

SECTION 27 05 33  
COMMUNICATIONS BUILDING PATHWAYS – CONDUITS AND BOXES  
Construction Specification

**PART 1 GENERAL****1.1 SUMMARY**

- A. Section Includes: Pathway systems within buildings consisting of conduit and boxes (outlet, device, pull, and other boxes) to support low voltage systems (telecommunications, Television, paging, security, and other signal (low voltage) systems)
- B. Related Sections
  - 1. Comply with the Related Sections paragraph of Section 270000.
  - 2. Section 270526, "Communication Grounding and Bonding"
  - 3. Section 270528, "Communication Building Pathways"
  - 4. Section 270536, "Communication Building Pathways – Cable Tray"
  - 5. Section 271100, "Communication Rooms"

**1.2 REFERENCES**

- A. Comply with the References requirements of Section 270000.
- B. In addition to those codes, standards, etc., listed in 270000, comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:
  - 1. American National Standards Institute (ANSI)
    - a. ANSI C80.1, "Specifications for Rigid Steel Conduit, Zinc Coated"
    - b. ANSI C80.3, "Specifications for Electrical Metallic Tubing"
    - c. ANSI C80.6, "Electrical Intermediate Metal Conduit"
  - 2. ASTM International
    - a. ASTM A123, "Standard Specification of Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products"
    - b. ASTM A653, "Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process"
    - c. ASTM D1654, "Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments"
  - 3. International Electronic Committee (IEC)
    - a. ANSI/IEC 60529, "Degrees of Protection Provided by Enclosures (IP Code)"
  - 4. National Electrical Manufacturer Association (NEMA)
    - a. NEMA 250, "Enclosures for Electrical Equipment (1000 volts maximum)"
    - b. NEMA FB 1, "Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable"
    - c. NEMA OS 1, "Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports"

- d. NEMA OS 3, “Selection and Installation Guidelines for Electrical Outlet Boxes”
  - e. NEMA TC 2, “Electrical Polyvinyl Chloride (PVC) Conduit”
  - f. NEMA TC 3, “Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing”
  - g. NEMA TC 7, “Smooth-Wall Coilable Electrical Polyethylene Conduit”
5. Underwriters Laboratories (UL)
- a. UL 6, “Electrical Rigid Metal Conduit -Steel”
  - b. UL 50, “Enclosures for Electrical Equipment, Non-Environmental Considerations”
  - c. UL 360, “Liquid-Tight Flexible Steel Conduit”
  - d. UL 467, “Grounding and Bonding Equipment”
  - e. UL 514A, “Metal Outlet Boxes”
  - f. UL 514B, “Conduit, Tubing, and Cable Fittings”
  - g. UL 514C, “Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
  - h. UL 651, “Schedule 40 and 80 Rigid PVC Conduit”
  - i. UL 797, “Electrical Metallic Tubing - Steel”
  - j. UL 1242, “Electrical Intermediate Metal Conduit - Steel”
  - k. UL 2024, “Signaling, Optical Fiber and Communications Raceways and Cable Routing Assemblies”

### 1.3 DEFINITIONS

- A. Definitions of Section 270000 apply to this Section.
- B. In addition to those Definitions of Section 270000, the following list of terms as used in this Section defined as follows:
  - 1. “Backbox”: A box [see “Box”] used to house cable terminations, to house devices, and to interface with cords/equipment; a backbox is installed with walls (such as within the cavities of framed walls and/or cast-in-place within concrete walls) such that the outlet/device finish (e.g., the coverplate/faceplate) is flush with the wall finish
  - 2. “Box”: A box (often 5-sided with 1 side open) manufactured of sheet metal with welded corners, drawn metal, cast metal, or nonmetallic material (thermoplastic) in accordance with NEMA OS 1 or NEMA OS 2 and installed in accordance with NFPA 70 Article 314; available in different sizes (volumes) and modular design configurations (gangable) that may be field assembled, one to another, to accommodate multiple devices; boxes may be used as outlet boxes, device boxes, backboxes, junction boxes, or pull boxes, depending on their intended use, and handhole enclosures.
  - 3. “CEC”: California Electrical Code (California Code of Regulations, Title 24 Part 3)
  - 4. “Device Box”: A box [see “Box”] with provisions for attaching and housing electrical devices (switches, receptacles, or similar wiring devices) manufactured in accordance with NEMA OS 1 and NEMA OS 2 and installed in accordance with NFPA 70 Article 314; available in different sizes (volumes) and modular design configurations (gangable) that may be field assembled, one to another, to accommodate multiple devices
  - 5. “EIMC”: Electrical Intermediate Metal Conduit – see “IMC”

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6. “EMT”: Electrical Metallic Tubing type conduit, as defined in ANSI C80.3 and NFPA 70 Article 358 An unthreaded thinwall raceway, generally made of steel (ferrous) with protective coatings or aluminum (nonferrous), of circular cross section designed for the physical protection and routing of conductors and cables and for use as an equipment grounding conductor when installed utilizing appropriate fittings (per NEC Article 358)“FMT: Flexible Metal Tubing type conduit, as defined in NFPA 70 Article 360
8. “Floor Box”: A box [see “Box”] used to house cable terminations, to house wiring devices, and to interface with cords/equipment; a floor box is a special purpose box installed with floors (such as cast-in-place within concrete) such that the box finish (e.g., the coverplate) is flush with the floor finish
9. “HDPE: High Density Polyethylene type conduit, as defined in NFPA 70 Article 353
10. “IMC”: Intermediate Metal Conduit type conduit, as defined in ANSI C80.6 and NFPA 70 Article 342
11. “Junction Box”: A box used to join different runs of raceway (such as conduit) or cables, or both, and to provide space for the connection and branching of the enclosed conductors; most boxes can be used solely as junction boxes as long as they are used with an appropriate cover and with appropriate (code-required) access
12. “LFMC”: Liquidtight Flexible Metal Conduit type conduit, as defined in NFPA 70 Article 353
13. “Outlet Box”: A box [see “Box”] used to house cable terminations (connectors, modular jacks, receptacles, or similar wiring interfaces) and to interface with cords/equipment
14. “NEC”: National Electrical Code (NFPA 70)
15. “NEMA”: National Electrical Manufacturers Association
16. “NFPA”: National Fire Protection Agency
17. “Pull Box”: A box used in a conduit-based pathway system to allow access to and enclose conduit ends for placing cables and to house the interface between duct banks segments
18. “RMC”: Rigid Metal Conduit type conduit, as defined in NFPA 70 Article 344 and ANSI C80.1
19. “RNC”: Rigid Nonmetallic Conduit type conduit, as defined in NFPA 70 Article 352 and as manufactured to NEMA TC 2 specifications
20. “UL”: Underwriters Laboratories

#### 1.4 SYSTEM DESCRIPTION

- A. The scope of work of this section includes planning and coordination with General Contractor and other trades of inside plant conduit pathway systems, furnishing necessary materials, and labor and associated services required to install these pathway systems.
- B. The drawings do not explicitly show on plans each and every conduit run needed for the project. Apply the guidelines described in this section and on the drawings to support the cabling described in Division 27 and shown on the low voltage drawings, and provide reasonably inferred standard conduits, fittings, and products required to complete the conduit installation to meet the design intent.
- C. The scope of work includes conduit, boxes, and related construction materials that may not be expressly specified herein or expressly called out on the drawings, such as: 1- and

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2-hole straps, nail straps, clamps and clamp backs, strut clamps, U-bolts, pipe hangers, clip-in and bolted hangers, bushings, ground bushings, service entrance cap/weatherhead, pull rope/tape, etc.

