount brackets.
 2. The patch panel should be flat
 3. The patch panel shall be equipped with 8-position modular ports and shall allow for termination using both T568A and T568B wiring schemes.
 4. The patch panel shall be equipped with front labeling space to facilitate port identification.
 5. The connector module shall meet or exceed the Category 6 performance criteria per ANSI/TIA-568-C.2.
- D. Category 6A UTP patch panel
1. The patch panel shall be compatible with 19" equipment racks, cabinets or wall mount brackets.
 2. The patch panel should be flat.
 3. The patch panel shall be equipped with 8-position modular ports and shall allow for termination using both T568A and T568B wiring schemes.
 4. The patch panel shall be equipped with front labeling space to facilitate port identification.
 5. The connector module shall meet or exceed the Category 6 performance criteria per ANSI/TIA-568-C.2.
- E. Category 6A FTP patch panel
1. The patch panel shall be compatible with 19" equipment racks, cabinets or wall mount brackets.
 2. The patch panel should be flat.
 3. The patch panel shall provide adequate space for individual port labeling on the front and cable/connector labeling on the back.
 4. The patch panel shall be a twenty-four (24) or forty-eight (48) port patch panel with open modular ports that accept a single CAT6A FTP connector module for each cable.
 5. The patch panel connector module opening should be of the industry standard keystone type.
 6. The connector module shall meet or exceed the Category 6A performance criteria per ANSI/TIA-568-C.2.

7. Any unused patch panel ports shall be filled with spare CAT6A FTP connector modules.
8. Provide complete with all required mounting hardware, fittings and cables needed to form a bonded (grounded) system.

2.02 MODULAR PATCH PANELS

- A. Acceptable manufacturers
 1. Ortronics
 2. Leviton
 3. Siemon
 4. Or approved equal
- B. Modular patch panel
 1. The patch panel shall be compatible with 19" equipment racks, cabinets or wall mount brackets.
 2. The patch panel should be flat.
 3. The patch panel shall provide adequate space for individual port labeling on the front and cable/connector labeling on the back.
 4. The patch panel shall be a twenty-four (24) or forty-eight (48) port patch panel with open modular ports that accept a keystone type connector module of various communications type cables.
 5. Any unused patch panel ports shall be filled with black blank inserts.
 6. Provide complete with all required mounting hardware, fittings and cables needed to form a bonded (grounded) system.

2.03 COPPER TERMINATION BLOCKS

- A. Acceptable manufacturers
 1. Ortronics
 2. Leviton
 3. Siemon
 4. Or approved equal
- B. 110 Type Wiring Blocks/Cross-Connect Kits:
 1. The 110-type wiring blocks shall be available in 100-pair, 300-pair and 900-pair configurations.
 2. The 110-type wiring block shall be Category 6.
 3. The cross-connect kits shall include all the components required to complete a wall-mounted 110 cross-connect installation and be available in

both 100- and/or 300-pair configuration. (Includes 110-blocks, connecting blocks and designation strips).

4. The termination block shall meet or exceed the performance criteria per ANSI/TIA-568-C.2.
5. Backbone cabling blocks shall use 5-pair connecting blocks on each 25-pair row.
6. Horizontal cabling blocks shall use 4-pair connecting blocks on each 25-pair row.

C. 66-Blocks

1. The 66-type wiring block shall be a 50-pair configuration.
 - a. The 66-type wiring block shall have a split clip system using bridge clips to connect incoming pairs to outgoing pairs.
 - b. The 66 block's labeling system shall use designation strips or covers to accommodate labels.

2.04 OPTICAL FIBER TERMINATION PANELS

A. Acceptable manufacturers

1. Corning Cable Systems: Pretium Solution (used with Corning optical fiber cabling)
2. Leviton: Opt-X series (used with Superior Essex optical fiber cabling)
3. Ortronics: Optimo series (used with Berk-Tek optical fiber cabling)
4. Or approved equal

B. Rack Mount Optical Fiber Panel/Enclosure

1. The rack mount optical fiber panel/enclosure shall be equipped with either a swing out mechanism or a sliding drawer to access fibers.
2. The rack mount optical fiber panel/enclosure shall be capable of terminating tight-buffered or loose tube optical fiber cable.
3. The rack mount optical fiber panel/enclosure shall provide for bend radius control throughout the panel as well as storage space for slack cabling.
4. The panel/enclosure shall meet or exceed the performance criteria per ANSI/TIA-568-C.3.
5. The rack mount optical fiber panel/enclosure shall be equipped with optical fiber adapter panels.
 - a. The optical fiber adapter panels shall accommodate either multimode or single mode terminated optical fiber.
 - b. The optical fiber adapter panels shall be compatible with LC Connectors.

- c. OM3 laser optimized adaptors shall be aqua in color and equipped with zirconia ceramic sleeves.
- d. Singlemode adaptors shall be blue or green in color and equipped with zirconia ceramic sleeves.

C. Wall Mount Optical Fiber Panel/Enclosure

- 1. The wall mount optical fiber panel/enclosure shall have a hinged door for access, with locking available for security.
- 2. The wall mount optical fiber panel/enclosure shall be capable of terminating tight-buffered or loose tube optical fiber cables and all popular connector types.
- 3. The wall mount optical fiber panel/enclosure shall provide for bend radius control throughout the panel as well as storage space for slack cabling.
- 4. The panel/enclosure shall meet or exceed the performance criteria per ANSI/TIA-568-C.3.
- 5. The wall mount optical fiber panel/enclosure shall be equipped with optical fiber adapter panels.
 - a. The optical fiber adapter panels shall accommodate either multimode or singlemode terminated optical fiber.
 - b. The optical fiber adapter panels shall be compatible with LC connectors.
 - c. OM3 laser optimized adaptors shall be aqua in color and equipped with zirconia ceramic sleeves.
 - d. Singlemode adaptors shall be blue or green in color and equipped with zirconia ceramic sleeves.

2.05 RESIDENTIAL MULTIMEDIA PANEL TERMINATION PANELS

A. Acceptable manufacturers

- 1. Leviton
- 2. On-Q
- 3. Or approved equal

B. Voice and Data Termination Module

- 1. The data module shall be Power Sum rated with a Power Sum NEXT performance equal to or better than the ANSI/TIA-568-C.2, Category 5e pair-to-pair NEXT performance specifications.
- 2. The data module shall be a printed circuit board module with no less than six (6) 8-position modular ports.

C. Bridge Voice Termination Module

1. The voice module shall be capable of bridging up to four (4) telephone lines through to nine (9) outlet locations (1 input block x 9 output blocks).
 2. The voice module shall be a 110-style module with a printed circuit board.
- D. Video Splitter Module
1. The Video Splitters shall be UL listed. It shall be of die-cast housing and printed circuit board construction. Frequency Range 5 MHz - 1 GHz.
 2. The in-unit splitter assignments shall be as follows:
 - a. One-bedroom and two-bedroom units shall be equipped with 4-way splitters.
 - b. Three-bedroom and higher units shall be equipped with 6-way splitters.

PART 3 EXECUTION

3.01 COPPER AND MODULAR PATCH PANELS

- A. Cables shall be dressed and terminated in accordance with the recommendations made in ANSI/TIA-568-C.0 and/or ANSI/TIA-568-C.1, manufacturer's recommendations and best industry practice.
- B. Pair untwist at the termination shall not exceed 13 mm (0.5 inch).
- C. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.
- D. Cables shall be neatly bundled and dressed to their respective patch panel. Each patch panel shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- E. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.02 COPPER TERMINATION BLOCKS

- A. Cables shall be dressed and terminated in accordance with the recommendations made in ANSI/TIA-568-C.0 and/or ANSI/TIA-568-C.1, manufacturer's recommendations and best industry practice.
- B. Pair untwist at the termination shall not exceed 13 mm (0.5 inch).
- C. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.
- D. Cables shall be neatly bundled and dressed to their respective termination block. Each termination block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

- E. Each cable shall be clearly labeled on the cable jacket within 12" of the termination block at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.
- F. Wall mounted termination block fields shall be mounted on communications plywood backboard.
- G. Wall mounted termination block fields shall be installed as per the requirements specified by the manufacturer's installation guidelines.

3.03 OPTICAL FIBER TERMINATION PANELS

- A. Cables shall be dressed and terminated in accordance with the recommendations made in ANSI/TIA-568-C.0 and/or ANSI/TIA-568-C.1, manufacturer's recommendations and best industry practices.
- B. Each cable shall be individually attached to the respective splice enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.
- C. Bend radius of the optic fiber cable in the panel/enclosure shall not exceed 10 times the outside diameter of the cable.
- D. Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.
- E. Each cable shall be clearly labeled at the entrance to the splice enclosure. Cables labeled within the bundle shall not be acceptable.
- F. A maximum of 12 strands of fiber shall be spliced in each tray
- G. All spare strands shall be installed into spare splice trays.
- H. Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the fiber panel.

3.04 CLOSEOUT AND ACCEPTANCE

- A. No additional burden to the Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for reinstallation work shall be coordinated, in writing, with the Owner prior to beginning the work.
- B. All specified Communications systems indicated on the drawings and specifications shall be complete.
- C. Specified shop drawings and product submittals shall have been submitted for review and all review comments and deficiencies shall have been resolved. Final shop drawings and product submittals shall have been submitted, reviewed and found to meet the requirements of the specifications.

- D. Issues and deficiencies identified in field reports and punch lists shall have been resolved. Final as-built drawings shall have been submitted, reviewed and found to meet the requirements of the specifications.
- E. Contractor shall provide written notice of final completion of the telecom infrastructure. Upon receipt, the Owner's Representative will review/observe the completed installation. Once the Owner's Representative is satisfied that all work is in accordance with the Contract Documents, the Contractor will be notified in writing.

END OF SECTION 27 1119

SECTION 27 1123

COMMUNICATIONS CABLE MANAGEMENT AND RUNWAY

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. Applicable requirements of Division 27 – Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Communications Cable Management and Runway.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.02 QUALITY ASSURANCE

- A. National Electric Code Compliance: Comply with all NEC articles that apply to construction and installation practices applicable to this section
- B. ANSI/TIA: Comply with all ANSI/TIA articles that apply to construction and installation practices applicable to this section
- C. UL Compliance: Provide products that are UL and or cUL-classified.
- D. NFPA Compliance: Comply with NFPA 70B, “Recommended Practice for Electrical Equipment Maintenance” pertaining to cable tray systems.
- E. All items of a given type shall be the products of the same manufacturer.
- F. Supply all equipment and accessories new and free from defects.

1.03 SUBMITTALS

- A. Product submittals:
 - 1. Provide an electronic Submittal Log matrix, listing each of the components to be used.
 - a. Submittal Log fields to include referenced specification section, manufacturer, component description and part number.
 - 2. Provide manufacturer’s cut sheet of each of the components to be used.
 - a. Specified component to be clearly designated on the manufacturer’s cut sheet.

- b. Manufacturer cut sheets to include detailed component performance parameters.
- B. Shop drawing submittals:
 - 1. Provide shop drawings that have been coordinated with field conditions and the work of other trades.
 - 2. Submit shop drawings for review and acceptance prior to commencement of work.
- C. Seismic and bracing documentation for the structural bracing and support of telecommunications equipment:
 - 1. Refer to Structural design documents for seismic requirements for non-structural components for all structural bracing and support of telecommunications equipment.
 - 2. Provide seismic design calculations and seismic design sketches prepared by the Contractor's California Certified structural engineer for coordination and approval by the Owner's Representative prior to fabricating or installing any supports. Any proposed reinforcement to be the responsibility of the Contractor. Coordinate seismic design with other trades, fire protection and site conditions.
- D. As-built documentation submittals:
 - 1. Provide as-built documentation of all telecommunications pathway systems under this section utilized throughout the site for review, acceptance and future reference.
 - 2. As-built documentation to include:
 - a. Record Drawings.
 - b. Database matrix of components used.
- E. Warranty documentation:
 - 1. Submit manufacturers extended warranty certification after the warranty acceptance by the manufacturer. It shall be the contractor's responsibility to facilitate the manufacturer specific warranty requirements.

1.04 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 PRODUCTS

2.01 CABLE MANAGEMENT

- A. Vertical cable management for 2-post & 4-post telecom racks

1. Acceptable manufacturers:
 - a. Chatsworth – Evolution series
 - b. B-line – RCM+ Extended depth series
 - c. Or approved equal
2. Use: The vertical cable manager shall create a space for storing and organizing cables along the side of the rack.
3. Material: High strength, lightweight aluminum alloy frame and/or steel.
4. Dimensions: 6” or 10” as noted on drawings. The vertical cable manager shall match the height of the rack.
5. The vertical cable manager shall bolt to the side of racks with included hardware.
6. The double-sided vertical cable manager shall be a double-sided H-shaped trough with a front door and a rear door. The double-sided trough shall provide independent front and rear cable pathways.
7. The middle of the managers shall be mostly open to allow easy cable pass-through.
8. The doors shall be removable, hinged to open from the right or left side, with a two-point latch on the right and left side to secure the door in the closed position.
9. The front and rear sides of the cable manager shall have finger shaped cable guides separated by openings that align with each U space on the rack. Openings between the guides will be evenly spaced.
10. The finger shaped cable guides shall be made from a composite plastic material (not metal) and shall have rounded edges to protect cables.
11. Internal cable management accessories:
 - a. Cable management spools that attach to the panels/mid-sections to provide slack management for patch cords.
 - b. Cable lashing bar kit to provide tie points for cable bundles at the rear/mid of the manager.
 - c. Fiber optic segregation kit that creates a separate pathway inside the manager to separate fiber optic cables from other cables.
12. Finish: Powder coated black with black cable guides.

