

## **SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 SUBMITTAL REQUIREMENTS**

A. Product Data

1. For surface raceways, wireways, fittings, boxes, enclosures, and cabinets.

B. Shop Drawings

1. Coordination Drawings: Prior to commencing with any related work, submit routing plans drawn to scale coordinated with the other trades. Drawing(s) shall include vertical and horizontal offsets, raceways sizes, equipment clearances, structural members, etc.

C. Definitions

1. EMT: Electric metallic tubing.
2. FMC: Flexible metallic conduit.
3. GRC/RMC: Galvanized rigid steel conduit.
4. IMC: Intermediate metal conduit.
5. LFMC: Liquid-tight flexible metallic conduit.
6. RNC: Rigid nonmetallic conduit.
7. Conduit/Raceway/Pathway: "Conduit", "raceway", "pathway" and similar terms shall be taken to mean "conduit" unless specifically indicated otherwise in project manual documents, or unless specifically directed otherwise in field by Owner or Design Professionals. All such terms shall be considered synonymous for the general purposes of installation means and methods.

### **PART 2 - PRODUCTS**

#### **2.1 MANUFACTURERS**

- A. Products: Metal conduits, tubing, boxes and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. Subject to compliance with requirements, manufacturers offering raceway, box and fitting related products that may be incorporated into the Work as applicable include, but are not limited to, the following:

1. Allied
2. Adalet.
3. AFC Cable Systems, Inc.
4. Allied Tube & Conduit; a Tyco International Ltd. Co.
5. Anamet Electrical, Inc.

6. Appleton Electric.
7. Armorcast Products Company
8. Arnco Corporation
9. Baxter
10. Bell Electric.
11. Bowers.
12. Cantex.
13. Carlon.
14. Carson Industries LLC
15. CDR Systems Corporation; Hubbell Power Systems
16. CertainTeed Corp.
17. Condux International, Inc.
18. Cooper
19. Eagle Electric Mfg Co., Inc.
20. Efcor.
21. EGS/Appleton Electric
22. Electri-Flex Company.
23. Erickson Electrical Equipment Company
24. FSR
25. General Electric Company
26. Highline Products
27. Hoffman; a Pentair company.
28. Hubbell.
29. Kraloy.
30. Lamson & Sessions; Carlon Electrical Products
31. LTV.
32. Midland-Ross Corp.
33. Milbank Manufacturing Co.
34. Mono-Systems, Inc.
35. NewBasis
36. Niedax-Kleinhuis USA, Inc.
37. Nordic Fiberglass, Inc
38. Norwalk
39. O-Z/Gedney; a brand of EGS Electrical Group.
40. Oldcastle Precast, Inc.; Christy Concrete Products
41. Panduit
42. Pass and Seymour, Inc.
43. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
44. Quazite
45. RACO
46. Regal.
47. Republic Conduit.
48. Robroy Industries.
49. Siemens/ITE
50. Southwire Company.
51. Spring City Electrical Manufacturing Company

52. Square D; a brand of Schneider Electric.
53. Stahlin Non-Metallic Enclosures; a division of Robroy Industries
54. Steel City.
55. Synertech Moulded Products; a division of Oldcastle Precast, Inc.
56. Tay-Mac
57. Thepitt.
58. Thomas & Betts Corporation.
59. Walker/Wiremold/Legrand
60. Western Tube and Conduit Corporation.
61. Westinghouse/Cutler-Hammer
62. Wheatland Tube Company; a division of John Maneely Company.
63. Wiegmann (Hubbell-Wiegmann)

