

**SECTION 26 05 33
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, and connection of conduit, fittings, and boxes to form complete, coordinated, grounded raceway systems. Raceways are required for all wiring unless shown or specified otherwise.
- B. Definitions:
 - 1. The term conduit, as used in this specification, shall mean any or all of the raceway types specified.
 - 2. EMT: Electrical metallic tubing.
 - 3. ENT: Electrical nonmetallic tubing.
 - 4. FMC: Flexible metal conduit.
 - 5. IMC: Intermediate metal conduit.
 - 6. LFMC: Liquidtight flexible metal conduit.
 - 7. LFNC: Liquidtight flexible nonmetallic conduit.

1.2 RELATED WORK

- A. Sealing around penetrations to maintain the integrity of fire rated construction: Section 07 84 00, FIRESTOPPING.
- B. General electrical requirements and items that is common to more than one section of Division 26: Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- C. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- D. Section 26 27 26 WIRING DEVICES
- E. Section 28 31 00 FIRE ALARM AND DETECTION

1.3 SEQUENCING AND SCHEDULING

- A. Prior to the start of construction and throughout the entire construction period, the Electrical Contractor shall be responsible to coordinate with the Division 28 Contractor(s) and the Owner as necessary for questionable items of size or to locate installation of all system components required on this project.

- B. The Division 28 Contractor(s) and Owner shall furnish all required speaker backboxes, intercom backboxes and all other special and non-standard backboxes to the Electrical Contractor at the start of construction. The Electrical Contractor shall coordinate this requirement so that all the special and non-standard backboxes are delivered to the job site in a timely manner by the Systems Contractor(s).
- C. Upon completion of the raceway and conduit system and during construction of this project, the Division 28 Contractor(s) and Owner will provide all equipment, devices and wallplates, wire/cabling and all final terminations.

1.4 SUBMITTALS

- A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:
 - 1. Shop Drawings:
 - a. Size and location of main feeders
 - b. Size and location of panels and pull boxes
 - c. Layout of required conduit penetrations through structural elements.
 - d. Custom enclosures and cabinets
 - e. Surface Mount Raceways
 - f. The specific item proposed and its area of application shall be identified on the catalog cuts.
 - 2. Product Data for the following:
 - a. Surface mounted raceways
 - b. Hinged-cover enclosures
 - c. Cabinets
- B. Certification: Prior to final inspection, deliver to the COTR four copies of the certification that the material is in accordance with the drawings and specifications and has been properly installed.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

- B. National Fire Protection Association (NFPA):
 - 1. 70-08 National Electrical Code (NEC)
- C. Underwriters Laboratories, Inc. (UL):
 - 1. 1-03 Flexible Metal Conduit
 - 2. 5-01 Surface Metal Raceway and Fittings
 - 3. 6-03 Rigid Metal Conduit
 - 4. 50-03 Enclosures for Electrical Equipment
 - 5. 360-03 Liquid-Tight Flexible Steel Conduit
 - 6. 467-01 Grounding and Bonding Equipment
 - 7. 514A-01 Metallic Outlet Boxes
 - 8. 514B-02 Fittings for Cable and Conduit
 - 9. 514C-05 Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
 - 10. 651-02 Schedule 40 and 80 Rigid PVC Conduit
 - 11. 651A-03 Type EB and A Rigid PVC Conduit and HDPE Conduit
 - 12. 797-03 Electrical Metallic Tubing
 - 13. 1242-00 Intermediate Metal Conduit
- D. National Electrical Manufacturers Association (NEMA):
 - 1. TC-3-04 PVC Fittings for Use with Rigid PVC Conduit and Tubing
 - 2. FB1-03 Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Metal Conduit and Tubing
 - 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. AFC Cable Systems, Inc.
 - b. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - c. O-Z Gedney; a unit of General Signal.
 - d. Wheatland Tube Company.
- B. NONMETALLIC CONDUIT AND TUBING
 - 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. AFC Cable Systems, Inc.
 - b. CANTEX Inc.
 - c. CertainTeed Corp.; Pipe & Plastics Group.
 - d. RACO; a Hubbell Company.
 - e. Thomas & Betts Corporation.
- C. COMMUNICATION, SECURITY, AND LIFE SAFETY CABLE TEXTILE INNERDUCT
 - 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. MaxCell

- b. Approved equal.