B. Horizontal cable management for telecom racks

1. Acceptable manufacturers:
 - a. Chatsworth – Evolution series
 - b. B-line – RCM+ Extended depth series
 - c. Or approved equal

2. Use: The horizontal cable manager will guide patch/equipment cords between the vertical cable manager and individual network port connections.
3. Material: High strength, lightweight aluminum alloy frame and/or steel.
4. Dimensions: 1RU or 2RU as noted on drawings. The horizontal cable manager shall match the rack-mount width of the rack.
5. The horizontal cable manager shall attach to the front or rear of the rack with screws and shall be sized to fit in standard EIA-310-D or EIA-310-E Universal rack-mount spacing (1.75" high U).
6. Cables must be able to access the cable manager so that no ports are blocked by the cables.
7. The horizontal cable manager shall be a single-sided C-shaped trough with a cover.
8. 2RU and 3RU high cable managers shall have openings at the rear to facilitate front-to-rear cabling through the horizontal manager.
9. The front of the cable manager shall have finger shaped cable guides along the top and bottom surfaces of the cable manager. Evenly spaced cable openings in between the cable guides shall allow cables to enter/exit the cable manager from/into the rack-mount space.
10. The cover shall be removable, hinged to open up or down and shall snap on to secure the cover in the closed position.
11. The finger shaped cable guides shall be made from a composite plastic material (not metal) and shall have rounded edges to protect cables.
12. Finish: Powder coated black with black cable guides.

2.02 SURFACE MOUNTED DISTRIBUTION RINGS

A. C-Rings/D-rings

1. Acceptable manufacturers:
 - a. Chatsworth
 - b. B-line
 - c. Or approved equal
2. Use: Support cables, patch cords and cross-connect wire on backboards.
3. Material: High-strength, fire-retardant material with rounded edges to prevent damage to cable and wire insulation.

2.03 CABLE RUNWAY

A. Cable runway

1. Acceptable manufacturers:
 - a. B-line

- b. Or approved equal
2. Use: Support pathway for cables and patch cords inside technology rooms.
 3. Material: High strength, lightweight 6063-T6 aluminum alloy.
 4. C-channel cable runway: 1.5" x 0.375" aluminum side rails, with 17/64" diameter holes at 1.571" intervals and rungs on 9" centers.
 5. Cable runway widths shall be as shown on drawings.
 6. Provide complete with all required mounting hardware, fittings and cables needed to form a bonded (grounded) system. Provide for bonding and grounding to meet TIA/EIA 606 Standards.
 7. Rungs can be removed or repositioned to accommodate the specific project or buildings requirements.
 8. Provide any accessory products related to the cable runways system to provide a complete and functional infrastructure system. The cable runway accessories include, but are not limited to:
 - a. Cable runway bend radius drop assemblies (sized per runway section);
 - b. Runway butt-splice, swivel splice and foot kits; Heavy duty stringer splice kits and brackets shall be used to attach end to end horizontal cable runway segments.
 - c. Cable runway corner brackets (sized per runway and site conditions);
 - d. Rack-to-runway mounting plates (sized per runway section);
 - e. Cable runway elevation kits (sized per site conditions);
 - f. Wall angle support brackets (sized per runway section);
 - g. Threaded rod assemblies with rod protectors for overhead attachment;
 - h. Slotted Support brackets for runway attachment to threaded rod assemblies; Runway end termination kits.
 - i. Vertical wall-mounting brackets;
 - j. Cable retaining posts (6" as required);
 - k. Protective end caps. Provide necessary runway accessory products to support cable runway.
 - l. Mounting brackets with pre-punched holes corresponding to NEMA electrical junction box and EIA/TIA mounting panel hole patterns.
- B. 9. UL classified.
 - C. 10. Finish: Powder coated [black/telco gray or clear aluminum].

2.04 FIBER OPTIC PATCH CABLE RACEWAY

- A. Fiber optic patch cable raceway
 - 1. Acceptable manufacturers:
 - a. Ortronics
 - b. Panduit
 - c. ADC
 - d. Or approved equal
 - 2. Use: Support pathway for fiber optic patch cords inside technology rooms.
 - 3. Material: Raceway shall be manufactured from impact-resistant and flame retardant PVC.
 - 4. Raceway minimum dimension: 4" x 4" square duct.
 - 5. Provide any accessory products related to raceway system to provide a complete and functional infrastructure system. The raceway accessories include, but are not limited to:
 - a. A full complement of brackets shall be available for attaching system components to ladder rack, threaded rod, auxiliary framing, strut, equipment racks and raised floor pedestals.
 - b. Raceway bend radius drop assemblies;
 - c. Ninety-degree horizontal elbow
 - d. Horizontal 'T' junction
 - e. Horizontal 'Cross' junction
 - f. End cap kit
 - g. Non-slip snap-on covers that can be easily removed to allow access for moves, additions and changes.
 - 6. The solid wall raceway system should be UL Listed as an optical fiber channel for general purpose use.

2.05 FINISH

- A. Channel and fittings finish shall be pure color, resist scratches, dents, and not peel or corrode. Raceway duct color shall be yellow.

PART 3 EXECUTION

3.01 CABLE MANAGEMENT

- A. Vertical cable management for 2-post & 4-post telecom racks
 - 1. Vertical managers shall be located and installed as indicated in the specifications and on the drawings.

2. Follow installation guidelines as per the requirements specified by the manufacturer.
3. Vertical cable managers shall be installed on both sides of a single equipment rack. Where two (2) or more racks are positioned in a row, vertical cable managers shall be installed between each rack and each end of the row.
4. Attach vertical cable managers to the side of the rack using the included hardware.
5. When more than one cable manager is used on a rack or group of racks, use the same make, style and size of vertical cable manager on the rack or in between racks.
6. Doors shall be attached to the cable manager in the closed position after cabling is complete.

B. Horizontal cable management for telecom racks

1. Horizontal managers shall be located and installed as indicated in the specifications and on the drawings.
2. Follow installation guidelines as per the requirements specified by the manufacturer.
3. When more than one horizontal cable manager is used on a rack or group of racks, use the same make and style of cable manager on the rack or racks.
4. Attach horizontal cable managers to the racks with four screws according to the manufacturer's installation instructions. Each cable manager shall be centered within the allocated rack-mount space (RU).
5. Horizontal managers shall be located so that the number of ports (cables) that each manager supports shall not exceed each cable manager's cable fill capacity.
6. Covers shall be attached to the cable manager and in the closed position after cabling is complete.

C. Surface mounted distribution rings

1. C-ring/D-rings shall be installed on $\frac{3}{4}$ " backboard, straight and level.
2. When more than one C-ring/D-ring is used, use the same make and style.
3. Attach horizontal C-rings/D-rings to the plywood backboards with utilizing all attachment locations possible according to the manufacturer's installation instructions.
4. The number of cables that each ring supports shall not exceed the cable fill capacity.

3.02 CABLE RUNWAYS

- A. Cable runways shall be located and installed as indicated in the specifications and on the drawings.
- B. Follow installation guidelines as per the requirements specified by the manufacturer.
- C. Coordinate the cable runway rungs with the vertical cable manager locations to provide for an unobstructed opening above the vertical cable managers. The specified C-channel cable runway rungs can be relocated to accommodate the requirement.
- D. Install radius runway drop-out fittings at all instances of cable runway grids where cable bundles enter or exit the cable runway system. Multiple drop-out fittings need to be placed next to each other to accommodate large cable bundles. Install drop-out wing sections at the ends of the waterfall drop-out fittings to ensure cable radius requirements are met where cables exit or enter the cable runway grid from the sides of the runway stringers.
- E. Install radius runway drop-out fittings at all instances on both sides above front end of vertical cable managers of cable runway to accommodate patch cord routing in both directions.
- F. Install cable-retaining posts on both sides of the cable runway grid. Retaining posts to be installed at all 90-degree corners, ends of each runway section and at 24" intervals along straight sections. Retaining posts to be installed on both sides of the runway ladder.
- G. Install ground cable support fittings to the underside of the cable runway grids to provide a separate pathway for all #6AWG telecom ground cables routed to the telecom ground bars. Install ground cable support fittings at minimum on 12" centers. Neatly bundle ground cables together with Velcro strips and lay inside the ground cable support fitting pathway. Lash ground cable bundles to every second fitting with Velcro strips
- H. Open ended cable runway sections shall be closed with runway termination kits.
- I. Support vertical cable runway sections to the plywood backboards with runway hold down clamp kits.
- J. Provide vertical cable runway sections from slab level to slab level in each telecom room where cables enter the telecom room through the floor slab and exit the telecom room through the ceiling slab.
- K. Provide vertical cable runway sections from slab level to the horizontal cable runway grid in each telecom room where cables enter the telecom room through the floor slab and do not continue through the ceiling slab.
- L. Vertical support to the slab above shall be provided if a cable runway section spans a distance greater than four (4) feet.

- M. Diagonal braces and threaded rod stiffeners shall be installed as additional structural support assembly as required by the Seismic Requirements for Non-Structural Components for all structural bracing and support of telecommunications equipment.
- N. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.
- O. Installation of cable runways shall provide minimum workable space clearances to the following:
 - 1. Provide minimum 3" of clear vertical space between bottom of cable runways and other obstructions.
 - 2. Provide minimum of 18" of clear horizontal space on at least one side of the cable tray for placing cable onto the cable runway.
 - 3. Provide minimum 12" of clear vertical space above cable runways.
 - 4. Ensure that lighting fixtures, structural supports, air ducts, conduits, piping and other trade work do not interfere with or restrict access to cable runways.
 - 5. No conduits/piping/support rods or other trade work to pass directly through cable runway surfaces.
- P. Install electrical backboxes with electrical receptacles on cable runway above telecom equipment racks using manufacturer's mounting brackets matched to the cable runway style. Route all electrical conduits to side and underneath cable runways to closest wall.
- Q. Installation of cable runways must at all times provide a clear cable pathway to accommodate the installation of telecommunications cable types and conform to the telecommunications industry standard bend radii for these cables.
- R. Seismic bracing:
 - 1. Provide seismic support and bracing for all cable runways installed under this work as required by local building code requirements and to project structural requirements.
 - 2. Seismic bracing should not obstruct or interfere with needed access clearances and cable bend radius requirements.
- S. Cable runway openings through fire partitions, fire walls or walls and floors shall be laid out in advance and fully coordinated with other trades.
- T. Fire rated penetrations: Where cable runways pass through fire partitions, fire walls or walls and floors provide a code compliant effective barrier against the spread of fire, smoke and gases.
- U. All field-cut cable runways shall be deburred prior to placement.

- V. Support all pathways from building construction. Do not support pathways from ductwork, piping or equipment hangers.
- W. Install cable runway level and straight.
- X. Cable runways shall not be used to house both low voltage and power cables.
- Y. Cable tray system shall be grounded in accordance with ANSI/TIA-607-B and NEC Article 250.
- Z. Cable runway system shall be installed straight, level and perpendicular to walls and ceiling slabs.

3.03 FIBER OPTIC PATCH CABLE RACEWAY

- A. The horizontal fiber optic patch cable raceway shall be located and installed as indicated in the specifications and on the drawings.
- B. Follow installation guidelines as per the requirements specified by the manufacturer
- C. Join the raceway duct fittings and straight sections with junction kits.
- D. Align the radius downspouts with the cable entry openings in the server equipment cabinets. Install radius downspout fittings at all instances where fiber optic patch cords enter or exit server equipment cabinets through cable openings in the cabinet roof top panels. Multiple downspout fittings might be needed per cabinet location.
- E. The raceway system shall be installed straight, level and perpendicular to walls and ceiling slabs.
- F. Tighten all fastening and joining hardware to the manufacturer's specifications. Replace any damaged bolts washers and nuts.
- G. Provide and install end cap kits on every open end of the raceway.
- H. The raceway shall be supported by threaded rods and specific threaded rod raceway support brackets from strut trapeze assemblies. The threaded rod support brackets should allow the bracket to be released from the threaded rod without removal of other brackets and hardware from the rod.
- I. The raceway shall be supported from the threaded rod support system at minimum 4-foot centers.
- J. Diagonal braces and threaded rod stiffeners shall be installed as additional structural support assembly as required by the Seismic Requirements for Non-Structural Components for all structural bracing and support of telecommunications equipment.
- K. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and

complete before proceeding with installation or use of products specified in this section.