## **2.2 METAL CONDUITS, TUBING, AND FITTINGS**

- A. EMT: Comply with FS WW-C-563, ANSI C80.3 and UL 797.
- B. IMC: Comply with ANSI C80.6 and UL 1242.
- C. GRC/RMC: Comply with ANSI C80.1 and UL 6. Provide steel conduit, galvanized/fused to inside and outside walls of conduit and fittings after fabrication and after threading.
- D. FMC: Comply with FS WW-C-566 and UL 1; zinc-coated steel. Provide flexible metal conduit formed from continuous length of spirally wound, interlocked zinc-coated or galvanized (inside & outside) strip steel. Provide conduit fittings for use with flexible steel conduit of threadless hinged clamp type, with insulated throats. Provide Straight Terminal Connectors consisting of one-piece body, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end with locknut. Do not use 45-degree or 90-degree Terminal Angle Connectors for flexible or water-tight flexible metal conduit in locations that will not be fully accessible after completion of construction. Provide full size green insulated ground wire for all applications, regardless of length.
- E. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
  1. Provide liquid-tight flexible metal conduit formed from continuous length of spirally wound, interlocked, double-wrapped hot-dipped zinc-galvanized (inside & outside) steel core. Provide liquid-tight jacket of flexible polyvinyl chloride (PVC) that is fully weatherproof, flame-retardant, heat resistant, oil resistant, sunlight resistant and that resists heat, oil and chemical breakdown.
  2. Provide smooth-wall type jackets (not a corrugated look) for furniture whip (and similar) applications in indoor finished areas.
  3. Provide Liquid-Tight Flexible Metal Conduit Fittings compliant with FS W-F-406, Type 1, Class 3, Style G. Provide cadmium plated, malleable iron fittings with compression type steel ferrule and neoprene gasket sealing rings, with insulated throat.

4. Provide Straight Terminal Connectors that are one-piece body, female ends with clamps and deep slotted machine screws for securing conduits, and male threaded ends with locknuts.
  5. Provide Terminal Angle Connectors that are 45-degree or 90-degree two-piece body construction with removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut. Do not use 45-degree or 90-degree Terminal Angle Connectors for flexible or water-tight flexible metal conduit in locations that will not be fully accessible after completion of construction.
  6. Provide full parity size green insulated ground wire for all applications, regardless of length.
  7. Provide installed LFMC systems using materials and installation methods that result in IP67 compliant.
- F. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
1. EMT: Provide steel, galvanized or zinc-coated water/concrete-tight fittings; do not use die-cast fittings. Provide Compression type for outdoor applications, and applications in other wet locations. Provide Compression or set screw type for indoor applications.
  2. GRC/RMC: Zinc-Galvanized Steel (after fabrication/factory-threading), threaded (fused-galvanized after threading.)
  3. Expansion Fittings: Material to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
  4. Provide terminal conduit fittings with insulated throats, or plastic bushings for conduits 2" and larger where insulated throats may not be readily available.
  5. Provide locknuts for securing conduit to metal enclosure with sharp edge for digging into metal, and ridged outside circumference for proper fastening. Provide screw type grounding terminal for metal bushings of standard or insulated type.
  6. Provide miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings, and plugs that are specifically designed for their particular application.
  7. Provide galvanized cast-metal (steel) conduit bodies of types, shapes and sizes as required to fulfill job requirements and NFPA 70 requirements. Construct conduit bodies with threaded-conduit-entrance ends, with removable covers, either cast or of galvanized steel, and with corrosion-resistant screws.
- G. Joint Compound for Threaded Conduit: 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.

## 2.3 NONMETALLIC CONDUITS AND FITTINGS

- A. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated. Comply with NEMA TC 3 for fittings; match to conduit or tubing type and material.
1. Provide electrical plastic conduit equal to Carlon Plus 40. Provide heavy wall electrical plastic conduit that is Schedule 40, 90 degrees C rated, constructed of polyvinyl chloride, in conformity with NEMA TC-2, in conformity with NFPA 70 Article 354, and is UL listed and labeled for direct burial, concrete encasement, and above ground use. Provide conduit/duct accessories of types, sizes, and materials, complying with manufacturer's published product information, which mate and match conduit and tubing.
  2. Provide Duct Spacers ("chairs") equal to Carlon #S288\*L series for base spacers, and #S289\*L series for intermediate spacers.
  3. Provide horizontal elbows for service entrance conduits that are maximum 45-degree. Provide minimum 24-inch radius. Provide larger minimum radius where indicated on drawings, or if directed in field. Provide multiple units as necessary to obtain required offset (i.e. provide two 45-degree elbows to obtain a 90-degree offset where needed). Provide 90-degree maximum elbows.
  4. Provide couplers, adapters, "O" rings, sealing, and other accessory components as required for a complete installation. Provide miscellaneous fittings that have been specifically designed and manufactured for their particular application.