- D. The scope of work includes basic construction materials that may not be explicitly specified herein or called out on the drawings, such as: concrete anchors, inserts, and/or expansion bolts; concrete fasteners; powder-actuated pins; construction channel/strut; threaded rod; wood fasteners (lag screws); beam clamps; purlin clips; stud box supports/brackets; floor-mount box supports; T-bar ceiling box support bar; channel-mount box supports; bonding pigtails; drywall ring (for ring & string); etc.
- E. Conduit Systems, including Pull Boxes
1. Provide conduit systems in accordance with CEC (Chapter 3 and Article 250), UL listing information, manufacturer's instructions, and compliant to local inspections and seismic restraint requirements. Conduit systems shall conform to ANSI/TIA-569-B standard and BICSI TDMM guidelines. Complete shall include all reasonably inferred conduits, fittings, connectors, couplers, straps, pull boxes, supports, etc., necessary for a complete installation to meet the intended application whether noted, indicated or specified in the Contract Documents or not. Duct bank routes and pull and junction box locations and elevations shown on the Drawings are diagrammatic in nature. Field verify route prior to installation.
  2. Provide pull boxes as necessary to facilitate proper cable placement, including the following:
    - a. no more than 180 degrees bend between placement points
    - b. no more than 150-200 feet conduit length (depending on the total bend between end points)
    - c. to meet AHJ requirements
  3. Seismic Bracing: Provide seismic bracing to conduit system (duct banks, pull boxes, etc). Seismic bracing shall be approved by a structural engineer licensed in the state of California.
  4. Seismic Joints: Provide seismic joints to conduit at building seismic joints. Seismic joint configurations shall be approved by a structural engineer licensed in the state of California.
  5. Expansion Joints/Fittings: Provide expansion joints and/or fittings to conduit where necessary. Expansion joints/fittings shall be approved by a structural engineer licensed in the state of California.
  6. Conduit systems shall be mechanically and electrically continuous throughout. Where EMT and associated fittings are used as part of equipment grounding system, provide a bonding type locknut where hub type fitting terminates into a threadless opening and provide compression ring type fittings for terminating and coupling.
  7. Minimum Conduit Size: Refer to drawings. If not noted on the drawings, the minimum conduit size shall be 25 mm (1").
  8. When cast in concrete floors and/or walls, adhere to structural design requirements. Unless otherwise noted on the drawings, the largest trade size conduits shall not exceed 1/3 the floor or wall thickness, and conduits shall be spaced a minimum of three conduit diameters apart.
  9. Bend radii for conduit trade sizes 63.5 mm (2-1/2") and larger shall be 10 times the conduit outside diameter (OD) and bend radii for conduit trade sizes 51 mm (2") and smaller shall be 8 times the conduit OD.

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10. Provide transition couplings where dissimilar conduit types are joined.
11. Conduit bodies or 'condulets' (LBs, etc.) are prohibited for telecommunications and audiovisual cables.
12. For type EMT conduits:
  - a. Provide steel (preferred) zinc plated or die cast set screw (or compression fittings). For set screw fittings, provide single screw fittings (e.g., 1-screw connectors and 2-screw couplers) for 37mm (1.5") and smaller conduits and provide double screw fittings (e.g., 2-screw connectors and 4-screw couplers) for 51mm (2") and larger conduits.
  - b. When cast in concrete, embedded masonry, or installed in dry locations (as defined by CEC), provide compression fittings and couplings.
  - c. When installed in damp locations (as defined by CEC), provide rain-tight type fittings and couplings.
13. For types IMC and RMC conduits:
  - a. Provide steel (preferred), zinc plated or die cast threaded fittings (set screw and/or bolt-on fittings are prohibited). Provide steel locknuts and metal bushings. Provide bonding type bushings where necessary for conductive continuity or for bonding to ground.
14. When attaching to concrete ceilings, provide vibration and shock resistant bases.
15. Conduit Straps: Provide steel straps – for interior applications, provide straps without spacers
16. At conduits entering into building from outside, provide duct plugs per duct.
17. For unused conduits, provide a mechanical-type seal/cap for protection and to keep the conduit free from debris.
18. Provide a pull tape into each conduit/duct between pull points.
  - a. Where boxes are exposed in damp or wet locations or located in hazardous areas, provide cast metal boxes with gasketed cast metal cover plates.
  - b. Provide supports for pull (and junction) boxes independently of conduit system and directly to the structure above. Provide seismic bracing for pull boxes.
19. Labeling:
  - a. Provide permanent labels on conduit ends and pull box lids.
20. Conduit Application
  - a. At interior concealed or exposed applications, 4" and smaller, provide EMT type conduit, unless otherwise note. EMT is the he preferred conduit type.
  - b. In cast-in-place concrete, RNC and EMT types will be allowed for telecommunications and other low voltage systems.
  - c. IMC and RMC will be allowed for telecommunications and other low voltage systems with written approval from the Engineer.
  - d. LFMC is allowed for telecommunications (and other low voltage systems) only for short spans requiring flexible connections. When used, upsize LFMC 1 full trade size (to allow for a derating of the fill capacity).
  - e. FMC is not allowed for telecommunications (and other low voltage systems) without written approval from the Engineer.

## F. Clearances (minimum):

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1. From fluorescent light fixtures, or other EMI sources = 6 inches (150 mm)
2. From any motor, transformer = 48 inches (1,220mm)
3. From flue, hot water, steam line or other non-insulated heat sources = 12 inches (300 mm)
4. No conduit and/or supports shall encroach into ceiling height, head room of walkways, and/or doorways.

## G. Penetrations:

1. When penetrating partitions and other construction assemblies, use approved methods.
2. When penetrating concrete walls (including shear walls) and/or floors, scan the area to be penetrated and core openings using methods approved by the structural engineer and by the AHJ. Obtain written approval for locations and means when not using methods included in the contract documents.
3. When penetrating fire rated assemblies, provide UL Classified and FM Approved fire rated systems in accordance with ASTM E814 (UL1479). Provide labels at both sides of the penetration. Refer to drawings for approved systems per application.
4. When penetrating acoustic rated assemblies, provide sealant to fill gaps, cavities, etc, to fully seal penetration.