D. METAL WIREWAYS

- 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. Cooper B-Line, Inc.
 - b. Hoffman
 - c. Square D; Schneider Electric.

E. BOXES, ENCLOSURES, AND CABINETS

- 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. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - b. EGS/Appleton Electric.
 - c. Erickson Electrical Equipment Company.
 - d. Hoffman.
 - e. Hubbell Incorporated;
 - f. Killark Electric Manufacturing Co. Division.
 - g. O-Z/Gedney; a unit of General Signal.
 - h. RACO; a Hubbell Company.
 - i. Thomas & Betts Corporation.
 - j. Walker Systems, Inc.; Wiremold Company (The).
 - k. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

2.2 MATERIAL

- A. Conduit Size: In accordance with the NEC, but not less than 1/2 inch unless otherwise shown. Where permitted by the NEC, 1/2 inch flexible conduit may be used for tap connections to recessed lighting fixtures.
- B. Conduit:
 - 1. Rigid galvanized steel: Shall Conform to UL 6, ANSI C80.1.
 - 2. Rigid aluminum: Shall Conform to UL 6A, ANSI C80.5.
 - 3. Rigid intermediate steel conduit (IMC): Shall Conform to UL 1242, ANSI C80.6.
 - 4. Electrical metallic tubing (EMT): Shall Conform to UL 797, ANSI C80.3. Maximum size not to exceed 4 inch and shall be permitted only with cable rated 600 volts or less.
 - 5. Flexible galvanized steel conduit: Shall Conform to UL 1.
 - 6. Liquid-tight flexible metal conduit: Shall Conform to UL 360.
- C. Conduit Fittings:
 - 1. Rigid steel and IMC conduit fittings:
 - a. Fittings shall meet the requirements of UL 514B and ANSI/NEMA FB1.
 - b. Standard threaded couplings, locknuts, bushings, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
 - c. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.

- d. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
 - e. Erickson (union-type) and set screw type couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
 - f. Sealing fittings: Threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.
- 2. Rigid aluminum conduit fittings:
 - a. Standard threaded couplings, locknuts, bushings, and elbows: Malleable iron, steel or aluminum alloy materials; Zinc or cadmium plate iron or steel fittings. Aluminum fittings containing more than 0.4 percent copper are prohibited.
 - b. Locknuts and bushings: As specified for rigid steel and IMC conduit.
 - c. Set screw fittings: Not permitted for use with aluminum conduit.
- 3. Electrical metallic tubing fittings:
 - a. Fittings shall meet the requirements of UL 514B and ANSI/NEMA FB1.
 - b. Only steel or malleable iron materials are acceptable.
 - c. Couplings and connectors: Concrete tight and rain tight, with connectors having insulated throats. Use gland and ring compression type couplings and connectors for conduit sizes 50 mm (2 inches) and smaller. Use set screw type couplings with four set screws each for conduit sizes over 2 inches. Use set screws of case-hardened steel with hex head and cup point to firmly seat in wall of conduit for positive grounding.
 - d. Indent type connectors or couplings are prohibited.
 - e. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
- 4. Flexible steel conduit fittings:
 - a. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
 - b. Clamp type, with insulated throat.
- 5. Liquid-tight flexible metal conduit fittings:
 - a. Fittings shall meet the requirements of UL 514B and ANSI/NEMA FB1.
 - b. Only steel or malleable iron materials are acceptable.
 - c. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
- 6. Surface metal raceway fittings: As recommended by the raceway manufacturer.
- 7. Expansion and deflection couplings:
 - a. Conform to UL 467 and UL 514B.