## 2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Metal Product Description: Provide sheet metal wireways, complying with UL 870 and NEMA 250, Type 1 for indoor applications and Type 3R for outdoor applications unless otherwise indicated, and sized according to NFPA 70. 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.
1. Provide screw-cover type for indoor applications, and flanged-and-gasketed type for outdoor applications unless otherwise indicated. Provide manufacturer's standard enamel finish. Protect sheet metal parts with rust inhibiting coating and baked enamel finish. Provide plate-finished hardware to prevent corrosion. Protect screws installed toward inside of wireway, with spring nuts to prevent wire insulation damage.
  2. 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. Provide electrical wireways of types, grades, sizes, and number of channels for each type of applicable service.
  3. Provide lay-in wireways with hinged covers in accordance with UL 870, and with components UL-listed, including lengths, connectors, and fittings. Provide units that allow fastening of hinged cover closed without use of parts other than standard lengths, fittings and connectors. Provide units capable of sealing cover in closed position with sealing wire. Provide wireways with knockouts. Provide

wireway connectors suitable for "lay-in" conductors, with connector covers permanently attached so that removal is not necessary to utilize the lay-in feature. Provide NEMA 3R units where used outdoors or in areas subject to moisture.

- B. Nonmetallic Product Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.
- C. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

## **2.5 BOXES, ENCLOSURES, AND CABINETS**

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be UL listed and labeled for use in wet locations, including cover plates and doors. Boxes, enclosures, and cabinets installed in damp and areas subject to moisture shall be UL listed and labeled for use in damp locations, including cover plates and doors. All other applications shall be UL listed and labeled for the location in which they are installed. Provide galvanized (after fabrication and after threading) boxes with galvanized or stainless-steel accessories, hardware and cover plates.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A. Provide galvanized-coated flat rolled code-gage non-gangable sheet-steel outlet/junction/pull boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Construct outlet boxes with mounting holes and with cable and conduit-size knockout openings in bottom and sides where applicable. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding. Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps, and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Provide with stainless steel nuts, bolts, screws and washers.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover. Only use for special applications with prior case-by-case approval from Design Professionals.
- D. Luminaire Outlet Boxes: Comply with outlet box specifications above; nonadjustable, designed for attachment of luminaire weight (50 lb, minimum) plus 100 percent factor of safety. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight, including 100 percent factor of safety.

- E. Box extensions used to accommodate new building finishes shall be of same material as recessed box and shall extend to the finished wall surface.
- F. Bushings, knockout closures and locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications.
- G. Device Box Dimensions: 4 inches square by 1-1/2 inches deep or 4 inches square by 2-1/8 inches deep, depending on device depths and wiring fill, with single-gang plaster/"mud" rings where only one device is being installed. Provide wider boxes for applications where more than two devices will be installed. Provide internal metal dividers where required under NFPA 70 for varying voltages, multiple circuits, etc. Gangable boxes (using multiple single-gang boxes to assemble multi-gang boxes) are prohibited.
- H. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 for indoor applications and Type 3R for outdoor applications with continuous-hinge cover with flush latch unless otherwise indicated, and with steel interior panels that are finished with manufacturer's standard enamel.
  - 1. Metal Enclosures: Stainless steel, or galvanized (after fabrication) steel, finished inside and out with manufacturer's standard enamel.
- I. Cabinets:
  - 1. Provide NEMA 250, stainless steel or Type 3R galvanized (after fabrication) steel boxes with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Provide hinged door in front cover with flush stainless-steel latch and concealed stainless-steel hinge. Provide key latch to match panelboards. Provide metal barriers to separate wiring of different systems and voltage. Provide accessory feet where required for freestanding equipment. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, listed by a qualified testing agency, and marked for intended location and application.
- J. Weathertight outlet boxes and covers:
  - 1. Provide corrosion-resistant weathertight/raintight outlet wiring boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit holes for fastening electrical conduit, suitably configured for each application, including face plate gaskets and corrosion-resistant plugs and fasteners. Provide weathertight outlets for interior and exterior locations exposed to weather or moisture.
  - 2. Provide weatherproof covers that mount on a single gang horizontal or vertical (depending on application) junction box to ensure weather protection for a standard outlet. Provide covers that can mount on indoor or outdoor junction boxes and that include a weatherproof cover/base assembly with gasket, two universal inserts, and mounting hardware. Provide weatherproof cover that

provides flexibility in installation. Provide covers that meet or exceed UL requirements for wet locations while in use, that meet requirements of NFPA 70 Article 410-57(b), and are minimum NEMA 3R rated. Provide weatherproof cover constructed of UV stabilized high impact polycarbonate material. Provide clear cover for the part that encloses the cord set, to allow visual inspection. Provide cover that meets agency requirements for cold impact at negative 60 degrees Fahrenheit (negative 51 degrees C). Provide covers with useable inside depth to accommodate plug head. Provide assemblies for outdoor applications, unless indicated otherwise on drawings, and for indoor applications that serve permanent or extended-use cord & plug load connected equipment.