## H. Duct Plugs

1. Provide duct plugs at conduit ends at building entrances.

## I. Outlet Boxes

1. Provide outlet boxes and covers/rings (raised and/or flat) in accordance with CEC Article 314 and NEMA OS 3. Ground and bond metal outlet boxes in accordance with NEC Article 250, Parts I, IV, V, VI, VII, and X.
2. Provide support for outlet boxes. Outlet boxes for telecommunications and audiovisual may share a support bracket (such as a stud span bracket) with electrical outlet boxes.

## J. Poke-Thrus

1. Coring: Refer to section 038213 for concrete core drilling requirements.
2. Provide poke-thrus, covers, and related products in accordance with CEC Article 314 and NEMA OS 3. Bond metal devices to ground in accordance with applicable portions of CEC Article 250 (such as Parts I, IV, V, VI, VII, and X).
3. At poke-thrus shared with power service, provide separation means in accordance with CEC.

## K. Floor Boxes

1. Provide floor boxes, covers, and related products in accordance with CEC Article 314 and NEMA OS 3. Bond metal boxes to ground in accordance with applicable portions of CEC Article 250 (such as Parts I, IV, V, VI, VII, and X).
2. At floor boxes shared with power service, provide separation means in accordance with CEC.

## 1.5 SUBMITTALS

- A. General: Conform to Submittal requirements as described in Section 270000.

- B. Quantity: Furnish quantities of each submittal as noted in Section 270000.
- C. Submittal Requirements Prior to the Start of Construction:
  - 1. Product Data: Submit product data showing manufacturer, part numbers, listings, fabrication materials, dimensions, capacities, finishes, knockout sizes and configuration, accessories, etc.
  - 2. Shop Drawings: Submit shop drawings consisting of the following:
    - a. Conduit layout/routes, supports locations, support details
    - b. Highlight proposed changes to pathways (routes, types, sizes, etc.) compared to the contract documents
    - c. Clearance variations and/or requests for exceptions
    - d. Seismic bracing details (also see “Seismic Calculations” below)
    - e. Instances of penetrations through fire and smoke rated barriers, including calling out firestopping type/UL System, size, quantity, and other relevant information
  - 3. Seismic Calculations: Submit seismic calculations for support systems in conformance Section 270000. Structural Calculations shall be prepared and signed by a California Registered Structural Engineer. If used, specify proof loads for drilled-in anchors.
- D. Submittal Requirements at Close Out:
  - 1. As-Built Drawings, showing the routes, types, sizes, quantities, dimensions, etc., of pathways (backbone pathways, primary pathways, conduit – required; secondary such as hangers – not necessary)
  - 2. O&M Manual, including as-built drawings, parts list (essentially final approved product data submittal), repair information, and maintenance requirements
- E. Substitutions
  - 1. Requests for substitutions shall conform to the general requirements and procedure outlined in Section 270000.

## 1.6 QUALITY ASSURANCE

- A. Comply with Quality Assurance requirements of section 270000.
- B. NEC Compliance: Comply with NEC, as applicable to construction and installation of conduit and boxes.
- C. NFPA Compliance: Comply with NFPA 70B, “Recommended Practice for Electrical Equipment Maintenance” pertaining to conduit and boxes.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Delivery, Storage and Handling requirements of section 270000.

## 1.8 WARRANTY

- A. Comply with Warranty requirements of section 270000.

## PART 2 PRODUCTS

## 2.1 ELECTRICAL METALLIC TUBING (TYPE EMT) CONDUIT AND FITTINGS

- A. Application: Products and assembled system shall be suitable for indoor applications, in accordance with the NEC Article 358
- B. Type EMT Conduit:
1. Type EMT conduit shall be formed of cold rolled strip steel, electrical-resistance welded continuously along the longitudinal seam, and zinc coated after welding. Type EMT conduit bore shall be smooth and free of blisters, nicks or other imperfections which could mar cables.
  2. Type EMT conduit shall be listed by a nationally recognized testing laboratory to UL 797, and shall bear (stamped or molded on conduit and fittings) the UL label. Markings shall be permanent. Type EMT conduit shall meet ANSI C80.3 specifications.
  3. Type EMT conduit shall be listed by a nationally recognized testing laboratory to UL Safety Standard 797 and UL Safety Standard 514B, and shall bear (stamped or molded on conduit and fittings) the UL label. Markings shall be permanent. Type EMT conduit shall meet ANSI C80.3 specifications.
  4. Type EMT conduit shall be recognized as a bonding conductor per NEC Article 250.118
  5. Factory elbows and bends minimum bend radius shall be 48".
  6. Manufacturers – Type EMT Conduit:
    - a. Allied Tube and Conduit Co (Electrical Group) "E-Z Pull" EMT conduit
    - b. Cal Conduit Products "CalBrite" EMT conduit
    - c. Republic Conduit
    - d. Western Tube and Conduit Corp
    - e. Or equal
- C. Fittings for EMT:
1. Fittings (connectors, couplers, straps, accessories, etc.) shall be listed by a nationally recognized testing laboratory to UL 514B, and shall bear the UL label (stamped or molded - such markings shall be permanent).
  2. Fittings shall be manufactured compliant to ANSI/NEMA FB 1.
  3. Standard Set-Screw Fittings: fabricated of steel with zinc electro-plated finish. Die cast zinc / cast malleable iron fittings not acceptable. Set-screws shall be case-hardened steel with hex head and cup point to firmly seat in wall of conduit for positive grounding.
  4. Compression Fittings: gland and ring compression type construction; fabricated of steel zinc plated or cast malleable iron; UL Listed as raintight and suitable for concrete
  5. Manufacturers – Fittings for EMT
    - a. Appleton Electric Co and/or O-Z Gedney (Emerson Electric Co)
    - b. Thomas & Betts Corp
    - c. Or equal
- D. Deflection/Expansion Sleeve:



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1. Application: Deflection/expansion sleeve shall compensate for movement in any direction between two conduit ends and shall withstand occasional vibration transmitted to conduit by rotating equipment or vehicular traffic.
  2. Deflection/expansion sleeve shall be listed by a nationally recognized testing laboratory to UL 514B and UL 467, and shall bear the UL label (stamped or molded - such markings shall be permanent).
  3. Deflection/expansion sleeve shall be fabricated of an inner sleeve, bonding braid, a neoprene outer sleeve with internal flexible stainless steel braid and outer stainless steel bands, ended with couplings (for connection to conduits).
  4. Deflection/expansion sleeve shall accommodate 0.75 inch (19mm) deflection, expansion, contraction, or parallel misalignment in any direction, shall allow up to 30 degree angular deflections, and shall be raintight.
  5. Manufacturer – EMT Expansion/Deflection Sleeve:
    - a. Cooper Crouse-Hinds XD series
    - b. O-Z Gedney (Emerson Electric Co) DX series
    - c. Or equal
- E. Expansion Sleeve:
1. Application: Expansion sleeve shall compensate for parallel movement between two conduits.
  2. Expansion sleeve shall comply with UL514.B and NEMA FB-1.
  3. Expansion sleeve shall be fabricated of an inner steel sleeve with an oversized outer sleeve sealed with slip bushings, configured such that the outer sleeve can move over the inner sleeve. Sleeve shall come equipped with internal or external bonding braid and be ended with couplers suitable to connect to conduit ends.
  4. Manufacturers – EMT Expansion Sleeve:
    - a. Cooper Crouse-Hinds XJG-EMT series
    - b. O-Z Gedney (Emerson Electric Co) TX series
    - c. Or equal