- b. Accommodate, 19 mm (0.75 inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
 - c. Include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL 467, and the NEC code tables for ground conductors.
 - d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.
- D. Conduit Supports:
- 1. Parts and hardware: Zinc-coat or provide equivalent corrosion protection.
 - 2. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
 - 3. Multiple conduit (trapeze) hangers: Not less than 38 mm by 38 mm (1-1/2 by 1-1/2 inch), 12 gage steel, cold formed, lipped channels; with not less than 9 mm (3/8 inch) diameter steel hanger rods.
 - 4. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.
- E. Outlet, Junction, and Pull Boxes:
- 1. UL-50 and UL-514A.
 - 2. Cast metal where required by the NEC or shown, and equipped with rustproof boxes.
 - 3. Sheet metal boxes: Galvanized steel, except where otherwise shown.
 - 4. Flush mounted wall or ceiling boxes shall be installed with raised covers so that front face of raised cover is flush with the wall. Surface mounted wall or ceiling boxes shall be installed with surface style flat or raised covers.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.
- H. Wireways: Equip with hinged covers, except where removable covers are shown.
- I. Cabinets:
- 1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 GENERAL RACEWAY REQUIREMENTS

- A. Raceways for the following systems that are in accessible locations shall have a manufacturer applied color coding as follows:
 - 1. Fire Alarm System: Red
 - 2. Telecommunications: Blue
 - 3. Audio/Visual: Yellow
 - 4. Security Systems: Green
 - 5. Building Automation System (BAS): Violet

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. In accordance with UL, NEC, as shown, and as hereinafter specified.
- B. Essential (Emergency) raceway systems shall be entirely independent of other raceway systems, except where specifically "accepted" by NEC Article 517.
- C. Install conduit as follows:
 - 1. In complete runs before pulling in cables or wires.
 - 2. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
 - 3. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
 - 4. Cut square with a hacksaw, ream, remove burrs, and draw up tight.
 - 5. Mechanically and electrically continuous.
 - 6. Independently support conduit at 8'0" on center. Do not use other supports i.e., (suspended ceilings, suspended ceiling supporting members, lighting fixtures, conduits, mechanical piping, or mechanical ducts).
 - 7. Support within 1 foot of changes of direction, and within 1 foot of each enclosure to which connected.
 - 8. Close ends of empty conduit with plugs or caps at the rough-in stage to prevent entry of debris, until wires are pulled in.
 - 9. Conduit installations under fume and vent hoods are prohibited.
 - 10. Secure conduits to cabinets, junction boxes, pull boxes and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
 - 11. Do not use aluminum conduits in wet locations.
 - 12. Unless otherwise indicated on the drawings or specified herein, all conduits shall be installed concealed within finished walls, floors and ceilings.
- D. Conduit Bends:
 - 1. Make bends with standard conduit bending machines.
 - 2. Conduit hickey may be used for slight offsets, and for straightening stubbed out conduits.

3. Bending of conduits with a pipe tee or vise is prohibited.
- E. Layout and Homeruns:
 1. Install conduit with wiring, including homeruns, as shown.
 2. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted approved by the Resident Engineer.
- F. 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.
- G. Complete raceway installation before starting conductor installation.
- H. Stub-up Connections:
 1. All conduits that stub-up/down through concrete slabs and finished floors shall be wrapped IMC or RSC and extended at least 6" above finished floor before conversion to EMT.
 2. Other than in a wall or under freestanding equipment such as switchboards, cabinets, transformers, etc., all other conduit stub-ups through concrete slabs and finished floors shall be provided with threaded steel coupling in slab, flush with top of floor level.
 3. When ready for final connections to surface panelboards, surface cabinets / equipment, free-standing outlets / equipment, motor connections or outlets within casework / millwork, extend with IMC or RSC at least 6 inches above finished floor before any conversion to other type(s) of conduit. Do not extend conduit(s) above finished floor during construction where subject to damage. Where equipment connections are not made under this contract, install screwdriver-operated threaded flush plugs flush with floor.
 4. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- I. Install no more than the equivalent of four 90-degree bends in any conduit run except for communications conduits, for which no more than the equivalent of two 90-degree bends in any conduit run.
- J. Conduit embedded in columns shall be placed inside of column reinforcing steel and the sectional area of conduit shall not be greater than 4% of the cross sectional area of the column.
- 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. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- M. 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.