- L. Installation of raceway shall provide minimum workable space clearances to the following:
 - 1. Provide minimum 6" of clear vertical space between bottom of cable runways and other obstructions.
 - 2. Provide minimum of 18" of clear horizontal space on at least one side of the raceway for placing cable into the raceway.
 - 3. Provide minimum 6" of clear vertical space above raceway.
 - 4. Ensure that lighting fixtures, structural supports, air ducts, conduits, piping and other trade work do not interfere with or restrict access to the raceway.
- M. Installation of cable raceways must at all times provide a clear cable pathway to accommodate the installation of telecommunications cable types and conform to the telecommunications industry standard bend radii for these cables.
- N. Seismic bracing:
 - 1. Provide seismic support and bracing for all raceways installed under this work as required by local building code requirements and to project structural requirements.
 - 2. Seismic bracing should not obstruct or interfere with needed access clearances and cable bend radius requirements.
- O. All field-cut raceways shall be deburred prior to placement.
- P. Support all raceways from building construction. Do not support pathways from ductwork, piping or equipment hangers.

3.04 CLOSEOUT AND ACCEPTANCE

- A. No additional burden to the Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for reinstallation work shall be coordinated, in writing, with the Owner prior to beginning the work.
- B. All specified Communications systems indicated on the drawings and specifications shall be complete.
- C. Specified shop drawings and product submittals shall have been submitted for review and all review comments and deficiencies shall have been resolved. Final shop drawings and product submittals shall have been submitted, reviewed and found to meet the requirements of the specifications.
- D. Issues and deficiencies identified in field reports and punch lists shall have been resolved. Final as-built drawings shall have been submitted, reviewed and found to meet the requirements of the specifications.

- E. Contractor shall provide written notice of final completion of the telecom infrastructure. Upon receipt, the Owner's Representative will review/observe the completed installation. Once the Owner's Representative is satisfied that all work is in accordance with the Contract Documents, the Contractor will be notified in writing.

END OF SECTION 27 1123

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SECTION 27 1313

COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. Applicable requirements of Division 27 – Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Communications Copper Backbone.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.02 QUALITY ASSURANCE

- A. National Electric Code Compliance: Comply with all NEC articles that apply to construction and installation practices applicable to this section
- B. ANSI/TIA: Comply with all ANSI/TIA articles that apply to construction and installation practices applicable to this section
- C. UL Compliance: Provide products that are UL and or cUL-classified.
- D. NFPA Compliance.
- E. All items of a given type shall be the products of the same manufacturer.
- F. Supply all equipment and accessories new and free from defects.
- G. Verification: The Contractor needs to ensure that the Owner has verified the installation and materials being enclosed within building features, buried, or otherwise hidden from view. The Contractor shall bear costs associated with uncovering or exposing installations or features that have not been inspected.
- H. All copper backbone cable sheaths shall delivered to the site on reels. The reels shall be lagged, wrapped or boxed to protect the copper cable sheath during shipping.

1.03 SUBMITTALS

- A. Product submittals:
 - 1. Provide an electronic Submittal Log matrix, listing each of the components to be used.

- a. Submittal Log fields to include referenced specification section, manufacturer, component description and part number.
 2. Provide manufacturer's cut sheet of each of the components to be used.
 - a. Specified component to be clearly designated on the manufacturer's cut sheet.
 - b. Manufacturer cut sheets to include detailed component performance parameters.
- B. Shop drawing submittals:
 1. Provide shop drawings that have been coordinated with field conditions and the work of other trades.
 2. Submit shop drawings for review and acceptance prior to commencement of work.
- C. As-built documentation submittals:
 1. Provide as-built documentation of all telecommunications pathway systems under this section utilized throughout the site for review, acceptance and future reference.
 2. As-built documentation to include:
 - a. Record Drawings.
 - b. Database matrix of components used.
- D. Warranty documentation:
 1. Submit manufacturers extended warranty certification after the warranty acceptance by the manufacturer. It shall be the contractor's responsibility to facilitate the manufacturer specific warranty requirements.

1.04 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 PRODUCTS

2.01 INDOOR COPPER BACKBONE CABLE

- A. Acceptable cable manufacturers
 1. Superior Essex
 2. Berk-Tek
 3. Or approved equal
- B. Multi-pair copper backbone cable (Non-shielded)

1. Type: Category 3 UTP meeting the 100-Ohm balanced twisted pair backbone requirements per the latest issue of ANSI/TIA-568-C.2
2. Cable construction:
 - a. Flame retardant PVC jacket for CMR rated cables.
 - b. Flame retardant low smoke PVC jacket for CMP rated cables.
 - c. 24AWG solid annealed copper conductors
 - d. Thermoplastic conductor insulation.
 - e. EIA/TIA color-coded in 25-pair subunits for easy identification.
3. Outer cable sheath marking must be legible and shall contain the following information:
 - a. Manufacturer's name.
 - b. Copper pair count.
 - c. Type: Category 3
 - d. UL listing: CMR or CMP
 - e. Sequential foot markings in 2-foot increments.
4. UL listed: CMR or CMP
 - a. Cables shall be rated (CMR or CMP) per the installation environment as required by the local AHJ and local codes.
 - b. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
5. Meets ICEA S-90-661 test criteria.
6. Rated maximum bandwidth:
 - a. 16MHz

C. Multi-pair copper backbone cable (Shielded)

1. Type: Category 3 ARMM UTP meeting the 100-Ohm balanced twisted pair backbone requirements per the latest issue of ANSI/TIA-568-C.2
2. Cable construction:
 - a. Flame retardant and abrasion resistant PVC jacket for CMR rated cables.
 - b. Corrugated 8 mil aluminum tape shield
 - c. 24AWG solid annealed copper conductors
 - d. Polyethylene foam with PVC conductor insulation.
 - e. EIA/TIA color-coded in 25-pair subunits for easy identification.

3. Outer cable sheath marking must be legible and shall contain the following information:
 - a. Manufacturer's name.
 - b. Copper pair count.
 - c. Type: Category 3
 - d. UL listing: CMR or CMP
 - e. Sequential foot markings in 2-foot increments.
4. UL listed: CMR
 - a. Cables shall be rated (CMR) per the installation environment as required by the local AHJ and local codes.
 - b. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
5. Rated maximum bandwidth:
 - a. 16 MHz

2.02 OUTDOOR COPPER BACKBONE CABLE

A. Acceptable cable manufacturers

1. Superior Essex
2. Berk-Tek
3. Or approved equal

B. Multi-pair copper backbone cable (Non-armored shielded)

1. Type: Category 3 UTP meeting the 100-Ohm balanced twisted pair backbone requirements per the latest issue of ANSI/TIA-568-C.2
2. Cable construction:
 - a. UV resistant polyethylene outer jacket.
 - b. 24AWG solid annealed copper conductors
 - c. Dual insulation consisting of an inner layer of foamed, natural polyolefin over which is applied a solid (skin) layer of polyolefin colored in accordance with industry standards.
 - d. EIA/TIA color-coded in 25-pair subunits for easy identification.
 - e. Filling Compound of 80 degs C ETPR, completely filling the interstices between the pairs and under the core wrap.
 - f. Core wrap of non-hygroscopic, dielectric tape applied over the core.
 - g. Shield of corrugated, 8 mil aluminum tape applied longitudinally with an overlap.

3. Outer cable sheath marking must be legible and shall contain the following information:
 - a. Manufacturer's name.
 - b. Copper pair count.
 - c. Type: Category 3
 - d. Sequential foot markings in 2-foot increments.
4. RDUP PE89 rated.
5. Meets ICEA S-84-608 test criteria.
6. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
7. Rated maximum bandwidth:
 - a. 16 MHz

C. Multi-pair copper backbone cable (Armored shielded)

1. Type: Category 3 UTP meeting the 100-Ohm balanced twisted pair backbone requirements per the latest issue of ANSI/TIA-568-C.2
2. Cable construction:
 - a. UV resistant polyethylene outer jacket.
 - b. 24AWG solid annealed copper conductors
 - c. Dual insulation consisting of an inner layer of foamed, natural polyolefin over which is applied a solid (skin) layer of polyolefin colored in accordance with industry standards.
 - d. EIA/TIA color-coded in 25-pair subunits for easy identification.
 - e. Filling Compound of 80 degs C ETPR, completely filling the interstices between the pairs and under the core wrap.
 - f. Core wrap of non-hygroscopic, dielectric tape applied over the core.
 - g. Inner shield of corrugated, copolymer coated, 8 mil aluminum tape applied directly over the core wrap; does not butt or overlap at any point along the length of the cable.
 - h. Outer shield of rodent resistant, corrugated, copolymer coated, 6 mil steel tape, applied directly over the aluminum and overlaps.
3. Outer cable sheath marking must be legible and shall contain the following information:
 - a. Manufacturer's name.
 - b. Copper pair count.
 - c. Type: Category 3

- d. Sequential foot markings in 2-foot increments.
4. RDUP PE89 rated.
5. Meets ICEA S-84-608 test criteria.
6. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
7. Rated maximum bandwidth:
 - a. 16MHz

2.03 SPLICE CLOSURES

A. Acceptable splice closure manufacturers

1. 3M
2. Preformed Line Products
3. Or approved equal

B. Canister Splice Closures

1. Splice closures shall be designed for splicing multi-pair copper cables in aerial, duct and buried outside plant applications.
2. Waterproof
3. UV resistant

C. All splice trays, seals and hardware shall be from the same manufacturer as the splice case.

PART 3 EXECUTION

3.01 INDOOR COPPER BACKBONE CABLES

- A. Cables shall be dressed and terminated in accordance with the recommendations made in ANSI/TIA-568-C.0 and/or ANSI/TIA-568-C.1, manufacturer's recommendations and best industry practices.
- B. Cables shall be installed separately from horizontal distribution cables at minimum to the following.
 1. Route through separate conduits and sleeves.
 2. Route through separate re-enterable fire stopping devices.
 3. Copper and fiber optic cables shall be separated on cable trays outside communications rooms.
 4. Copper and fiber optic cables shall be separated in bundles inside communications rooms on the cable runways.

- C. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit.
- D. Slack loops shall be provided on each copper cable segment and shall be supported on racking in accessible space.
 - 1. Leave minimum 15-feet of slack loop at each end of copper backbone cable.
 - 2. Leave minimum 10-feet of slack loop at each splice closure location.
 - 3. See drawings for additional slack loop requirements.
 - 4. Slack coils shall have at least two points of support on the racking support.
- E. Backbone cables shall at all times be securely attached to horizontal and vertical mounted cable trays and cable runways.
- F. Large bundles of cables and/or heavy cables shall be attached using metal clamps and/or metal banding to support the cables.
- G. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.
- H. Install all cabling per the manufacturer's recommended installation instructions, under the guidelines of TIA/EIA 568B and BICSI, and in quantities indicated on the drawings.
- I. Cable raceways shall not be filled greater than the NEC or ANSI/TIA/EIA-569-B maximum fill allowed for the particular raceway type.
- J. Cables shall not be attached to any building features other than specific communications support pathways. Where support for horizontal cable is required, the Contractor shall install appropriate communications pathways to support the cabling.
- K. All cables shall be visually inspected for insufficient bend radius during and after pulling. Damaged cables, or those installed under questionable methods and/or circumstances shall be replaced at no additional cost to the Owner.
- L. Cables shall be neatly bundled and dressed to their respective termination device.
- M. All cables shall be clearly labeled on both ends and in an accessible location no more than six inches (0'-6") from the cable ends.
- N. Cables shall be neatly dressed in bundles with hook-and-loop ties in all areas where the telecom pathways are exposed and visible (not covered by ceiling, wall structures or enclosed wireways and conduits).
- O. Allow slack in cables at entrances and exits of conduit sleeves and at transitions to cable wireways and trays. Never pull cables tight at cable tray transitions; doing so may damage the cables by crimping them on the cable tray side of the bundles.

- P. Keep the cables evenly distributed and neatly combed within the cable wireways and trays located outside the communications rooms.
- Q. Provide hook and loop ties loosely around cables every ten feet only as a measure of keeping cables inside enclosed cable wireways to avoid cables spilling out of wireways when cover is opened.
- R. Do not allow the cables to be pulled tight against the corner edges or to be unevenly balanced on one side of the cable trays or wireways.

3.02 OUTDOOR COPPER BACKBONE CABLES (OUTSIDE PLANT)

- A. Slack loops shall be provided on each cable segment and shall be supported on racking in accessible space.
 - 1. Leave minimum 15-feet of slack loop at each end of copper backbone cable.
 - 2. Leave minimum 15-feet of slack loop at communications entrance room.
 - 3. Leave minimum length of slack loop at each communications manhole location. (Manhole sizes will determine slack loop lengths. See drawings for lengths required)
 - 4. Leave minimum 10-feet of slack loop at each splice closure location.
 - 5. See drawings for additional slack loop requirements.
 - 6. Slack coils shall have at least two points of support on the racking support.
- B. All cables shall be tagged and identified within each manhole.
- C. Place initial cables in bottom conduits to facilitate easy subsequent cable placement.
- D. Place leader guard in the duct before placing cable to prevent damaging the cable sheath on the sharp edge of the duct.
- E. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.
- F. Copper backbone cables shall be bonded and grounded in accordance with the recommendations made in the ANSI/TIA-607-B standard, manufacturer's recommendations and best industry practice.

3.03 CLOSEOUT AND ACCEPTANCE

- A. No additional burden to the Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for reinstallation work shall be coordinated, in writing, with the Owner prior to beginning the work.
- B. All specified Communications systems indicated on the drawings and specifications shall be complete.