## 2.2 INTERMEDIATE METAL CONDUIT (TYPE IMC) AND FITTINGS

- A. Application: Products and assembled system shall be suitable for indoor applications, in accordance with the NEC Article 342
- B. Type IMC Conduit:
1. Type IMC conduit shall be fabricated of hot dip galvanized steel. The conduit bore shall be smooth and free of blisters, nicks or other imperfections which could mar cables.
  2. Type IMC conduit shall be listed by a nationally recognized testing laboratory to UL 1242, and shall bear (stamped or molded on conduit and fittings) the UL label. Markings shall be permanent. Type IMC conduit shall meet ANSI C80.6 specifications.
  3. Type IMC conduit shall be listed by a nationally recognized testing laboratory to UL Safety Standard 1242 and UL Safety Standard 514-B, and shall meet ANSI C80.6 specifications.
  4. Type IMC conduit shall be recognized as a bonding conductor per NEC Article 250.118

5. Factory elbows and bends minimum bend radius shall be 48”.
  6. Manufacturers – Type IMC Conduit:
    - a. Allied Tube and Conduit Co (Electrical Group) “Kwik-Couple” conduit
    - b. Western Tube and Conduit Corp
    - c. Or equal
- C. Fittings for IMC:
1. Fittings, connectors, couplers, straps, accessories, etc., shall be listed by a nationally recognized testing laboratory to UL 514B, and shall bear (stamped or molded on conduit and fittings) the UL label. Markings shall be permanent.
  2. Fittings, connectors, couplers, straps, accessories, etc., shall be manufactured compliant to ANSI/NEMA FB 1
  3. Fittings, connectors, couplers, etc., shall be threaded - raintight and concrete tight where required by application.
  4. Standard threaded couplings, locknuts, bushings, and elbows shall be fabricated of steel or malleable iron. Locknuts shall be bonding type with sharp edges for digging into the metal wall of an enclosure. Three piece couplings: Electroplated, cast malleable iron.
  5. Manufacturers – Fittings for IMC
    - a. Appleton Electric Co and/or O-Z Gedney (Emerson Electric Co)
    - b. Thomas & Betts Corp
    - c. Or equal
- D. Deflection/Expansion Sleeve:
1. Application: Deflection/expansion sleeve shall compensate for movement in any direction between two conduit ends and shall withstand occasional vibration transmitted to conduit by rotating equipment or vehicular traffic.
  2. Deflection/expansion sleeve shall comply with UL467 and UL514.
  3. Deflection/expansion sleeve shall be fabricated of an inner sleeve, bonding braid, a neoprene outer sleeve with internal flexible stainless steel braid and outer stainless steel bands, ended with couplings (for connection to conduits).
  4. Deflection/expansion sleeve shall accommodate 0.75 inch (19mm) deflection, expansion, contraction, or parallel misalignment in any direction, shall allow up to 30 degree angular deflections, and shall be raintight.
  5. Manufacturer – EMT Expansion/Deflection Fitting/Sleeve:
    - a. O-Z Gedney (Emerson Electric Co) DX series
    - b. Thomas & Betts XD series
    - c. Or equal
- E. Expansion Sleeve:
1. Application: Expansion sleeve shall compensate for parallel movement between two conduits.
  2. Expansion sleeve shall comply with UL514.B and NEMA FB-1.
  3. Expansion sleeve shall be fabricated of an inner steel sleeve with an oversized outer sleeve sealed with slip bushings, configured such that the outer sleeve can move over the inner sleeve. Sleeve shall come equipped with internal or external bonding braid and be ended with couplers suitable to connect to conduit ends.

4. Manufacturers – IMC (and/or RMC) Expansion Sleeve:
  - a. Cooper Crouse-Hinds XJG series
  - b. O-Z Gedney (Emerson Electric Co) TX series
  - c. Or equal
- F. Expansion Sleeve At Box Termination:
  1. Application: Expansion sleeve shall compensate for parallel movement between a conduit and a junction box/enclosure.
  2. Expansion sleeve shall comply with UL514.B and NEMA FB-1.
  3. Expansion sleeve shall be sealed sleeve design fabricated of malleable or ductile iron heads and steel sleeve.
  4. Manufacturers – IMC (and/or RMC) Expansion Sleeve:
    - a. O-Z Gedney (Emerson Electric Co) Type EXE series
    - b. Or equal

### 2.3 RIGID METAL CONDUIT (TYPE RMC) AND FITTINGS

- A. Application: Products and assembled system shall be suitable for indoor applications, in accordance with the NEC Article 344
- B. Type RMC Conduit:
  1. Type RMC conduit shall be fabricated of steel, galvanized inside and out (e.g., hot dip galvanized). Pre-threaded conduit ends shall be hot dip galvanized after cutting. Type RMC conduit bore shall be smooth and free of blisters, nicks or other imperfections which could mar cables.
  2. Type RMC conduit shall be listed by a nationally recognized testing laboratory to UL 6, and shall bear (stamped or molded on conduit and fittings) the UL label. Markings shall be permanent. Type RMC conduit shall meet ANSI C80.1 specifications.
  3. Type RMC conduit shall be listed by a nationally recognized testing laboratory to UL Safety Standard 6 and UL Safety Standard 514-B, and shall bear (stamped or molded on conduit and fittings) the UL label. Markings shall be permanent. Type RMC conduit shall meet ANSI C80.1 specifications.
  4. Type RMC conduit shall be recognized as a bonding conductor per NEC Article 250.118
  5. Factory elbows and bends minimum bend radius shall be 48”.
  6. Manufacturers – Type RMC Conduit:
    - a. Allied Tube and Conduit Co (Electrical Group) “Kwik-Couple” conduit
    - b. Western Tube and Conduit Corp
    - c. Or equal
- C. Fittings for RMC Conduit:
  1. Fittings, connectors, couplers, bushings, straps, accessories, etc., shall be listed by a nationally recognized testing laboratory to UL 514B, and shall bear (stamped or molded on conduit and fittings) the UL label. Markings shall be permanent.
  2. Fittings, connectors, couplers, bushings, straps, accessories, etc., shall be manufactured compliant to ANSI/NEMA FB 1.