- N. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces, including food service refrigerated walk-in units.
 2. Where conduits enter or leave hazardous locations.
 3. Where otherwise required by NFPA 70.
- O. Expansion Joints:
1. Exposed Conduits 3 Inches and Larger, That Are Secured to Building Construction on Opposite Sides of a Building Expansion Joint: Provide with expansion fittings. The fittings shall allow 8" conduit movement (4" in either direction). The fittings shall be installed in accordance with the manufacturer's recommendations.
 2. Exposed Conduits Smaller than 3 Inches: Provide with junction boxes on both sides of the expansion joint, and connected by 15 inches of slack flexible conduit. Flexible conduit shall have a copper green ground bonding jumper installed. In lieu of the flexible conduit installation, expansion fittings may be installed as specified above.
 3. Conduits Contained within Concrete and Masonry Walls: Provide with deflection / expansion fittings. The fittings shall be concrete tight and watertight. The fittings shall be suitable for use with PVC conduit by using adapters in each end. Install in accordance with the manufacturer's recommendations.
- P. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC in damp or wet locations not subject to severe physical damage.
- Q. 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.
- R. Backboxes shall not be installed back-to-back in non-rated walls. Provide 6-inch separation minimum unless otherwise noted.

3.3 COMMUNICATION CABLING REQUIREMENTS (NOT USED)

3.4 FIRE DETECTION AND ALARM REQUIREMENTS

- A. The Electrical Contractor shall comply with the following:
1. Provide a complete raceway system (minimum ¾"), outlet boxes, junction boxes, fittings and supports. All fire alarm cabling shall be in conduit. All fire alarm conduits shall have manufactured applied red integral color. Conduit field painted

will be rejected and replaced at the Contractor's expense. Final device location and quantities shall be per approved fire alarm shop drawings signed by the Authority Having Jurisdiction.

2. All fire alarm junction box covers shall be labeled and completely painted with red paint.
3. Detectors are shown on the drawings to indicate general coverage only and may not accurately show the required spacing. Locate boxes for the smoke detectors 15 feet (max.) from walls and 30 feet (max.) between detectors.
4. Install pull wires in all empty conduits and raceways.
5. Fire alarm conduits inside a building shall have a 6 ft. minimum separation between loops or be separated by a fire wall.
6. Install all special and non-standard backboxes furnished by the Fire Alarm Systems Contractor.
7. All other outlet boxes shall be minimum 4" square x 2½" deep, with single or two gang plaster ring. Verify plaster ring with device being provided by the Fire Alarm Contractor.
8. Where devices are to be surface mounted DO NOT use boxes with multiple knockouts.

3.5 PENETRATIONS

A. Cutting or Holes:

1. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the COTR prior to drilling through structural sections.
2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the COTR as required by limited working space.

B. Fire Stop: Where conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING, with rock wool fiber or silicone foam sealant only. Completely fill and seal clearances between raceways and openings with the fire stop material.

C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight as specified in Section 07 92 00, JOINT SEALANTS.

3.6 CIRCUIT HOMERUNS

- #### A.
- In general, the branch circuiting shall be as indicated on the Drawings. Do not combine the conductors from two or more of the conduits indicated on the Drawings into a single homerun conduit without written approval from the Engineer.

3.7 CONCEALED WORK INSTALLATION (NOT USED)

3.8 EXPOSED WORK INSTALLATION

- A. Unless otherwise indicated on the drawings, exposed conduit is only permitted in mechanical and electrical rooms.
- B. Conduit for conductors above 600 volts:
 - 1. Rigid steel or rigid aluminum.
 - 2. Aluminum conduit mixed indiscriminately with other types in the same system is prohibited.
- C. Conduit for Conductors 600 volts and below:
 - 1. Rigid steel, IMC, rigid aluminum, or EMT. Different type of conduits mixed indiscriminately in the system is prohibited.
- D. Align and run conduit parallel or perpendicular to the building lines.
- E. Install horizontal runs close to the ceiling or beams and secure with conduit straps.
- F. Support horizontal or vertical runs at not over 2400 mm (eight foot) intervals.
- G. Surface metal raceways: Use only where shown.
- H. Painting:
 - 1. Paint exposed conduit as specified in Section 09 91 00, PAINTING.
 - 2. Provide legends where conduits pass through walls and floors and at maximum 20 foot intervals in between.