- C. Specified shop drawings and product submittals shall have been submitted for review and all review comments and deficiencies shall have been resolved. Final shop drawings and product submittals shall have been submitted, reviewed and found to meet the requirements of the specifications.
- D. Issues and deficiencies identified in field reports and punch lists shall have been resolved. Final as-built drawings shall have been submitted, reviewed and found to meet the requirements of the specifications.
- E. Contractor shall provide written notice of final completion of the telecom infrastructure. Upon receipt, the Owner's Representative will review/observe the completed installation. Once the Owner's Representative is satisfied that all work is in accordance with the Contract Documents, the Contractor will be notified in writing.

END OF SECTION 27 1313

SECTION 27 1323

COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. Applicable requirements of Division 27 – Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Communications Optical Fiber Backbone Cabling.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.02 QUALITY ASSURANCE

- A. National Electric Code Compliance: Comply with all NEC articles that apply to construction and installation practices applicable to this section
- B. ANSI/TIA: Comply with all ANSI/TIA articles that apply to construction and installation practices applicable to this section
- C. UL Compliance: Provide products that are UL and or cUL-classified.
- D. NFPA Compliance.
- E. All items of a given type shall be the products of the same manufacturer.
- F. Supply all equipment and accessories new and free from defects.
- G. Verification: The Contractor needs to ensure that the Owner has verified the installation and materials being enclosed within building features, buried, or otherwise hidden from view. The Contractor shall bear costs associated with uncovering or exposing installations or features that have not been inspected.
- H. All fiber cable sheaths shall delivered to the site on reels. The reels shall be lagged, wrapped or boxed to protect the fiber cable sheath during shipping. All reels shall include the manufacturer's OTDR traces and power meter attenuation data.

1.03 SUBMITTALS

- A. Product submittals:
 - 1. Provide an electronic Submittal Log matrix, listing each of the components to be used.

- a. Submittal Log fields to include referenced specification section, manufacturer, component description and part number.
 2. Provide manufacturer's cut sheet of each of the components to be used.
 - a. Specified component to be clearly designated on the manufacturer's cut sheet.
 - b. Manufacturer cut sheets to include detailed component performance parameters.
- B. Shop drawing submittals:
 1. Provide shop drawings that have been coordinated with field conditions and the work of other trades.
 2. Submit shop drawings for review and acceptance prior to commencement of work.
- C. As-built documentation submittals:
 1. Provide as-built documentation of all telecommunications pathway systems under this section utilized throughout the site for review, acceptance and future reference.
 2. As-built documentation to include:
 - a. Record Drawings.
 - b. Database matrix of components used.
- D. Warranty documentation:
 1. Submit manufacturers extended warranty certification after the warranty acceptance by the manufacturer. It shall be the contractor's responsibility to facilitate the manufacturer specific warranty requirements.

1.04 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 PRODUCTS

2.01 INDOOR OPTICAL FIBER BACKBONE CABLE

- A. Acceptable cable manufacturers
 1. Corning Cable Systems
 2. Superior Essex
 3. Berk-Tek
 4. Or approved equal

- B. Multimode optical fiber cable (Armored)
1. Type: 50 μ m
 2. Fiber optic glass grade: OM3
 3. Cable construction:
 - a. Outer sheath is flame-retardant.
 - b. Have integrated dielectric central strength member.
 - c. TIA-598 color-coded buffered fibers in subunits for easy identification.
 - d. Protected by a flexible, spiral wrapped interlocking armored metal made of aluminum or galvanized steel without interruption from end to end for protection and strength. The metallic armor shall be wrapped in the industry standard color, outer sheath to designate the type of optical fiber.
 4. Outer cable sheath marking must be legible and shall contain the following information:
 - a. Manufacturer's name.
 - b. Fiber strand count.
 - c. Fiber type: 50 μ m
 - d. Fiber optic glass grade: OM3
 - e. UL listing: OFCR or OFCP
 - f. Sequential foot markings.
 5. UL listed: OFCR or OFCP
 - a. Cables shall be rated (OFCR or OFCP) per the installation environment as required by the local AHJ and local codes.
 - b. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
 6. Meets ICEA S-83-596 test criteria.
 7. Maximum attenuation:
 - a. 3.5 dB/km @ 850 nm
 - b. 1.5 dB/km @ 1,300 nm
 8. Minimum overfilled launch bandwidth:
 - a. 1,500 MHz-km @ 850 nm
 - b. 500 MHz-km @ 1,300 nm
 9. Minimum effective modal bandwidth:
 - a. 2,000 MHz-km @ 850 nm

- b. 500 MHz-km @ 1,300 nm
 - 10. Guaranteed Ethernet distances supported:
 - a. 1 Gbps: 1,000 meters @ 850 nm & 600 meters @ 1,300 nm
 - b. 10 Gbps: 300 meters @ 850 nm & 300 meters @ 1,300 nm
- C. Multimode optical fiber cable (Non-armored)
1. Type: 50 μ m
 2. Fiber optic glass grade: OM3
 3. Cable construction:
 - a. Outer sheath is flame-retardant.
 - b. Have integrated dielectric central strength member.
 - c. TIA-598 color-coded buffered fibers in subunits for easy identification.
 4. Outer cable sheath marking must be legible and shall contain the following information:
 - a. Manufacturer's name.
 - b. Fiber strand count.
 - c. Fiber type: 50 μ m
 - d. Fiber optic glass grade: OM3
 - e. UL listing: OFNR or OFNP
 - f. Sequential foot markings.
 5. UL listed: OFNR or OFNP
 - a. Cables shall be rated (OFNR or OFNP) per the installation environment as required by the local AHJ and local codes.
 - b. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
 6. Meets ICEA S-83-596 test criteria.
 7. Maximum attenuation:
 - a. 3.5 dB/km @ 850 nm
 - b. 1.5 dB/km @ 1,300 nm
 8. Minimum overfilled launch bandwidth:
 - a. 1,500 MHz-km @ 850 nm
 - b. 500 MHz-km @ 1,300 nm
 9. Minimum effective modal bandwidth:
 - a. 2,000 MHz-km @ 850 nm

- b. 500 MHz-km @ 1,300 nm
- 10. Guaranteed Ethernet distances supported:
 - a. 1 Gbps: 1,000 meters @ 850 nm & 600 meters @ 1,300 nm
 - b. 10 Gbps: 300 meters @ 850 nm & 300 meters @ 1,300 nm
- D. Single mode optical fiber cable (Armored)
 1. Type: Single mode
 2. Fiber optic glass grade: Zero water peak
 3. Cable construction:
 - a. Outer sheath is flame-retardant.
 - b. Have integrated dielectric central strength member.
 - c. TIA-598 color-coded buffered fibers in subunits for easy identification.
 - d. Protected by a flexible, spiral wrapped interlocking armored metal made of aluminum or galvanized steel without interruption from end to end for protection and strength. The metallic armor shall be wrapped in the industry standard color, outer sheath to designate the type of optical fiber.
 4. Outer cable sheath marking must be legible and shall contain the following information:
 - a. Manufacturer's name.
 - b. Fiber strand count.
 - c. Fiber type: Single mode
 - d. Fiber optic glass grade: Zero waterpeak
 - e. UL listing: OFCR or OFCP
 - f. Sequential foot markings.
 5. UL listed: OFCR or OFCP
 - a. Cables shall be rated (OFCR or OFCP) per the installation environment as required by the local AHJ and local codes.
 - b. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
 6. Meets ICEA S-83-596 test criteria.
 7. Maximum attenuation:
 - a. 0.7 dB/km @ 1,310 nm
 - b. 0.7 dB/km @ 1,550 nm
 8. Guaranteed Ethernet distances supported:

- a. 1 Gbps: 5,000 meters @ 1,310 nm
 - b. 10 Gbps: 10,000 meters @ 1,310 nm & 40,000 meters @ 1,550 nm
- E. Single mode optical fiber cable (Non-armored)
- 1. Type: Single mode
 - 2. Fiber optic glass grade: Zero water peak
 - 3. Cable construction:
 - a. Outer sheath is flame-retardant.
 - b. Have integrated dielectric central strength member.
 - c. TIA-598 color-coded buffered fibers in subunits for easy identification.
 - 4. Outer cable sheath marking must be legible and shall contain the following information:
 - a. Manufacturer's name.
 - b. Fiber strand count.
 - c. Fiber type: Single mode
 - d. Fiber optic glass grade: Zero waterpeak
 - e. UL listing: OFNR or OFNP
 - f. Sequential foot markings.
 - 5. UL listed: OFNR or OFNP
 - a. Cables shall be rated (OFNR or OFNP) per the installation environment as required by the local AHJ and local codes.
 - b. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
 - 6. Meets ICEA S-83-596 test criteria.
 - 7. Maximum attenuation:
 - a. 0.7 dB/km @ 1,310 nm
 - b. 0.7 dB/km @ 1,550 nm
 - 8. Guaranteed Ethernet distances supported:
 - a. 1 Gbps: 5,000 meters @ 1,310 nm
 - b. 10 Gbps: 10,000 meters @ 1,310 nm & 40,000 meters @ 1,550 nm

2.02 INDOOR/OUTDOOR OPTICAL FIBER BACKBONE CABLE

- A. Acceptable cable manufacturers
 - 1. Corning Cable Systems

2. Superior Essex
 3. Berk-Tek
 4. Or approved equal
- B. Multimode optical fiber cable (Armored)
1. Type: 50 μm
 2. Fiber optic glass grade: OM3
 3. Cable construction:
 - a. Outer sheath is flame-retardant and UV-resistant.
 - b. Have integrated dielectric central strength member.
 - c. Indoor/outdoor rated with no need for a transition splice when entering indoor rated facilities.
 - d. TIA-598 color-coded buffered fibers in subunits for easy identification.
 - e. Water-blocking enabled.
 - f. Protected by a flexible, spiral wrapped interlocking armored metal made of aluminum or galvanized steel without interruption from end to end for protection and strength. The metallic armor shall be wrapped in the industry standard color, outer sheath to designate the type of optical fiber.
 4. Outer cable sheath marking must be legible and shall contain the following information:
 - a. Manufacturer's name.
 - b. Fiber strand count.
 - c. Fiber type: 50 μm
 - d. Fiber optic glass grade: OM3
 - e. UL listing: OFCR or OFCP
 - f. Sequential foot markings.
 5. UL listed: OFCR or OFCP
 - a. Cables shall be rated (OFCR or OFCP) per the installation environment as required by the local AHJ and local codes.
 - b. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
 6. Meets ICEA S-104-696 test criteria.
 7. Maximum attenuation:
 - a. 3.5 dB/km @ 850 nm
 - b. 1.5 dB/km @ 1,300 nm

8. Minimum overfilled launch bandwidth:
 - a. 1,500 MHz-km @ 850 nm
 - b. 500 MHz-km @ 1,300 nm
 9. Minimum effective modal bandwidth:
 - a. 2000 MHz-km @ 850 nm
 - b. 500 MHz-km @ 1,300 nm
 10. Guaranteed Ethernet distances supported:
 - a. 1 Gbps: 1,000 meters @ 850 nm & 600 meters @ 1,300 nm
 - b. 10 Gbps: 300 meters @ 850 nm & 300 meters @ 1,300 nm
- C. Multimode optical fiber cable (Non-armored)
1. Type: 50 μ m
 2. Fiber optic glass grade: OM3
 3. Cable construction:
 - a. Outer sheath is flame-retardant and UV-resistant.
 - b. Have integrated dielectric central strength member.
 - c. Indoor/outdoor rated with no need for a transition splice when entering indoor rated facilities.
 - d. TIA-598 color-coded buffered fibers in subunits for easy identification.
 - e. Water-blocking enabled.
 4. Outer cable sheath marking must be legible and shall contain the following information:
 - a. Manufacturer's name.
 - b. Fiber strand count.
 - c. Fiber type: 50 μ m
 - d. Fiber optic glass grade: OM3
 - e. UL listing: OFNR or OFNP
 - f. Sequential foot markings.
 5. UL listed: OFNR or OFNP
 - a. Cables shall be rated (OFNR or OFNP) per the installation environment as required by the local AHJ and local codes.
 - b. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
 6. Meets ICEA S-104-696 test criteria.

7. Maximum attenuation:
 - a. 3.5 dB/km @ 850 nm
 - b. 1.5 dB/km @ 1,300 nm
 8. Minimum overfilled launch bandwidth:
 - a. 1,500 MHz-km @ 850 nm
 - b. 500 MHz-km @ 1,300 nm
 9. Minimum effective modal bandwidth:
 - a. 2,000 MHz-km @ 850 nm
 - b. 500 MHz-km @ 1,300 nm
 10. Guaranteed Ethernet distances supported:
 - a. 1 Gbps: 1,000 meters @ 850 nm & 600 meters @ 1,300 nm
 - b. 10 Gbps: 300 meters @ 850 nm & 300 meters @ 1,300 nm
- D. Single mode optical fiber cable (Armored)
1. Type: Single mode
 2. Fiber optic glass grade: Zero water peak
 3. Cable construction:
 - a. Outer sheath is flame-retardant and UV-resistant.
 - b. Have integrated dielectric central strength member.
 - c. Indoor/outdoor rated with no need for a transition splice when entering indoor rated facilities.
 - d. TIA-598 color-coded buffered fibers in subunits for easy identification.
 - e. Water-blocking enabled.
 - f. Protected by a flexible, spiral wrapped interlocking armored metal made of aluminum or galvanized steel without interruption from end to end for protection and strength. The metallic armor shall be wrapped in the industry standard color, outer sheath to designate the type of optical fiber.
 4. Outer cable sheath marking must be legible and shall contain the following information:
 - a. Manufacturer's name.
 - b. Fiber strand count.
 - c. Fiber type: Single mode
 - d. Fiber optic glass grade: Zero waterpeak
 - e. UL listing: OFCR or OFCP
 - f. Sequential foot markings.