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3. Fittings, connectors, couplers, bushings, etc., shall be threaded – rain-tight and concrete-tight where required by application.
  4. Fabrication Materials:
    - a. Connectors, couplers, and similar fittings: steel/zinc (preferred), die cast zinc, or malleable iron; 3-piece couplings: electroplated, cast malleable iron.
    - b. Locknuts: steel, zinc-coated; bonding type locknuts shall have sharp edges for digging into the metal wall of an enclosure (to establish conductive connection with enclosure)
    - c. Insulating bushings: die cast zinc with thermoplastic liner rated >100 degree C
  5. Manufacturers – Fittings for RMC
    - a. Appleton Electric Co and/or O-Z Gedney (Emerson Electric Co)
    - b. Thomas & Betts Corp
    - c. Or equal
- D. Deflection/Expansion Sleeve:
1. Application: Deflection/expansion sleeve shall compensate for movement in any direction between two conduit ends and shall withstand occasional vibration transmitted to conduit by rotating equipment or vehicular traffic.
  2. Deflection/expansion sleeve shall comply with UL467 and UL514.
  3. Deflection/expansion sleeve shall be fabricated of an inner sleeve, bonding braid, a neoprene outer sleeve with internal flexible stainless steel braid and outer stainless steel bands, ended with couplings (for connection to conduits).
  4. Deflection/expansion sleeve shall accommodate 0.75 inch (19mm) deflection, expansion, contraction, or parallel misalignment in any direction, shall allow up to 30 degree angular deflections, and shall be raintight.
  5. Manufacturer – EMT Expansion/Deflection Fitting/Sleeve:
    - a. O-Z Gedney (Emerson Electric Co) DX series
    - b. Thomas & Betts XD series
    - c. Or equal
- E. Expansion Sleeve:
1. Application: Expansion sleeve shall compensate for parallel movement between two conduits.
  2. Expansion sleeve shall comply with UL514.B and NEMA FB-1.
  3. Expansion sleeve shall be fabricated of an inner steel sleeve with an oversized outer sleeve sealed with slip bushings, configured such that the outer sleeve can move over the inner sleeve. Sleeve shall come equipped with internal or external bonding braid and be ended with couplers suitable to connect to conduit ends.
  4. Manufacturers – RMC (and/or IMC) Expansion Sleeve:
    - a. Cooper Crouse-Hinds XJG series
    - b. O-Z Gedney (Emerson Electric Co) TX series
    - c. Or equal
- F. Expansion Sleeve at Box Termination:

## Conduits and Boxes

1. Application: Expansion sleeve shall compensate for parallel movement between a conduit and a junction box/enclosure.
2. Expansion sleeve shall comply with UL514.B and NEMA FB-1.
3. Expansion sleeve shall be sealed sleeve design fabricated of malleable or ductile iron heads and steel sleeve.
4. Manufacturers – RMC (and/or IMC) Expansion Sleeve:
  - a. O-Z Gedney (Emerson Electric Co) Type EXE series
  - b. Or equal

#### 2.4 RIGID NONMETALLIC CONDUIT (RNC) AND FITTINGS – ELECTRICAL PVC CONDUIT (EPC) – SCHEDULE 40 AND SCHEDULE

- A. Application: products and assembled system shall be suitable for indoor applications, in accordance with the NEC Article 352
- B. Conduit and fittings shall be homogeneous polyvinylchloride (PVC) material free from visible cracks, holes or foreign inclusions. The conduit bore shall be smooth and free of blisters, nicks or other imperfections which could mar cables.
- C. Conduit, fittings, and accessories shall be UL Listed, and shall bear (permanently stamped or molded on conduit and fittings) the UL label. Markings shall be permanent.
- D. Conduit, fittings, and accessories shall be from a single manufacturer to assure system integrity.
- E. Type RNC Conduit:
  1. Conduit shall comply with UL 651 and NEMA TC 2 types EPC-40 (schedule 40) or EPC-80 (schedule 80).
  2. Conduit shall include an integral bell fitting at one end.
  3. Factory elbows' and bends' minimum bend radius shall be 1,220 mm (48 inches).
- F. Fittings for RNC:
  1. Fittings (couplings, connectors, adaptors, transition fittings, etc.) shall comply with UL 514B and NEMA TC 3.
  2. Fittings shall be slip-on type and solvent weld type.
  3. Factory fittings and bends minimum bend radius shall be 48”.
- G. Expansion Fitting:
  1. Expansion fittings shall be designed to compensate for length changes due to temperature variations in exposed conduit runs.
- H. End Caps: Pre-manufactured water-tight end caps
- I. PVC Solvent Cement
  1. Application: For use in outdoor and underground installations to permanently join PVC sections (conduit ends, couplers, etc)
  2. Safe for human skin contact and not deleterious to cable insulation
  3. Workable at temperatures from 40 to 100 degree F
- J. Manufacturers:

1. Allied Tube & Conduit
2. Carlon
3. JM Eagle
4. Ridgeline Pipe Manufacturing
5. Or equal

## 2.5 LIQUID-TIGHT FLEXIBLE METAL CONDUIT (TYPE LFMC) AND FITTINGS

- A. Application: Products and assembled system shall be suitable for indoor applications, in accordance with the NEC Article 350
- B. Type LFMC Conduit:
1. Type LFMC conduit shall be fabricated in continuous lengths from of single strip, flexible continuous, interlocked, and double-wrapped steel; galvanized inside and outside; coated with liquid-tight jacket of flexible polyvinyl chloride (PVC).
  2. Type LFMC conduit shall be listed by a nationally recognized testing laboratory to UL 360, and shall bear (stamped or molded on conduit and fittings) the UL label. Markings shall be permanent.
  3. Manufacturers:
    - a. AFC Cable Systems, Inc. (a part of Atkore International)
    - b. ANAMET Electrical (a.k.a., Anaconda Sealtite)
    - c. Electri-Flex Company
    - d. Southwire Company
    - e. Or equal
- C. Fittings for LFMC:
1. Connector body and gland nut shall be of cadmium plated steel or cast malleable iron, with tapered, male, threaded hub; insulated throat and neoprene "O" ring gasket recessed into the face of the stop nut. The clamping gland shall be of molded nylon with an integral brass push in ferrule.
  2. Manufacturers – Fittings for LFMC
    - a. Appleton Electric Co and/or O-Z Gedney (Emerson Electric Co)
    - b. Cooper Industries
    - c. Thomas & Betts Corp
    - d. Or equal

## 2.6 PULL TAPE

- A. Application: for installing/placing low voltage cables into conduit/ducts
- B. Description: flat, woven, polyester or Kevlar® tape
1. Lubricated (for easy pulling and reduced friction)
  2. Durably printed with sequential footage or meter markings
  3. UV resistant, and resistant to rot and mildew
  4. Pulling strength: 273 kg (60lb), minimum
  5. Low elongation

- C. Manufacturers:
  - 1. Neptco Inc MULTETAPE®
  - 2. Pacific Strapping Inc HERCULINE®
  - 3. Or equal