3.9 HAZARDOUS LOCATIONS (NOT USED)

3.10 WET OR DAMP LOCATIONS

- A. Unless otherwise shown, use conduits of rigid steel or IMC.
- B. Provide sealing fittings, to prevent passage of water vapor, where conduits pass from warm to cold locations, i.e., (refrigerated spaces, constant temperature rooms, air conditioned spaces building exterior walls, roofs) or similar spaces.
- C. Unless otherwise shown, use rigid steel or IMC conduit within 5 feet of the exterior and below concrete building slabs in contact with soil, gravel, or vapor barriers. Conduit shall include an outer factory coating of 20 mil bonded PVC or field coat with asphaltum before installation. After installation, completely coat damaged areas of coating.

3.11 MOTORS AND VIBRATING EQUIPMENT

- A. Use flexible metal conduit for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission.
- B. Provide liquid-tight flexible metal conduit for installation in exterior locations, moisture or humidity laden atmosphere, corrosive atmosphere, water or spray wash-down operations, inside (air stream) of HVAC units, and locations subject to seepage or dripping of oil, grease or water. Provide a green ground wire with flexible metal conduit.

3.12 EXPANSION JOINTS

- A. Conduits 3 inches and larger, that are secured to the building structure on opposite sides of a building expansion joint, require expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.
- B. Provide conduits smaller than 3 inches with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible conduit to produce 5 inch vertical drop midway between the ends. Flexible conduit shall have a copper green ground bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for 375 mm (15 inches) and larger conduits are acceptable.
- C. Install expansion and deflection couplings where shown.

3.13 CONDUIT SUPPORTS, INSTALLATION

- A. Safe working load shall not exceed 1/4 of proof test load of fastening devices.
- B. Use pipe straps or individual conduit hangers for supporting individual conduits. Maximum distance between supports is 8 foot on center.
- C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and 200 pounds. Attach each conduit with U-bolts or other approved fasteners.
- D. Support conduit independently of junction boxes, pull boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.
- E. Fasteners and Supports in Solid Masonry and Concrete:
 - 1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
 - 2. Existing Construction:

- a. Steel expansion anchors not less than 1/4 inch bolt size and not less than 1-1/8 inch embedment.
 - b. Power set fasteners not less than 1/4 inch diameter with depth of penetration not less than 3 inches.
 - c. Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.
- F. Hollow Masonry: Toggle bolts are permitted.
- G. Bolts supported only by plaster or gypsum wallboard are not acceptable.
- H. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.
- I. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
- J. Chain, wire, or perforated strap shall not be used to support or fasten conduit.
- K. Spring steel type supports or fasteners are prohibited for all uses except: Horizontal and vertical supports/fasteners within walls.
- L. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

3.14 INSTALLATION COORDINATION WITH COMMUNICATIONS CABLES

- A. Separation from EMI Sources:
- 1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 - 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches
 - 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches Electrical Equipment Rating More Than 5 kVA: A minimum of 12

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches
Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches
5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches

3.15 BOX INSTALLATION

- A. Boxes for Concealed Conduits:
 1. Flush mounted.
 2. Provide raised covers for boxes to suit the wall or ceiling, construction and finish.
- B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling in operations.
- C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.
- D. Outlet boxes in the same wall mounted back-to-back are prohibited. A minimum 24 inch, center-to-center lateral spacing shall be maintained between boxes.
- E. Minimum size of outlet boxes for ground fault interrupter (GFI) receptacles is 4 inches square by 2-1/8 inches deep, with device covers for the wall material and thickness involved.
- F. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIG-FA JB No. 1".
- G. On all Branch Circuit junction box covers, identify the circuits with black marker.

3.16 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

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