5. UL listed: OFCR or OFCP
 - a. Cables shall be rated (OFCR or OFCP) per the installation environment as required by the local AHJ and local codes.
 - b. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
 6. Meets ICEA S-104-696 test criteria.
 7. Maximum attenuation:
 - a. 0.7 dB/km @ 1,310 nm
 - b. 0.7 dB/km @ 1,550 nm
 8. Guaranteed Ethernet distances supported:
 - a. 1 Gbps: 5,000 meters @ 1,310 nm
 - b. 10 Gbps: 10,000 meters @ 1,310 nm & 40,000 meters @ 1,550 nm
- E. Single mode optical fiber cable (Non-armored)
1. Type: Single mode
 2. Fiber optic glass grade: Zero water peak
 3. Cable construction:
 - a. Outer sheath is flame-retardant and UV-resistant.
 - b. Have integrated dielectric central strength member.
 - c. Indoor/outdoor rated with no need for a transition splice when entering indoor rated facilities.
 - d. TIA-598 color-coded buffered fibers in subunits for easy identification.
 - e. Water-blocking enabled.
 4. Outer cable sheath marking must be legible and shall contain the following information:
 - a. Manufacturer's name.
 - b. Fiber strand count.
 - c. Fiber type: Single mode
 - d. Fiber optic glass grade: Zero waterpeak
 - e. UL listing: OFNR or OFNP
 - f. Sequential foot markings.
 5. UL listed: OFNR or OFNP
 - a. Cables shall be rated (OFNR or OFNP) per the installation environment as required by the local AHJ and local codes.

- b. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
- 6. Meets ICEA S-104-696 test criteria.
- 7. Maximum attenuation:
 - a. 0.7 dB/km @ 1,310 nm
 - b. 0.7 dB/km @ 1,550 nm
- 8. Guaranteed Ethernet distances supported:
 - a. 1 Gbps: 5,000 meters @ 1,310 nm
 - b. 10 Gbps: 10,000 meters @ 1,310 nm & 40,000 meters @ 1,550 nm

2.03 OUTDOOR OPTICAL FIBER BACKBONE CABLE

- A. Acceptable cable manufacturers
 - 1. Corning Cable Systems
 - 2. Superior Essex
 - 3. Berk-Tek
 - 4. Or approved equal
- B. Multimode optical fiber cable (Armored)
 - 1. Type: 50 μ m
 - 2. Fiber optic glass grade: OM3
 - 3. Cable construction:
 - a. Outer sheath is UV-resistant.
 - b. Have integrated dielectric central strength member.
 - c. Outdoor rated.
 - d. Loose tube fiber
 - e. Gel free with water blocking tape.
 - f. TIA-598 color-coded buffered fibers in subunits for easy identification.
 - g. Protected by a flexible, spiral wrapped interlocking armored metal made of aluminum or galvanized steel without interruption from end to end for protection and strength. The metallic armor shall be wrapped in the industry standard color, outer sheath to designate the type of optical fiber.
 - 4. Outer cable sheath marking must be legible and shall contain the following information:
 - a. Manufacturer's name.
 - b. Fiber strand count.

- c. Fiber type: 50 μ m
 - d. Fiber optic glass grade: OM3
 - e. Sequential foot markings.
5. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
 6. Meets ICEA S-87-640 test criteria.
 7. Maximum attenuation:
 - a. 3.5 dB/km @ 850 nm
 - b. 1.5 dB/km @ 1,300 nm
 8. Minimum overfilled launch bandwidth:
 - a. 1,500 MHz-km @ 850 nm
 - b. 500 MHz-km @ 1,300 nm
 9. Minimum effective modal bandwidth:
 - a. 2,000 MHz-km @ 850 nm
 - b. 500 MHz-km @ 1,300 nm
 10. Guaranteed Ethernet distances supported:
 - a. 1 Gbps: 1,000 meters @ 850 nm & 600 meters @ 1,300 nm
 - b. 10 Gbps: 300 meters @ 850 nm & 300 meters @ 1,300 nm
- C. Multimode optical fiber cable (Non-armored)
1. Type: 50 μ m
 2. Fiber optic glass grade: OM3
 3. Cable construction:
 - a. Outer sheath is UV-resistant.
 - b. Have integrated dielectric central strength member.
 - c. Outdoor rated.
 - d. Loose tube fiber
 - e. Gel free with water blocking tape.
 - f. TIA-598 color-coded buffered fibers in subunits for easy identification.
 4. Outer cable sheath marking must be legible and shall contain the following information:
 - a. Manufacturer's name.
 - b. Fiber strand count.

- c. Fiber type: 50 μ m
 - d. Fiber optic glass grade: OM3
 - e. Sequential foot markings.
5. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
 6. Meets ICEA S-87-640 test criteria.
 7. Maximum attenuation:
 - a. 3.5 dB/km @ 850 nm
 - b. 1.5 dB/km @ 1,300 nm
 8. Minimum overfilled launch bandwidth:
 - a. 1,500 MHz-km @ 850 nm
 - b. 500 MHz-km @ 1,300 nm
 9. Minimum effective modal bandwidth:
 - a. 2,000 MHz-km @ 850 nm
 - b. 500 MHz-km @ 1,300 nm
 10. Guaranteed Ethernet distances supported:
 - a. 1 Gbps: 1,000 meters @ 850 nm & 600 meters @ 1,300 nm
 - b. 10 Gbps: 300 meters @ 850 nm & 300 meters @ 1,300 nm
- D. Single mode optical fiber cable (Armored)
1. Type: Single mode
 2. Fiber optic glass grade: Zero water peak
 3. Cable construction:
 - a. Outer sheath is UV-resistant.
 - b. Have integrated dielectric central strength member.
 - c. Outdoor rated.
 - d. Loose tube fiber
 - e. Gel free with water blocking tape.
 - f. TIA-598 color-coded buffered fibers in subunits for easy identification.
 - g. Protected by a flexible, spiral wrapped interlocking armored metal made of aluminum or galvanized steel without interruption from end to end for protection and strength. The metallic armor shall be wrapped in the industry standard color, outer sheath to designate the type of optical fiber.

4. Outer cable sheath marking must be legible and shall contain the following information:
 - a. Manufacturer's name.
 - b. Fiber strand count.
 - c. Fiber type: Single mode
 - d. Fiber optic glass grade: Zero waterpeak
 - e. Sequential foot markings.
 5. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
 6. Meets ICEA S-87-640 test criteria.
 7. Maximum attenuation:
 - a. 0.7 dB/km @ 1,310 nm
 - b. 0.7 dB/km @ 1,550 nm
 8. Guaranteed Ethernet distances supported:
 - a. 1 Gbps: 5,000 meters @ 1,310 nm
 - b. 10 Gbps: 10,000 meters @ 1,310 nm & 40,000 meters @ 1,550 nm
- E. Single mode optical fiber cable (Non-armored)
1. Type: Single mode
 2. Fiber optic glass grade: Zero water peak
 3. Cable construction:
 - a. Outer sheath is UV-resistant.
 - b. Have integrated dielectric central strength member.
 - c. Outdoor rated.
 - d. Loose tube fiber
 - e. Gel free with water blocking tape.
 - f. TIA-598 color-coded buffered fibers in subunits for easy identification.
 4. Outer cable sheath marking must be legible and shall contain the following information:
 - a. Manufacturer's name.
 - b. Fiber strand count.
 - c. Fiber type: Single mode
 - d. Fiber optic glass grade: Zero waterpeak
 - e. Sequential foot markings.

5. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
6. Meets ICEA S-87-640 test criteria.
7. Maximum attenuation:
 - a. 0.7 dB/km @ 1,310 nm
 - b. 0.7 dB/km @ 1,550 nm
8. Guaranteed Ethernet distances supported:
 - a. 1 Gbps: 5,000 meters @ 1,310 nm
 - b. 10 Gbps: 10,000 meters @ 1,310 nm & 40,000 meters @ 1,550 nm

2.04 SPLICE CLOSURES

A. Acceptable splice closure manufacturers

1. Corning Cable Systems
2. Superior Essex
3. 3M
4. Or approved equal

B. Canister Splice Closures

1. Splice closures shall be designed for splicing fibers in aerial, duct and buried outside plant applications.
2. Waterproof
3. UV resistant
4. All splice trays, seals and hardware shall be from the same manufacturer as the splice case.

PART 3 EXECUTION

3.01 INDOOR OPTICAL FIBER BACKBONE CABLES

- A. Cables shall be dressed and terminated in accordance with the recommendations made in ANSI/TIA-568-C.0 and/or ANSI/TIA-568-C.1, manufacturer's recommendations and best industry practices.
- B. Cables shall be installed separately from horizontal distribution cables at minimum to the following.
 1. Route through separate conduits and sleeves.
 2. Route through separate re-enterable fire stopping devices.
 3. Copper and fiber optic cables shall be separated on cable trays outside communications rooms.

4. Copper and fiber optic cables shall be separated in bundles inside communications rooms on the cable runways.
- C. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit.
- D. Slack loops shall be provided on each fiber optic cable segment and shall be supported on racking in accessible space.
 1. Leave minimum 15-feet of slack loop at each end of fiber backbone cable.
 2. Leave minimum 10-feet of slack loop at each splice closure location.
 3. See drawings for additional slack loop requirements.
 4. Slack coils shall have at least two points of support on the racking support.
- E. Backbone cables shall at all times be securely attached to horizontal and vertical mounted cable trays and cable runways.
- F. Large bundles of cables and/or heavy cables shall be attached using metal clamps and/or metal banding to support the cables.
- G. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.
- H. Install all horizontal station cabling per the manufacturer's recommended installation instructions, under the guidelines of TIA/EIA 568B and BICSI, and in quantities indicated on the drawings.
- I. Cable raceways shall not be filled greater than the NEC or ANSI/TIA/EIA-569-B maximum fill allowed for the particular raceway type.
- J. Cables shall not be attached to any building features other than specific communications support pathways. Where support for horizontal cable is required, the Contractor shall install appropriate communications pathways to support the cabling.
- K. All cables shall be visually inspected for insufficient bend radius during and after pulling. Damaged cables, or those installed under questionable methods and/or circumstances shall be replaced at no additional cost to the Owner.
- L. Cables shall be neatly bundled and dressed to their respective termination device.
- M. All cables shall be clearly labeled on both ends and in an accessible location no more than six inches (0'-6") from the cable ends.
- N. Cables shall be neatly dressed in bundles with hook-and-loop ties in all areas where the telecom pathways are exposed and visible (not covered by ceiling, wall structures or enclosed wireways and conduits).
- O. Allow slack in cables at entrances and exits of conduit sleeves and at transitions to cable wireways and trays. Never pull cables tight at cable tray transitions;

doing so may damage the cables by crimping them on the cable tray side of the bundles.

- P. Keep the cables evenly distributed and neatly combed within the cable wireways and trays located outside the communications rooms.
- Q. Do not allow the cables to be pulled tight against the corner edges or to be unevenly balanced on one side of the cable trays or wireways.
- R. The backbone cable sheaths shall be clamped at the side of the fiber termination panels with a backbone cable sheath clamp, or equal, designed for the size of the cable sheath outside diameter and the termination panel. The clamps shall be staggered to allow for a tight cable configuration entering the fiber shelves.

3.02 OUTDOOR OPTICAL FIBER BACKBONE CABLES (OUTSIDE PLANT)

- A. Slack loops shall be provided on each fiber optic cable segment and shall be supported on racking in accessible space.
 - 1. Leave minimum 15-feet of slack loop at each end of fiber backbone cable.
 - 2. Leave minimum 15-feet of slack loop at communications entrance room.
 - 3. Leave minimum length of slack loop at each communications manhole location. (Manhole sizes will determine slack loop lengths. See drawings for lengths required)
 - 4. Leave minimum 10-feet of slack loop at each splice closure location.
 - 5. See drawings for additional slack loop requirements.
 - 6. Slack coils shall have at least two points of support on the racking support.
- B. All cables shall be tagged and identified within each manhole.
- C. Place initial cables in bottom conduits to facilitate easy subsequent cable placement.
- D. Place leader guard in the duct before placing cable to prevent damaging the cable sheath on the sharp edge of the duct.
- E. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.

3.03 SPLICE CLOSURE INSTALLATION

- A. Splice closures shall be installed as per the requirements specified by the manufacturer's installation guidelines.
- B. Splice closures shall be located in accessible locations and housed in an enclosure intended and suitable for the environmental conditions.
- C. At each splice location the cable ends will be sealed watertight at all times.

- D. All splicing shall be of the fusion type made under Light Injection and Detection Mode, whenever applicable. The Contractor shall provide certified and experienced personnel for splicing.
- E. Contractor's tools and equipment shall be in excellent working order. Any worn or improperly working tools shall be discarded and not used on this project. All fusion splicers shall be calibrated and labeled according to the manufacturer's specifications. Contractor shall submit certification of calibration for the fusion splicers.
- F. Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.
- G. Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the splice closure.
- H. Each optical fiber cable shall be individually attached to the respective enclosure by mechanical means.
- I. Each optical fiber cable shall be clearly labeled at the entrance to the enclosure.