## 2.7 PULL STRING

- A. Application: For use with manual or power fishing systems for light duty cable or tape pulling applications
- B. Description: round, woven, polypropylene line
  - 1. Packaged in storage container with easy, quick, and tangle-free dispensing
  - 2. UV resistant, and resistant to rot and mildew
  - 3. Low elongation
- C. Manufacturers:
  - 1. Ideal Industries Inc Powr-Fish® or Valu-Line™ poly pull line
  - 2. Klein Tools #56110 poly pull line
  - 3. Or equal

## 2.8 DUCT PLUGS

- A. Application: Suitable for installation within conduits at termination/end entering into underground maintenance holes/pull boxes and into buildings from underground/exterior, opening into a telecommunications space.
- B. Duct plugs shall be sized per conduit trade/actual size and per cable outside diameter – as required per instance.
- C. Duct plugs shall be re-enterable and re-usable.
- D. Manufacturers:
  - 1. Tyco (JACKMOON)
  - 2. Or equal

## 2.9 PULL BOXES

- A. Application: For use indoors as cable placement point (pull box) for low voltage cabling and wiring within a conduit raceway system.
- B. Compliances:
  - 1. Pull boxes shall meet the requirements of UL 50 and NEMA Type 1.
  - 2. Pull boxes shall be listed by a nationally recognized testing laboratory for the purpose.
- C. Material and Finish:
  - 1. Thickness: 16 gauge, minimum
  - 2. Material: the following materials are acceptable for pull boxes
    - a. Pre-galvanized steel (ASTM A653), then formed
    - b. Mild steel formed, then hot-dipped galvanized (per ASTM A123)

- c. Mild steel formed, then painted (polyester or epoxy powder coat, meeting ASTM D1654)
- D. Size: pull box size shall comply with CEC 314.28
- E. Configuration: pull boxes shall --- Covers shall be secured by machine screws at 6 inches intervals.
- F. Manufacturers:
  - 1. Cooper B-Line (Eaton)
  - 2. Hoffman (Pentair)
  - 3. Hubbell Wiegmann (SC Series enclosures, as an example)
  - 4. Or equal

## 2.10 STEEL OUTLET BOXES AND COVERS

- A. Application: For use indoors as outlet box, backbox, and/or junction box of low voltage systems to house wiring, cabling, terminations, and connectors; may also house and support components.
  - 1. Outlet boxes shall permit access to conductors for maintenance
  - 2. Outlet boxes shall come with knock-outs or punch-outs for easy creation of holes to accept conduit connectors.
- B. Compliances:
  - 1. Outlet boxes shall meet the requirements of CEC Article 314.
  - 2. Outlet boxes shall be listed by a nationally recognized testing laboratory to UL 514A for Class 2 and Class 3 power-limited circuits (such as data and signal) providing bonding without the use of bonding jumpers, for remote control circuits, and for telecommunications circuits in accordance with NEC Article 314.
  - 3. Outlet boxes shall be manufactured compliant to NEMA: FB-1 and OS-1.
  - 4. Outlet boxes shall be fire resistant and suitable for use in rated spaces (reference: UL Fire Resistance Directory / "Orange Book").
- C. Material and Finish:
  - 1. Material: <AISI/SAE 1008 Steel> <hot rolled, pre-galvanized steel, minimum spangle, AISI C-1008>
  - 2. Thickness: CEC 314.40(B) / 1.59 mm (0.0625in), minimum
  - 3. Finish: G60 hot dip zinc galvanized (0.60 oz/sq ft), meeting ASTM A123, or pre-galvanized (continuous sheet galvanizing) meeting per ASTM A653
  - 4. Finish Thickness: ~0.0005 inches
- D. Square Box and Covers/Rings – 5"
  - 1. Dimensions: 5 in square x 2.875 in deep
  - 2. Volume: 64 in<sup>3</sup>
  - 3. Outlet box shall come equipped with integrated cable management/slack support.
  - 4. Manufacturers:
    - a. Randl Industries



- b. Or equal
- E. Square Box – 4-11/16", Extra Deep
  - 1. Dimensions: 4-11/16 in square x 3 (or 3-1/4) in deep
  - 2. Volume: 66.7 in<sup>3</sup>
  - 3. Box shall have standard 4-11/16 screw pattern (accept standard 4-11/16" covers/mud rings/tile covers/etc).
  - 4. Knock-outs: top, bottom: 3/4 in to 2 in; sides: 3/4" to 1-1/4"
  - 5. Manufacturers:
    - a. Gavin Industries
    - b. RACO (Hubbell Electrical Products)
    - c. Or equal
- F. Square Box – 4-11/16", Deep
  - 1. Dimensions: 4-11/16 in square x 2-1/8 in deep
  - 2. Volume: 42 in<sup>3</sup>
  - 3. Box shall have standard 4-11/16 screw pattern (accept standard 4-11/16" covers/mud rings/tile covers/etc).
  - 4. Manufacturers:
    - a. Appleton Electric Co and/or O-Z Gedney (Emerson Electric Co)
    - b. Garvin Industries
    - c. RACO (Hubbell Electrical Products)
    - d. Steel City (Thomas & Betts)
    - e. Or equal

## 2.11 BOX SUPPORT ACCESSORIES

- A. Box accessories shall comply with UL standards and shall be listed by a nationally recognized testing laboratory.
- B. Stud-Mount Single-Box Bracket
  - 1. Erico
  - 2. Garvin
  - 3. Raco
  - 4. Or equal
- C. Stud-Mount Multi-Box Bracket
  - 1. Erico
  - 2. Garvin
  - 3. Raco
  - 4. Or equal
- D. Floor-Mount Box Mounting Bracket
  - 1. Erico
  - 2. Garvin

3. Raco
  4. Or equal
- E. T-Bar Bracket
1. Erico #510HD; bracket for outlet box, attaches to T-bar ceiling grid
- F. T-Bar Support
1. Erico #4ACS; adapter/support for outlet box, attaches to T-bar ceiling grid

## 2.12 MULTI-SERVICE FLOOR BOXES

- A. Application: For use indoors as a multi-service (telecommunications, audiovisual, power) outlet box to house wiring, cabling, termination, connectors, and receptacles installed within a cast concrete floor
- B. Box Construction: Seam welded 14 gauge steel
- C. Compliances:
1. Floor boxes shall be listed by a nationally recognized testing laboratory to UL 514A for Class 2 and Class 3 power-limited circuits (such as data and signal) providing bonding without the use of bonding jumpers, and remote control) circuits and for telecommunications circuits in accordance with NFPA 70 Article 314 for use in tile, terrazzo, carpet, and wood covered floors.
  2. Floor box assemblies shall meet the scrub water exclusions requirements of UL 514A for use in tile, terrazzo, carpet, and wood covered floors.
- D. Load Capacity: Floor box assembly (back box, cover, etc) shall be rated to 300 lbs (minimum) static load.
- E. Features:
1. Suitable for cast-in-place concrete applications
  2. 8 gangs, minimum
  3. Knock-outs (or punch-outs) for easy creation of holes to accept conduit connectors
  4. Permit access to conductors behind terminations (for maintenance)
- F. Cover Finish: Coordinate with Architect
- G. Manufacturers:
1. FSR Inc.
  2. Hubbell
  3. Wiremold
  4. Or equal