3.04 CLOSEOUT AND ACCEPTANCE

- A. No additional burden to the Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for reinstallation work shall be coordinated, in writing, with the Owner prior to beginning the work.
- B. All specified Communications systems indicated on the drawings and specifications shall be complete.
- C. Specified shop drawings and product submittals shall have been submitted for review and all review comments and deficiencies shall have been resolved. Final shop drawings and product submittals shall have been submitted, reviewed and found to meet the requirements of the specifications.
- D. Issues and deficiencies identified in field reports and punch lists shall have been resolved. Final as-built drawings shall have been submitted, reviewed and found to meet the requirements of the specifications.
- E. Contractor shall provide written notice of final completion of the telecom infrastructure. Upon receipt, the Owner's Representative will review/observe the completed installation. Once the Owner's Representative is satisfied that all work is in accordance with the Contract Documents, the Contractor will be notified in writing.

END OF SECTION 27 1323

SECTION 27 1513

COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. Applicable requirements of Division 27 – Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Communications Copper Horizontal Cabling.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.02 QUALITY ASSURANCE

- A. National Electric Code Compliance: Comply with all NEC articles that apply to construction and installation practices applicable to this section
- B. ANSI/TIA: Comply with all ANSI/TIA articles that apply to construction and installation practices applicable to this section
- C. UL Compliance: Provide products that are UL and or cUL-classified.
- D. NFPA Compliance.
- E. All items of a given type shall be the products of the same manufacturer.
- F. Supply all equipment and accessories new and free from defects.

1.03 SUBMITTALS

- A. Product submittals:
 - 1. Provide an electronic Submittal Log matrix, listing each of the components to be used.
 - a. Submittal Log fields to include referenced specification section, manufacturer, component description and part number.
 - 2. Provide manufacturer's cut sheet of each of the components to be used.
 - a. Specified component to be clearly designated on the manufacturer's cut sheet.
 - b. Manufacturer cut sheets to include detailed component performance parameters.

- B. Shop drawing submittals:
 - 1. Provide shop drawings that have been coordinated with field conditions and the work of other trades.
 - 2. Submit shop drawings for review and acceptance prior to commencement of work.
- C. As-built documentation submittals:
 - 1. Provide as-built documentation of all telecommunications pathway systems under this section utilized throughout the site for review, acceptance and future reference.
 - 2. As-built documentation to include:
 - a. Record Drawings.
 - b. Database matrix of components used.
- D. Warranty documentation:
 - 1. Submit manufacturers extended warranty certification after the warranty acceptance by the manufacturer. It shall be the contractor's responsibility to facilitate the manufacturer specific warranty requirements.

1.04 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 PRODUCTS

2.01 HORIZONTAL COPPER CABLE

- A. Acceptable cable manufacturers
 - 1. Berk-Tek
 - 2. Superior Essex
 - 3. Siemon
 - 4. Or approved equal
- B. Category 5e Balanced Twisted Pair Cable
 - 1. The horizontal balanced twisted pair cable shall meet or exceed the Category 5e transmission characteristics per ANSI/TIA/EIA-568-C.2.
 - 2. Four balanced pairs of 24AWG solid copper conductors.
 - 3. Cables shall be rated (CMR or CMP) per the installation environment as required by the local AHJ and local codes.

4. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
 5. Jacket colors shall be:
 - a. **Green** for analog voice.
- C. Category 6 Balanced Unshielded Twisted Pair Cable (UTP)
1. The horizontal balanced twisted pair cable shall meet or exceed the Category 6 transmission characteristics per issue of ANSI/TIA/EIA-568-C.2.
 2. Four balanced pairs of 23AWG solid copper conductors.
 3. Cables shall be rated (CMR or CMP) per the installation environment as required by the local AHJ and local codes.
 4. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
 5. Jacket colors shall be:
 - a. Blue for data.
 - b. Blue for Security.

PART 3 EXECUTION

3.01 GENERAL

- A. Install all horizontal station cabling per the manufacturer's recommended installation instructions, under the guidelines of TIA/EIA 568B and BICSI, and in quantities indicated on the drawings.
- B. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit.
- C. Cable raceways shall not be filled greater than the ANSI/TIA/EIA-569-B maximum fill for the particular raceway type.
- D. Cables shall be installed in continuous lengths from origin to destination (no splices).
- E. Where transition points or consolidation points are allowed, they shall be located in accessible locations and housed in an enclosure intended and suitable for the purpose.
- F. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.
- G. Horizontal distribution cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause

deformation of the bottom cables within the bundle and degrade cable performance.

- H. Cables shall not be attached to any building features other than specific communications support pathways. Where support for horizontal cable is required, the Contractor shall install appropriate communications pathways to support the cabling.
- I. All cables shall be visually inspected for insufficient bend radius during and after pulling. Damaged cables, or those installed under questionable methods and/or circumstances shall be replaced at no additional cost to the Owner.
- J. Contractor shall ensure that all TIA/EIA and industry standards are met with special regards to maximum stripping length of cable jackets. No four (4) pair cables shall have more than three-eighths inch ($\frac{3}{8}$ ") of cable jacket removed beyond the termination points.
- K. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-C.2 document, manufacturer's recommendations and best industry practices.
- L. Leave a minimum of 12" of slack for twisted pair cables at the outlet. Cables shall be coiled in the in-wall box, surface-mount box or modular furniture raceway without exceeding the manufacturers bend radius. In hollow-wall installations where box-eliminators are used, excess wire can be stored in the wall. Excess slack shall be loosely coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.
- M. Cables shall be neatly bundled and dressed to their respective termination device. Each terminating device shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- N. All cables shall be clearly labeled on both ends and in an accessible location no more than six inches (0'-6") from the cable ends.
- O. The Owner reserves the right to specify an alternate location for any outlet or equipment without increasing contractor unit cost – providing that the alternate location is specified prior to roughing-in of pathway and cable and is not farther than ten (10) feet away from the original location specified.
- P. Cables shall be neatly dressed in bundles with hook-and-loop ties in all areas where the telecom pathways are exposed and visible (not covered by ceiling, wall structures or enclosed wireways and conduits) right up to the rear of the termination blocks.
- Q. Copper and fiber optic station cables shall be separated in neat separate bundles inside communications rooms on the cable runways.
- R. Allow slack in cable bundles at entrances and exits of conduit sleeves and at transitions to cable wireways and trays. Never pull cables tight at cable tray

transitions; doing so may damage the cables by crimping them on the cable tray side of the bundles.

- S. Keep the cables evenly distributed and neatly combed within the cable wireways and trays located outside the communications rooms.
- T. Provide hook and loop ties loosely around cables every ten feet only as a measure of keeping cables inside enclosed cable wireways to avoid cables spilling out of wireways when cover is opened.
- U. Do not allow the cables to be pulled tight against the corner edges or to be unevenly balanced on one side of the cable trays or wireways.

3.02 CLOSEOUT AND ACCEPTANCE

- A. No additional burden to the Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for reinstallation work shall be coordinated, in writing, with the Owner prior to beginning the work.
- B. All specified Communications systems indicated on the drawings and specifications shall be complete.
- C. Specified shop drawings and product submittals shall have been submitted for review and all review comments and deficiencies shall have been resolved. Final shop drawings and product submittals shall have been submitted, reviewed and found to meet the requirements of the specifications.
- D. Issues and deficiencies identified in field reports and punch lists shall have been resolved. Final as-built drawings shall have been submitted, reviewed and found to meet the requirements of the specifications.
- E. Contractor shall provide written notice of final completion of the telecom infrastructure. Upon receipt, the Owner's Representative will review/observe the completed installation. Once the Owner's Representative is satisfied that all work is in accordance with the Contract Documents, the Contractor will be notified in writing.

END OF SECTION 27 1513

SECTION 27 1543

COMMUNICATIONS FACEPLATES AND CONNECTORS

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. Applicable requirements of Division 27 – Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Communications Faceplates and Connectors.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.02 QUALITY ASSURANCE

- A. National Electric Code Compliance: Comply with all NEC articles that apply to construction and installation practices applicable to this section
- B. ANSI/TIA: Comply with all ANSI/TIA articles that apply to construction and installation practices applicable to this section
- C. UL Compliance: Provide products that are UL and or cUL-classified.
- D. NFPA Compliance.
- E. All items of a given type shall be the products of the same manufacturer.
- F. Supply all equipment and accessories new and free from defects.

1.03 SUBMITTALS

- A. Product submittals:
 - 1. Provide an electronic Submittal Log matrix, listing each of the components to be used.
 - a. Submittal Log fields to include referenced specification section, manufacturer, component description and part number.
 - 2. Provide manufacturer's cut sheet of each of the components to be used.
 - a. Specified component to be clearly designated on the manufacturer's cut sheet.
 - b. Manufacturer cut sheets to include detailed component performance parameters.

- B. Shop drawing submittals:
 - 1. Provide shop drawings that have been coordinated with field conditions and the work of other trades.
 - 2. Submit shop drawings for review and acceptance prior to commencement of work.
- C. As-built documentation submittals:
 - 1. Provide as-built documentation of all telecommunications pathway systems under this section utilized throughout the site for review, acceptance and future reference.
 - 2. As-built documentation to include:
 - a. Record Drawings.
 - b. Database matrix of components used.
- D. Warranty documentation:
 - 1. Submit manufacturers extended warranty certification after the warranty acceptance by the manufacturer. It shall be the contractor's responsibility to facilitate the manufacturer specific warranty requirements.

1.04 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 PRODUCTS

2.01 COPPER CABLE CONNECTORS

- A. Acceptable manufacturers
 - 1. Ortronics
 - 2. Leviton
 - 3. Siemon
 - 4. Or approved equal
- B. Category 6, 8-Position, 8-Contact (8P8C) Modular Connector
 - 1. The connector module shall meet or exceed the Category 6 performance criteria per ANSI/TIA-568-C.2.
 - 2. The connector shall snap into an industry standard keystone type opening
 - 3. The connector module shall be designed for use at the work area (WA), communications room (TR) and/or equipment room (ER) without modification.

4. The connector module shall be available in both the T568A and T568B wiring configurations within the same module.
5. The connector module shall have an insulation displacement connection featuring insulation splicing of 22 to 24 AWG plastic-insulated solid copper conductors forming a gas-tight connection.
6. Icons shall be used if offered from the manufacturer.
7. Connector and Icon colors shall be:
 - a. White for all connectors and icons
 - b. Green for voice connectors and icons
 - c. White for data connectors and icons

2.02 OPTICAL FIBER CONNECTORS

A. Acceptable manufacturers

1. Corning Cable Systems: UniCam series (used with Corning optical fiber cabling)
2. Leviton: FastCAM series (used with Superior Essex optical fiber cabling)
3. Ortronics: Optimo series (used with Berk-Tek optical fiber cabling)
4. Or approved equal

B. Multimode Optical Fiber Connectivity Laser optimized OM3

1. The optical fiber connector shall be a pre-polished, field-installable connector that eliminates the need for hand polishing, bonding, or epoxy in the field.
2. The optical fiber field-installable connector shall be **LC** for installation onto multimode laser optimized OM3 50/125-micron fiber.
3. The optical fiber field-installable connector shall be compatible with 900-micron buffered fibers.
4. The optical fiber field-installable connector shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.
5. The optical fiber connectors shall have a maximum insertion loss of 0.5 dB per connector pair.
6. The connector materials shall be a ceramic ferrule with composite housing.
7. Laser optimized multimode OM3 fiber connector shall be identifiable by aqua colored components.

C. Single mode fiber connectivity

1. The optical fiber connector shall be a pre-polished, field-installable connector that eliminates the need for hand polishing, bonding, or epoxy in the field.

2. The optical fiber field-installable connector shall be **LC** for installation onto single mode 8.3/125-micron fiber.
3. The optical fiber field-installable connector shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.
4. The optical fiber field-installable connector shall be compatible with 900-micron buffered fibers or 250-micron loose-tube fibers.
5. The optical fiber connectors shall have a maximum insertion loss of 0.5 dB per connector pair.
6. The connector materials shall be a ceramic ferrule with composite housing.
7. Single mode fiber connector shall be identifiable by blue colored components.

2.03 OPTICAL FIBER PIGTAIL ASSEMBLIES

A. Acceptable manufacturers

1. Corning Cable Systems (used with Corning optical fiber cabling)
2. Leviton (used with Superior Essex optical fiber cabling)
3. Ortronics (used with Berk-Tek optical fiber cabling)
4. Or approved equal

B. Single mode optical fiber connectivity

1. Available in 6-, 8-, 12-, 16-, and 24-fiber capacities.
2. Each pigtail assembly is factory terminated and tested.
3. Ultra Physical Contact (UPC) type connector polish and finish.
4. The optical fiber connector shall be LC for installation onto single mode 8.3/125-micron fiber.
5. The optical fiber connector shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.
6. The optical fiber connector shall be compatible with 900-micron buffered fibers or 250-micron loose-tube fibers.
7. The optical fiber connectors shall have a maximum insertion loss of 0.4 dB per connector pair.
8. Optical return loss shall be equal to or better than -55dB.
9. Pigtails shall have minimum 2 meters of attached cordage.
10. The connector materials shall be a ceramic ferrule with composite housing.
11. Single mode fiber connector shall be identifiable by blue colored components.

2.04 COAXIAL CONNECTORS

A. Acceptable manufacturers

1. Ortronics
2. Leviton
3. Siemon
4. Or approved equal

B. Coaxial F-Type connectors

1. Coaxial connectors shall be sealed to prevent moisture from migrating into the connector and have three hundred sixty (360) degree radial compression.
2. F-type coaxial connections shall have a minimum cable retention rating of forty (40) pounds and be manufactured with F-type interface that is compatible with components specifically manufactured for the specific F-type threaded ports.
3. All modular outlet coaxial connectors shall function to the specified performance parameters for video signal traffic that is connected via video patch cords.
4. Ensure connector size and type is compatible with the specified coaxial cable.
5. Utilize corrosion resistant connectors when applicable.
6. Connectors shall be solderless, 75-Ohm impedance and be designed for the specific type of cable used.
7. Series 6 connectors shall be one piece. Series 11 connectors shall use the cable's center conductor as the connector's center pin.
8. All Series 6 and Series 11 connections shall be made with compression-type connectors.
9. The coaxial adapter module that occupies the faceplate shall be a 75-ohm, F-type connector.
10. The connector shall snap into an industry standard keystone type opening.

2.05 FACEPLATES

A. Acceptable manufacturers

1. Ortronics
2. Leviton
3. Siemon
4. Or approved equal

B. Faceplates and Outlet housings

1. Faceplate and outlet housing connector openings shall be the industry standard keystone type.
2. Faceplate shall be available in 4-, 6- and 8-port configurations.
3. Faceplates shall be available in single- and double-gang format.
4. Faceplate shall be available in angled connector module format and or accommodate angled connector module formats.
5. Faceplates for wall-mounted phones shall be one (1) port single gang faceplates that have wall-mount lugs allowing vertical phone mounting.
6. Faceplates for flush floor mounted outlets shall be coordinated with the floor box or poke thru device that will be selected and installed for the project.
7. System furniture faceplates shall be capable of fitting in the furniture system selected for the project.
8. Furniture faceplate extenders shall be used (if required) to maintain proper bend radii within the furniture raceway/pathway.
9. Faceplates shall provide a labeling location using built-in labeling windows for both the individual outlet port and the entire outlet housing location, unless otherwise indicated.
10. The faceplates shall provide for connector modularity and flexibility in configuring multimedia outlets that respond to various network media needs such as audio, video, coaxial and optical fiber applications.
11. Color and material finish shall [match architectural finish requirements] [be same as electrical faceplates].

2.06 SURFACE MOUNT OUTLET HOUSINGS

A. Acceptable manufacturers

1. Ortronics
2. Leviton
3. Siemon
4. Or approved equal

B. Surface mount outlet housings

1. Surface mount outlet housings shall be a high-density low-profile design with (2) two or (4) four connector openings.
2. Connector openings shall be the industry standard keystone type.
3. Outlet housing shall close with a snap-lock cover and provide for cable knockouts on the housing base.
4. Base shall include tie-wrap anchor points at all cable entrances.

5. Provide screws and NEMA compliant screw openings for mechanical fastening to building structures.
6. The cover shall provide the option of securing it to the base with a security screw that is hidden under the outlet identification window.
7. Outlet housing shall be constructed of high-impact, fire-retardant plastic, UL Listed and compliant with TIA/EIA-568-B specifications.
8. Outlet housing cover shall provide a labeling location using built-in labeling windows for both the individual outlet port and the entire outlet housing location, unless otherwise indicated.
9. The outlet housing shall provide for connector modularity and flexibility in configuring multimedia outlets that respond to various network media needs such as audio, video, coaxial and optical fiber applications.
10. The outlet housing shall be deep enough to provide for connector modularity and flexibility in configuring multimedia outlets that respond to various network media needs such as audio, video, coaxial and optical fiber applications.
11. The outlet housing shall have the option for internal storage space for slack cabling and a built-in spool for controlling optical fiber cable bend radius. Internal slack spool option shall be provided at all locations where optical fiber horizontal cables are present.
12. Match the faceplate and outlet housing supplier.
13. Color and material finish shall [match architectural finish requirements] [be same as electrical faceplates].

PART 3 EXECUTION

3.01 COPPER CABLE CONNECTORS

- A. Install all connectors under the guidelines of the manufacturers' recommended instructions and per all TIA/EIA 568B standards, BICSI guidelines, and manufacturer approved industry practices.
- B. All installed connectors shall be protected from incidental damage, paint, dust ingress or other potential damages that might cause performance degradation during and after installation.
- C. Cable pair twists of Category **6** cable shall be maintained within 0.5-inch of the point of termination. Under no circumstances shall cable pairs be untwisted or otherwise altered prior to termination.

3.02 OPTICAL FIBER CONNECTORS

- A. Install all connectors under the guidelines of the manufacturers' recommended instructions and per all TIA/EIA 568B standards, BICSI guidelines, and manufacturer approved industry practices.

- B. All splicing shall be of the fusion type made under Light Injection and Detection Mode, whenever applicable. The Contractor shall provide certified and experienced personnel for splicing.
- C. All fusion splicers shall be calibrated and labeled according to the manufacturer's specifications. Contractor shall submit certification of calibration for the fusion splicers to the Engineer.

3.03 COAXIAL CONNECTORS

- A. Install all connectors under the guidelines of the manufacturers' recommended instructions and per all TIA/EIA 568B standards, BICSI guidelines, and manufacturer approved industry practices.
- B. Cable preparation and connector application shall be done only with tools approved for use with the connector.

3.04 FACEPLATES AND SURFACE MOUNT OUTLET HOUSINGS

- A. Materials finishes and color of all faceplates and outlet housing components shall be approved before purchase and installation.
- B. Faceplates located on walls shall be flush mounted, level and plumb.
- C. Install blank inserts in all un-used port openings.
- D. Blank inserts shall match the faceplate and outlet housing color except for stainless steel faceplates which shall use black, blank inserts.
- E. Outlets located in systems furniture may be served from a wall adjacent to the furniture cluster or a floor box. If the cable is exposed prior to entering furniture raceway, install spiral wrap tubing to protect the cable per the manufacturer's recommendations.
- F. Outlet locations as well as each individual utilized port must be labeled in accordance with approved labeling scheme.
- G. Connector order for faceplates and outlet housings are to the following:
 - 1. General media connector order: Use a sequential clockwise order starting with port opening 1 for the copper Category 6 connectors, then coaxial connectors followed by optical fiber connectors.
 - 2. Voice and data specific Category 6 connector order: Use a sequential clockwise order starting with port opening 1 for the voice specific connectors, then follow with the data specific connectors.
 - 3. Optical fiber connector order: Use a sequential clockwise order starting with the first open port for multimode connectors, then follow with single mode connectors.
- H. The same orientation and positioning of jacks and connectors shall be utilized throughout the installation.

3.05 CLOSEOUT AND ACCEPTANCE

- A. No additional burden to the Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for reinstallation work shall be coordinated, in writing, with the Owner prior to beginning the work.
- B. All specified Communications systems indicated on the drawings and specifications shall be complete.
- C. Specified shop drawings and product submittals shall have been submitted for review and all review comments and deficiencies shall have been resolved. Final shop drawings and product submittals shall have been submitted, reviewed and found to meet the requirements of the specifications.
- D. Issues and deficiencies identified in field reports and punch lists shall have been resolved. Final as-built drawings shall have been submitted, reviewed and found to meet the requirements of the specifications.
- E. Contractor shall provide written notice of final completion of the telecom infrastructure. Upon receipt, the Owner's Representative will review/observe the completed installation. Once the Owner's Representative is satisfied that all work is in accordance with the Contract Documents, the Contractor will be notified in writing.

END OF SECTION 27 1543

SECTION 27 1619 - COMMUNICATIONS PATCH CORDS AND STATION CORDS

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. Applicable requirements of Division 27 – Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Communications Patch Cords and Station Cords.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.02 QUALITY ASSURANCE

- A. National Electric Code Compliance: Comply with all NEC articles that apply to construction and installation practices applicable to this section
- B. ANSI/TIA: Comply with all ANSI/TIA articles that apply to construction and installation practices applicable to this section
- C. UL Compliance: Provide products that are UL and or cUL-classified.
- D. NFPA Compliance.
- E. All items of a given type shall be the products of the same manufacturer.
- F. Supply all equipment and accessories new and free from defects.

1.03 SUBMITTALS

- A. Product submittals:
 - 1. Provide an electronic Submittal Log matrix, listing each of the components to be used.
- B. Submittal log fields to include referenced specification section, manufacturer, component description and part number.
 - 1. Provide manufacturer's cut sheet of each of the components to be used.
- C. Specified component to be clearly designated on the manufacturer's cut sheet.
- D. Manufacturer cut sheets to included detailed component performance parameters.
- E. Shop drawing submittals:

1. Provide shop drawings that have been coordinated with field conditions and the work of other trades.
2. Submit shop drawings for review and acceptance prior to commencement of work.

F. As-built documentation submittals:

1. Provide as-built documentation of all telecommunications pathway systems under this section utilized throughout the site for review, acceptance and future reference.
2. As-built documentation to include:

1.04 RECORD DRAWINGS

A. Database Matrix of Components Used

1. Warranty documentation:
 - a. Submit manufacturers extended warranty certification after the warranty acceptance by the manufacturer. It shall be the contractor's responsibility to facilitate the manufacturer specific warranty requirements.

1.05 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 PRODUCTS

2.01 COPPER PATCH/STATION/ZONE CORDS

A. Acceptable manufacturers

1. Berk-Tek
2. Superior Essex
3. Siemon
4. Or approved equal

B. Category 5e Cords

1. The Category 5e patch cord/workstation cord shall be 4-pair, with 24 AWG solid or stranded copper conductors with a modular RJ45 male plug connector equipped with (8) eight gold anodized pins factory terminated at each end of the patch cord. Modular plug connectors will be snag free in design or will utilize a molded plastic boot to cover the modular plug tab.

2. Copper patch cords for zone cable patching: Category 5e Solid CMP Cable with an eight position RJ45 style male connector on one end and a female style Jack Module on the other end.
3. The Category 5e modular cord cable shall be UL Listed as Type CMR.
4. The Category 5e patch cord/workstation cord shall meet or exceed the requirements of ANSI/TIA-568-C.2.
5. The Category 5e copper patch cords shall match the manufacturer's cable assembly of the horizontal cable specified.
6. Jacket colors shall be:
 - a. Green for analog voice.
 - b. Blue for Security.

C. Category 6 Cords

1. The Category 6 patch cord/workstation cord shall be 4-pair, with 24 AWG solid or stranded copper conductors with a modular RJ45 male plug connector equipped with (8) eight gold anodized pins factory terminated at each end of the patch cord. Modular plug connectors will be snag free in design or will utilize a molded plastic boot to cover the modular plug tab.
2. Copper patch cords for zone cable patching: Category 6 Solid CMP Cable with an eight position RJ45 style male connector on one end and a female style Jack Module on the other end.
3. The Category 6 modular cord cable shall be UL Listed as Type CMR.
4. The Category 6 patch cord/workstation cord shall meet or exceed the requirements of ANSI/TIA-568-C.2.
5. The Category 6 copper patch cords shall match the manufacturer's cable assembly of the horizontal cable specified.
6. Jacket colors shall be:
 - a. Blue for data.
 - b. Blue for Security.

2.02 OPTICAL FIBER PATCH/STATION CORDS

A. Acceptable manufacturers

1. Corning Cable Systems
2. Leviton
3. Ortronics
4. Or approved equal

B. Multimode 50/125-Micron (OM3) cords

1. The 50/125-micron fiber used in the multimode fiber patch cord/station cord shall have a maximum attenuation of 3.5 dB/km @ 850 nm and 1.5 dB/km @ 1,300 nm.
2. The 50/125-micron 850nm laser optimized multimode fiber patch cord/station cord shall meet or exceed the requirements of ANSI/TIA-568-C.3.
3. The optical fiber cord connector shall be LC.
4. The multimode fiber cord assembly shall be dual zip jacketed.
5. The optical fiber patch cords shall match the manufacturer's cable assembly of the backbone and horizontal cable specified.

C. Single mode cords

1. The 8.3/125-micron fiber used in the single mode fiber patch cord shall have a maximum attenuation of 1.0 dB/km @ 1310 nm and 1.0 dB/km @ 1550 nm.
2. The optical fiber cord connector shall have a maximum insertion loss of 0.5 dB and a reflectance of -30 dB.
3. The 8.3/125-micron single mode fiber patch cord/station cord shall meet or exceed the requirements of ANSI/TIA-568-C.3.
4. The optical fiber cord connector shall be LC.
5. The single mode fiber patch cord assembly shall be dual zip jacketed.
6. Angle polish connectors shall be used for video distribution.
7. The optical fiber patch cords shall match the manufacturer's cable assembly of the backbone and horizontal cable specified.