## 2.13 MULTI-SERVICE POKE-THRUS COMBO - AV / TEL / POWER

- A. Application: For use indoors as a multi-service (telecommunications, audiovisual, power) outlet to house wiring, cabling, termination, connectors, and receptacles
1. Poke thrus shall permit access to conductors for maintenance.
- B. Compliances:

## Conduits and Boxes

1. Poke thrus shall be listed by a nationally recognized testing laboratory for the purpose.
  2. Poke thrus shall comply to UL 514A for Class 2 and Class 3 power-limited circuits (such as data and signal) providing bonding without the use of bonding jumpers, and remote control) circuits and for telecommunications circuits in accordance with NFPA 70 Article 314 for use in tile, terrazzo, carpet, and wood covered floors.
  3. Poke thrus shall meet (or exceed) UL 514A requirements for scrub water test.
- C. Fire Rating:
1. Poke thrus shall be listed by a nationally recognized testing laboratory as a rated penetrating device.
  2. The poke-thru outlet shall maintain the rating of the concrete slab/deck within allowable penetration methods.
  3. Poke thrus shall provide at least two-hour fire rating.
- D. Load Capacity: Floor box assembly (back box, cover, etc) shall be rated to 300 lbs (minimum) static load.
- E. Construction:
1. Body shall be fabricated of steel (or die cast) non-flammable materials.
  2. Body shall include integral intumescent material for firestopping feature.
  3. Stubs shall be fabricated of listed EMT.
  4. Boxes shall fabricated of welded steel and shall be listed for the purpose.
- F. Cover Finish: Coordinate with Architect.
- G. Manufacturer:
1. Wiremold
    - a. "Evolution" 8AT series poke-thru; 8 inch diameter
    - b. "Evolution" 6AT series poke-thru; 6 inch diameter
  2. Or equal

**2.14 MULTI-SERVICE WALL BOXES FOR FLAT PANEL DISPLAYS**

- A. Application: indoor use as a multi-service (telecommunications, audiovisual, power) outlet box to house wiring, cabling, termination, connectors, and receptacles and serve a flat panel display
- B. Listings: Wall boxes shall be listed by a nationally recognized testing laboratory to UL 514A.
- C. Fabrication Material: Backbox: Seam welded 14 gauge steel; Cover: 1/16" steel, electro-painted
- D. Outlet box shall feature capacity for the following:
1. Power: 1 duplex receptacle, duplex or decora style
  2. Telecom/Network: 2 network jacks (refer to section 271513 for jack information)
  3. AV: 2 positions for AAP (or equivalent) modules
  4. Conduit Connections: 1 positions for 1.25-inch conduits at top, 1 positions for 1.25-inch conduits at bottom, 1 positions for 1.25-inch conduits at each side,

- E. Manufacturers:
  - 1. FSR
  - 2. Wiremold
  - 3. Chief Manufacturing
  - 4. Or equal

## 2.15 WEATHERPROOF (OUTDOOR) OUTLET BOXES AND COVERS

- A. Application: For use outdoors (generally wet, damp, and/or dry locations) as an outlet box, and/or back box of low voltage systems to house wiring, cabling, termination, and connectors; may also house and support components.
  - 1. Outlet boxes shall permit access to conductors for maintenance
- B. Outlet boxes shall be listed by a nationally recognized testing laboratory to UL 514A for Class 2 and Class 3 power-limited circuits (such as data and signal) providing bonding without the use of bonding jumpers, for remote control circuits, and for telecommunications circuits in accordance with NEC Article 314.
- C. Outlet boxes shall be die cast.
- D. Outlet boxes shall come with manufactured threaded openings for connection connections
- E. Outlet boxes (box, including conduit connections, plus cover assembly) shall be NEMA 3R rated.
- F. Manufacturers:
  - 1. Bell (Hubbell Electrical Products)
  - 2. Garvin Industries
  - 3. Or equal

## PART 3 EXECUTION

### 3.1 GENERAL

- A. Comply with the Execution requirements of Section 270000.

### 3.2 EXAMINATION AND PREPARATION

- A. Prior to installation, plan routes and locations of pathway systems and coordinate with other trades and building systems (ductwork, plumbing, electrical raceways, wall construction, ceilings, etc.). Pathway systems shall not unnecessarily cross other trade's work, shall not prevent removal of ceiling tiles or panels, and shall not block access to mechanical or electrical equipment. Provide offsets as required to avoid obstruction of pathway systems with other trades/systems.
- B. Prior to installation, examine areas to receive pathways systems to verify conditions are ready for work and to verify conformance with manufacturer and specification tolerances. Notify the Owner's Representative in writing of conditions that would adversely affect the installation, or subsequent

### 3.3 INSTALLATION

- A. Secure raceway/pathway systems to building structures using approved support methods and components (fasteners, anchors, clamps, hangers, etc) and complaint to the CEC.

- B. Conduit Systems, including Pull Boxes
1. Run conduit in groups/banks in the most direct route possible, parallel to building lines, and at elevations that avoid unnecessary offsets. Do not route conduit through areas in which flammable material may be stored, or over or adjacent to boilers, incinerators, hot water lines, or steam lines. Completed conduit systems installation shall not encroach into the ceiling height headroom of walkways or doorways.
  2. Trapeze Supported Conduit Runs
    - a. Support conduit runs using "trapeze" hangers fabricated from construction channel and threaded steel rods anchored to building structures. Fasten conduit to construction channel using standard conduit clamps or equivalent.
    - b. Seismically brace trapeze supports compliant to applicable codes.
  3. Surface-Mounted Conduit Runs
    - a. Single Conduit Runs: Support single conduit runs to building structure using construction channel with approved anchors and hardware or using 2-hole (preferred) or 1-hole conduit straps (or similar support apparatus). Where installed in damp or wet locations, support conduit to building structure using conduit clamp such that clamp backs add space between conduit and mounting substrate.
    - b. Multiple Conduit Runs: Support multi-conduit runs to building structure using construction channel with approved anchors and hardware. Select anchors based on installation substrate. Fasten conduit to construction channel using standard conduit clamps or equivalent.
    - c. Install vibration control apparatus as required to meet isolation requirements.
  4. Install conduit free from dents, bruises or deformations. Remove and replace damaged conduits with new undamaged material.
  5. Install metallic conduit so as to not be in contact with other dissimilar metal pipes (e.g., plumbing) to minimize galvanic corrosion.
  6. Make bends and offsets using standard conduit bending hand tool and/or machines or use factory fittings. The use of any item not specifically designed for bending conduit is strictly prohibited.
  7. When routing conduit within concrete:
    - a. Place conduits at a depth as required by the project's structural engineer. In lieu of no direction, place conduits in the middle of the concrete's depth.
    - b. Do not place conduits between reinforcing steel and the bottom of floor slabs.
    - c. Space conduits a minimum of three conduit diameters apart unless otherwise noted on the drawings.
    - d. Avoid crossing conduits (to minimize displacement of concrete). Obtain written approval/detail from structural engineer for crossing and for instances not adhering to general structural details.
    - e. Only use compression fittings. Fully wrap fittings with duct tape.
  8. For conduits that turn up and protrude from finished concrete, extend conduits 25mm – 75mm (1" to 3") above the surface of the floor, unless conditions require other extension lengths.
  9. For rigid and intermediate steel conduit:

- a. Ream conduit smooth after cutting and threading.
  - b. Coat field-threaded joints with UL approved conductive type compound to ensure low resistance ground continuity through conduit and to prevent seizing and corrosion.
10. Pull Boxes: Install pull boxes and junction boxes at locations that are accessible. Install pull boxes and junction boxes at locations that are concealed, unless as noted on drawings; pull boxes and junction boxes may be exposed in electrical rooms, utility rooms, storage areas, or when installed in 'open' spaces (such as no ceilings). Adjust locations and installation as coordinated with construction conditions and as required for seismic bracing. Within ceiling space (e.g., above ceiling grid), do not install higher than 1m (~3') above grid.
  11. Ream conduit ends cut in the field (non-factory) to eliminate sharp edges, burrs, etc.
  12. Clean completed conduits of foreign matter and/or moisture (e.g., pull a bristle mandrel through).
  13. Secure pull strings/mule tapes at conduit ends or within boxes to prevent recoiling back into duct.
  14. After installation of conduit system and during ongoing general construction, protect conduits and tightly cover/seal open ends.
  15. Leave no unused openings in any pull or junction box. Install close-up plugs as required to seal openings.
  16. Label each conduit end in a clear manner by designating the location of the other conduit end (i.e. room name, junction box number, etc.). Indicate conduit length on the label.
  17. For connections to equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission, use short length (maximum of 6ft) of the FMC or LFMC conduit. For installation in exterior locations, or humidity-laden atmosphere, corrosive atmosphere, water hose or spray wash down operations, and locations subject to seepage or dripping of oil, grease or water, use LFMC. Provide a green ground wire with FMC or LFMC conduit.
  18. Terminations, Connections and Joints
    - a. Securely connect conduits to boxes, cabinets, wireways, etc., using conduit connectors suitable for the application and one (or two) locknuts and, where required, an insulating bushing or insulated connectors. Torque threaded items to proper tightness.
    - b. Where conduits are bonded to ground, securely attach grounding bushings and route bonding jumpers in as short of a path as possible to grounding point.
    - c. Where joints and/or connections cannot be made tight, use a bonding jumper to maintain electrical continuity through the connection.
    - d. Where terminations are subject to vibration, use a bonding bushing or wedge to maintain electrical continuity through the connection. Where subject to vibration or dampness, use insulating bushings to protect conductors.
    - e. Vibration/Movement Isolation: At connections/terminations subject to vibration, movement, misalignment, and/or noise transmission, transition duct bank conduit to a short length (maximum of 2-3 feet) of LFMC. Secure conduit to structure immediately prior to the transition.

### C. Outlet Boxes / Back Boxes

## Conduits and Boxes

1. Install boxes plumb and square. Match heights of surrounding outlets (e.g., an adjacent electrical receptacle). Adjust locations and heights as required to suit coordination requirements of construction conditions.
  2. Install boxes flush with walls, ceilings and floors except where exposed work is called for on the drawings, required, or appropriate.
  3. Do not make unused openings in boxes (such as knocking out fabricated knock-outs without using the opening for a conduit connector). Replace boxes containing inadvertent or unused openings.
  4. Framed Walls, both Fire Rated and Non-Rated
    - a. Install outlet boxes and covers/raised rings during rough-in such that the finished condition is flush with wall finishes.
    - b. Do not install outlet boxes back-to-back (outlet boxes facing opposite sides of a wall). At framed walls not fire rated, install boxes with at least 6" separation. At fire rated framed walls, install boxes with at least 24" and 1 framing stud separation.
    - c. Patch/repair openings in wall (plaster, drywall, and/or plasterboard) around boxes and/or raised rings to eliminate visible gaps after outlet gets finished, in accordance with CEC 314.21.
  5. Ceilings
    - a. At ceilings, install boxes, supports (such as T-bar support bracket), and cover/ring such that the finished condition is flush with ceiling finishes, except where noted otherwise and where conditions prevent a flush installation
    - b. At non-accessible ceilings, install service conduit continuous to an accessible location
  6. Concrete Cast-In-Place Walls and Floors
    - a. Set boxes in place within forms (for walls) and casting volume (for floors) such that the finished condition is flush with wall and floor finishes. Ensure proper concrete cover, according to structural requirements.
  7. Masonry Walls
    - a. Adjust position of outlet boxes to suit masonry course lines. Coordinate cutting of masonry walls to achieve neat openings for boxes.
- D. Wall Boxes for Flat Panel Displays
1. Install boxes plumb and square. Install boxes and covers/raised rings during rough-in such that the finished condition is flush with wall finishes. Patch openings around covers/raised rings to eliminate visible gaps after outlet gets finished.
  2. Confirm heights of each box. Coordinate with heights of associated services (e.g., electrical receptacle). Adjust locations and heights as required to coordinate with construction conditions.
  3. Do not make unused openings in boxes (such as knocking out fabricated knock-outs without using the opening for a conduit connector). Replace boxes containing inadvertent or unused openings.
  4. Do not install boxes back-to-back in a framed wall (boxes facing opposite sides of a wall), unless noted so on the drawings. At framed walls not fire rated, install boxes with at least 6" separation. At fire rated framed walls, install boxes with at least 24" and 1 framing stud separation.
- E. Floor Boxes

1. Install floor boxes square, plumb, level, and flush with structural floor. Align box with adjacent surfaces.
    - a. Tolerance: 1/16"
  2. For floor boxes with combined power and communications circuits, install metal dividers for separation of circuits.
  3. Install covers to suit finish conditions. Coordinate floor finishes (such as carpet) with other trades.
- F. Poke-Thrus
1. Install poke-thrus flush with structural floor.
  2. Install covers to suit finish conditions. Coordinate floor finishes (such as carpet) with other trades.

### 3.4 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

### 3.5 FINAL INSPECTION AND CERTIFICATION

- A. Punch the Work of this Section compliant to the requirements of Section 270000.
- B. Comply with system acceptance and certification requirements of Section 270000.

END OF SECTION