PART 3 EXECUTION

3.01 COPPER PATCH/STATION/ZONE CORDS

- A. Copper patch cords/workstation cords shall be installed as per the requirements specified by the manufacturer's installation guidelines.
- B. Copper patch cord lengths for patching inside the communications spaces are to be provided appropriate to patching from network hardware equipment ports to the copper patch panels ports within the spaces.
- C. Verify lengths and counts of copper patch cords with Owner's representative prior to purchase.
- D. Patch and workstation cords: Provide (2) copper patch cords (one for each end of the cable termination) for every cable installed.
- E. Zone Cords: Provide the corresponding number of zone patch cord cables for every copper station cable installed in floor mounted outlet that needs to be

connected with a zone patch cord to a table surface mounted monument. See architectural and AV documents for locations.

- F. Provide unit pricing for one (1) each of the following patch cords:
 - 1. Three meter (3m) copper cords
 - 2. Five meter (5m) copper cords
 - 3. Seven meter (7m) copper cords
- G. Install copper patch cord cables between the Owner provided network equipment and the horizontal station cabling patch panel according to the Owner provided patching matrix.
- H. Install copper patch cord cables at the workstation and other IP end device locations. (eg. Security cameras, servers, touch panel AV devices etc.)
- I. The bundling and dressing of the copper patch cord cables is as follows:
 - 1. Bundle patch cord cables in sequential order of multiples of twelve (12).
 - 2. Use Velcro strips to dress copper patch cord bundles to within ten (10) inches of each end of the bundle.
 - 3. Route copper patch cord bundles along the cable runway sections connecting the patch panel style data termination field with the telecommunications racks containing the network equipment.
 - 4. At all times route the copper patch cord bundles inside the vertical- wire minders provided at the patch panel data termination field and the telecommunications racks containing the network equipment.
 - 5. At all times provide clear access to all power and fan tray modules installed in the network equipment.
 - 6. At all times provide clear access to all power receptacles located in the telecommunications racks.
- J. The Contractor shall provide a checklist for each box of above owner supplied components which will include a listing and final count of the contents pre-installation and post installation, test results of the individual patch cords, signature of the Owner's Representative verifying the contents, signature of the Contractor, date of the inspection of the box, date of the testing of the patch cords, date of acceptance of the box, and the location where the box is to be stored. The Contractor will be responsible for the contents of the box until the Owner's Representative signs for final acceptance.

3.02 OPTICAL FIBER PATCH/STATION CORDS

- A. Fiber patch cords/workstation cords shall be installed as per the requirements specified by the manufacturer's installation guidelines.
- B. Optical fiber cord lengths for patching inside the communications spaces are to be provided appropriate to patching from network hardware equipment ports to the optical fiber termination panel ports within the spaces.

- C. Verify lengths and counts of optical fiber patch cords with Owner's representative prior to purchase.
- D. Provide (4) 10-foot LOMMF patch cords and (4) 10-foot SMF patch cords for every IDF room/closet.
- E. Provide (6) 10-foot LOMMF patch cords and (6) 10-foot SMF patch cords for each MDF room.
- F. Provide unit pricing for one (1) each of the following patch cords:
 - 1. Three meter (3 m) Singlemode duplex LC to LC and SC to LC
 - 2. Five meter (5 m) Singlemode duplex LC to LC and SC to LC
 - 3. Seven meter (7 m) Singlemode duplex LC to LC and SC to LC
 - 4. Three meter (3 m) LOMMF duplex LC to LC and SC to LC
 - 5. Five meter (5 m) LOMMF duplex LC to LC and SC to LC
 - 6. Seven meter (7 m) LOMMF duplex LC to LC and SC to LC
 - 7. Three meter (3 m) LOMMF duplex LC to LC and ST to LC
 - 8. Five meter (5 m) LOMMF duplex LC to LC and ST to LC
 - 9. Seven meter (7 m) LOMMF duplex LC to LC and ST to LC
- G. Install appropriate lengths to provide for one (1) fiber optic 2-strand, 50/125 multimode patch cord cable for every Gigabit or 10Gigabit multimode fiber optic LAN backbone uplink port to be connected on the Owner provided network equipment switch chassis.
- H. Install the number of fiber optic patch cord cables with appropriate lengths.
- I. Install fiber optic patch cord cables between the Owner provided network equipment switch chassis and/or the fiber optic termination panel according to the Owner provided fiber optic patching matrix.
- J. The bundling and dressing of the fiber optic patch cord cables is as follows:
 - 1. Use Velcro strips to dress fiber optic patch cord bundles to within twelve (12) inches of each end of the bundle.
 - 2. At all times route the patch cords inside the vertical- wire minders provided at the patch panel data termination field and the telecommunications racks containing the network equipment.
 - 3. At all times provide strain relief according to EIA/TIA standards for fiber optic cables.
 - 4. At all times provide clear access to all power and fan tray modules installed in the network equipment.
 - 5. At all times provide clear access to all power receptacles located in the telecommunications racks.

- K. The Contractor shall provide a checklist for each box of above owner supplied components which will include a listing and final count of the contents pre-installation and post installation, test results of the individual patch cords, signature of the Owner's Representative verifying the contents, signature of the Contractor, date of the inspection of the box, date of the testing of the patch cords, date of acceptance of the box, and the location where the box is to be stored. The Contractor will be responsible for the contents of the box until the Owner's Representative signs for final acceptance.

3.03 TESTING

- A. All structured cabling components provided and installed will be under a manufacturer's warranty throughout the installation period and as indicated on the warranty contract. Any components of the Permanent Link or connecting hardware patch cords supplied under this project that fail the test parameters during the active onsite testing that will be done by others (the Professional Services of the supplier of the network equipment LAN hardware) after this contract shall be replaced at no cost to the Owner by the Contractor under the warranty requirements of this project.

3.04 CLOSEOUT AND ACCEPTANCE

- A. No additional burden to the Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for reinstallation work shall be coordinated, in writing, with the Owner prior to beginning the work.
- B. All specified Communications systems indicated on the drawings and specifications shall be complete.
- C. Specified shop drawings and product submittals shall have been submitted for review and all review comments and deficiencies shall have been resolved. Final shop drawings and product submittals shall have been submitted, reviewed and found to meet the requirements of the specifications.
- D. Issues and deficiencies identified in field reports and punch lists shall have been resolved. Final as-built drawings shall have been submitted, reviewed and found to meet the requirements of the specifications.
- E. Contractor shall provide written notice of final completion of the telecom infrastructure. Upon receipt, the Owner's Representative will review/observe the completed installation. Once the Owner's Representative is satisfied that all work is in accordance with the Contract Documents, the Contractor will be notified in writing.

END OF SECTION 27 1619

SECTION 28 0500

ELECTRONIC SAFETY AND SECURITY GENERAL PROVISIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes general administrative and procedural requirements for Sections numbering 28 and is intended to supplement, not supersede, the requirements specified in Division 1.
- B. Related Sections
 - 1. General: Consult all other Sections, determine the extent and character of related work, and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable system.
 - 2. Related Sections:
 - a. Section 01 8113 - Sustainable Design Requirements
 - b. Section 07 8400 - Firestopping
 - c. Section 08 7100 - Door Hardware
 - d. Section 08 1000 - Doors and Frames
 - e. Section 26 0533 - Raceway and Boxes for Electrical Systems
 - f. Section 27 0529 - Hangers and Supports For Communications Systems
 - g. Section 28 0513 - Conductors and Cables for Electronic Safety and Security
 - h. Section 28 0553 - Identification for Electronic Safety and Security
 - i. Section 28 0800 - Commissioning of Electronic Safety and Security
 - j. Section 28 1300 - Access Control
 - k. Section 28 2300 - Video Surveillance
 - l. Section 28 5100 - Security Communication System
- C. General and Supplementary Conditions: Drawings and general provisions of Contract and Division 1 of the Specifications, apply to 28 series sections.

1.02 REFERENCES

- A. Reference to codes, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies shall mean that latest edition of such publications adopted and published prior to submittal of the bid. Consider such codes or standards a part of this Specification as though fully repeated herein.

- B. Codes: Perform work in accordance with all applicable requirements of the latest edition of all governing codes, rules and regulations including but not limited to the following minimum standards, whether statutory or not:
 - 1. National Electric Code (NEC), NFPA 70.
 - 2. Uniform Building Code (UBC).
 - 3. Uniform Fire Code (UFC).
 - 4. Uniform Mechanical Code (UMC).
 - 5. National, State, Local and any other binding building and fire codes.
 - 6. FCC Regulations:
 - a. Part 15 – Radio Frequency Devices & Radiation Limits
 - 7. Underwriter’s Laboratories (UL): Applicable listing and ratings.
 - a. UL 294: Access Control System Units
 - b. UL 1076: Proprietary Burglar Alarm Units and Systems
 - 8. EIA testing standards
- C. Make a copy of each document readily available during the course of construction for reference by field personnel.

1.03 INSTALLER QUALIFICATIONS

- A. Any company specializing in performing work of the type specified in this section must:
 - 1. Have a minimum of three (3) years of documented experience
 - 2. Be approved by system manufacturer
 - 3. Submit contact names and phone numbers for at least three references connected with successful past projects, with projects of similar difficulty & size

1.04 DEFINITIONS

- A. The Definitions of Division 1 shall apply to the 28 sections.
- B. In addition to those Definitions of Division 1, the following list of terms as used in this specification shall be defined as follows:
 - 1. “Furnish”: To purchase, procure, acquire, and deliver complete with related accessories.
 - 2. “Install”: To set in place, join, unite, fasten, link, attach, set up or otherwise connect together and test before turning over to the University, all parts, items, or equipment supplied by contractor. Installation shall be complete and ready for regular operation.
 - 3. “Provide”: To furnish, transport, install, erect, connect, test and turn over to the Owner, complete and ready for regular operation.
 - 4. “Connect”: To install all required patch cords, equipment cords, cross-connect wire, etc. to complete an electrical or optical circuit.

5. "As directed": As directed or instructed by the Owner, or their authorized representative.
6. "Cabling": A combination of all cables, wire, cords, and connecting hardware [e.g., cables, conductor terminations, connectors, outlets, patch panels, blocks, and labeling].
7. "ACAMS": Access Control & Alarm Monitoring System
8. "SEC": Security Equipment Panels
9. "VSS": Video Surveillance System

1.05 SYSTEM DESCRIPTION

A. Drawings

1. Layout: Follow the general layout shown on the Drawings except where other work may conflict with the Drawings.
2. Accuracy: The Drawings show a diagrammatic representation of the system within the constraints of the symbology applied.
3. The Drawings do not fully represent the entire installation for the Security System. Drawings indicate the layout and location of control components, as well as location of security devices, i.e. card readers, door locks and contacts, glass break detectors, etc. The Drawings do not show all conduits, wire and cabling between every system component, equipment, device, etc.
4. Provide detailed point-to-point diagrams that allow the Contractor to achieve desired results using their own procedures and methods. Submit CAD shop drawings for review prior to installation

B. Contractors Design Requirements

1. The Project Drawings represent the level of system design to be provided by the engineer. Contractor shall provide all additional system design work required, including:
 - a. Conduit layout and sizing
 - b. Wire and cable layout and sizing including type and quantity
 - c. Point-to-point wiring and equipment hook-up information
 - d. Equipment mounting details
 - e. Design of equipment cabinets and interface components
 - f. System one-line or block diagram
 - g. Other detailed design work required
 - h. Reflected ceiling plan for devices installed in ceiling

- C. Obtain shop drawings of other related systems that require integration and coordinate means and methods to complete the system as described and specified in these sections.

1.06 SUBMITTALS

- A. General: Submit required submittal(s) in accordance with General Conditions of the Contract, and Division 1 Submittal Procedures Section 013 300
- B. Cover Letter: Include a cover letter stating that the submittal is in full compliance with the requirements of the Contract Documents. List in full the items and data submitted, signed (and stamped, if applicable) by the person who prepared the submittal. Failure to comply with this requirement shall constitute grounds for rejection of submittal.
- C. Submittal Description: Product Data
 - 1. General: Product data submittals must be approved by the Owner prior to release of order for equipment and prior to installation.
 - 2. Quantity: As noted in Division 1 (minimum of four).
 - 3. Format:
 - a. Provide each product data submittal in a 3-ring binder with front cover and spine clear pockets for insertion of the submittal information.
 - b. Clearly label the cover and the spine of each submittal with the following information:
 - 1) Client Name.
 - 2) Project Number and Contract Number.
 - 3) Project Name and Address.
 - 4) Contractor's Submittal Number.
 - 5) Submittal Title.
 - 6) Specification Section Number.
 - 7) Date of Submittal. Format: <month> <day>, <year>.
 - 8) Contractor Name.
 - c. Include a Table of Contents at the beginning of the submittal that lists materials by article and paragraph number found in the section and in the order outlined in the specification (e.g., "2.03-b Card Reader").
 - d. Include tabbed separators for improved navigation through the submittal.
 - e. Delivery dates for all equipment.
 - 4. Content:
 - a. Product Information:
 - 1) Include product data consisting of manufacturer's technical data, product literature, "catalog cuts", data sheets, specifications, and block wiring diagrams (if necessary). This data shall clearly describe the product's characteristics, physical and dimensional information, electrical performance data, materials used in fabrication, material color & finish, and other relevant information such as test data, typical usage examples, independent test agency information, and storage requirements.