3. Provide minimal profile assemblies that are rated NEMA 3R While In Use and that employ recessed box and cover design, equal to Thomas & Betts “Red Dot” series. Provide trim color(s) to match surrounding finished wall surface.

## **2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING**

- A. General Requirements for Handholes and Boxes: Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application. 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. Provide weatherproof cover, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location. Provide nonskid cover finish, with a minimum coefficient of friction of 0.50, and with molded or embossed lettering to indicate contents.
- B. 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. 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. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.
- C. Polymer-Concrete Handholes/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. Design for flush burial with open bottom unless otherwise indicated.
  1. Outdoor junction and pull boxes for branch-circuit-scale applications: Provide flush grade-mounted junction/pull box assemblies, equal to Quazite #PG1212-BG-12, 12 inches deep, with bolted cover and open bottom. Provide larger sizes where required by NFPA 70 based on conduit quantities/sizes and wire fill. Provide assemblies constructed of polymer concrete. Provide assemblies that are unaffected by UV light, moisture, freezing, and sub soil chemicals. Provide assemblies that have minimum 30-year projected life in all climates. Provide enclosures/covers that are gasketed with stainless steel inserts and bolts. Provide covers with factory logo for service type contained within. Provide assemblies



- that are heavy duty (ANSI Tier 15), and rated for a design load of 22,500 pounds and test load of 33,750 pounds. Provide outdoor mounted junction/pull boxes flush grade/slab mounted (level & plumb), set on a minimum 12" deep bed of pea gravel. Install so that conduits enter the boxes from below. Field verify specific installation requirements with Owner's Representative and Design Professional prior to rough-in of outdoor grade-mounted junction/pull boxes.
2. Outdoor handhole/pull boxes for feeder-scale applications: Provide flush grade mounted junction/pull box assemblies, equal to Quazite #PG2436-BG-24, 24" deep with bolted cover and open bottom. Provide larger sizes where required by NFPA 70 based on conduit quantities/sizes and wire fill. Provide larger sizes where required by NFPA 70 or field conditions. Provide assemblies constructed of polymer concrete. Provide assemblies that are unaffected by UV light, moisture, freezing, and sub soil chemicals. Provide assemblies that have minimum 30-year projected life in all climates. Provide enclosures/covers gasketed with stainless steel inserts and bolts. Provide covers with factory logo for service type contained within. Provide assemblies that are heavy duty (ANSI Tier 15), rated for a design load of 22,500 pounds, and rated for a test load of 33,750 pounds. Provide outdoor mounted junction/pull boxes flush grade/slab mounted (level & plumb), and set on a minimum 12-inch-deep bed of pea gravel. Install so that conduits enter the boxes from below. Field verify specific installation requirements with Owner's Representative and Design Professional prior to rough-in of outdoor grade-mounted junction/pull boxes.

## **PART 3 - EXECUTION**

### **3.1 RACEWAY APPLICATION**

- A. Raceway Fittings: Compatible with (Listed accordingly) raceways and suitable for use and location.
  1. EMT: Comply with NEMA FB 2.10 and with requirements of these specifications.
  2. GRC/RMC and IMC: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
  3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

### **3.2 INSTALLATION**

- A. General Installation.
  1. Minimum Raceway Size: 3/4-inch trade size.
  2. Install wire in raceway/conduit unless specifically permitted otherwise elsewhere in Division 26 sections, or on drawings.
  3. Layout and install all electrical work in strict compliance with Chapter 1, Part B, Section 110.26 of the latest adopted edition of NFPA 70. Locations and routing that may be shown on plans are schematic and diagrammatic in nature.

4. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for Conduits and raceways required by NFPA 70 as a minimum.
5. Layout all proposed raceway routing, elevations, installation methods, etc. on coordination drawings and coordinate all proposed raceway routing with all affected trades prior to commencing with work. In addition, review the information with Owner and Design Professionals for all areas where the raceways will be visible after completion of construction, to ensure a neatly organized installation occurs. Where raceways must be exposed in finished/regularly occupied areas, install them in a manner that minimizes detrimental effects on room aesthetics. Install so raceways are as out of site as reasonably possible. For instance, where applicable for exposed work and if so directed by the Design Professionals or the Owner, make drops near corners, window casings, door casings, etc. Likewise, if a receptacle needs to be installed at the center of a wall, install the raceway down the wall in a corner of the room then transition and run horizontally to the outlet location if so directed by the Design Professional or the Owner. Use compression fittings for EMT applications in these areas. Do not use strut or fasteners that stand off from wall for wall applications in these areas. Install exposed wall-mounted conduits tight to wall using one-hole straps for conduits 1-1/4 inches and smaller, and use two-hole straps for conduits 1-1/2 inches and larger.
6. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
7. Do not install aluminum products in contact with, or near proximity to, concrete or earth.
8. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.
9. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter.
10. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
11. Locate all structural elements within concrete prior to pre-drilling anchors. Contractor is responsible for repairing all damage to structural elements resulting from the scope of this work.
12. Provide fittings as needed for a complete installation. Provide locknuts for securing conduit to enclosures with ridged outside circumference for proper fastening. Provide miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings, and plugs that are specifically designed and intended for their particular application.
13. Provide knockout closures to cap unused knockout holes where blanks have been removed.
14. Provide flexible connections or expansion fittings where all conduits cross building expansion joints. Coordinate exact quantity & location with Architectural plans prior to installation of work.
15. Install electrical boxes in those locations that ensure accessibility to enclosed electrical wiring.
16. Do not install boxes back-to-back in walls. Provide not less than 6" (150 mm) separation in general, not less than 16" separation for acoustically rated walls and

- not less than 24" separation for the following applications: fire walls, fire barriers, smoke barrier walls, and fire partitions. Where outlet boxes are shown back-to-back on common walls, offset accordingly when installed.
17. Fire walls, fire barriers, smoke barrier walls and fire partitions: Steel outlet boxes that do not exceed 16 square inches in area may be used in fire walls, fire barriers, smoke barrier walls, and fire partitions only if the total area of such openings does not exceed 100 square inches for any 100 square feet of wall area. Verify with local authorities having jurisdiction prior to commencing with related rough-in work. Provide outlet boxes, equipment back-boxes, etc. in fire walls, fire barriers, smoke barrier walls, and fire partitions that are of the type tested for use in fire-resistance-rated assemblies. Install in accordance with the tested assembly, and with the instructions included in the listing. Install firestopping at penetrations of fire-rated floor and wall assemblies.
  18. Neatly cut openings for boxes so that standard size (not "midway" or "jumbo") cover plates will cover all parts of the opening. Position recessed outlet boxes accurately to allow for surface finish thickness. Do not use round boxes.
  19. Fasten electrical boxes firmly and rigidly to substrates and structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry as applicable. Provide box supports that are independent of conduit. Protect boxes from construction debris and damage subsequent to installation of boxes.
  20. Use of synthetic or plastic "tie-wraps", "zip ties", "wire ties" and similar products are not permitted as a permanent means of anchoring, securing, supporting or otherwise installing any cables, conductors, conduits, raceways, devices, equipment or other electrical work. Do not use perforated straps.
  21. Consider the outlet, junction, and pull box locations indicated on drawings approximate unless there are prevailing codes that require specific spacings or locations. Study the general construction with relation to spaces and equipment surrounding each outlet, and neatly install outlets accordingly.
  22. Install wiring for different power voltages in raceway systems separate from each other. Install wiring for the various electrical systems in raceway systems that are separate from each other.
  23. Provide steel conduit and steel fittings for indoor above-slab applications, as specified in this section.
  24. Provide conduit fittings with insulated throats. Plastic bushings may be used for conduits 2" and larger where insulated throats may not be readily available.
  25. Provide maximum of 40 percent fill for raceways, or a threshold of less if required by NFPA 70 or project conditions.
  26. Keep raceways at least 12 inches away from parallel runs of flues, hot-water pipes, and other sources of heat. Install horizontal raceway runs above liquid and steam piping. Where the lines are not insulated, the clearances shall be increased until the temperature of the conduit, with no live conductors enclosed, does not rise above the ambient temperature of the installation area.
  27. Support risers at each floor level with suitable hangers.
  28. Level and square raceway runs, and install at proper elevations and heights.
  29. Protect coatings, finishes, and cabinets from damage and deterioration. Repair damage to galvanized finishes with zinc-rich paint or coating, color to match

- surface, recommended by manufacturer. Make these repairs prior to products receiving finish coats of paint.
30. Pathway Evacuation and Protection: Cap and plug conduit ends with standard accessories as soon as conduit has been permanently installed. Prior to the installation of cable, clean and vacuum boxes, conduits/raceways, supports, etc. Clean inside of conduit before wiring is pulled. Remove solids or other hindrances that could impede its full utilization or that could damage cable during or after installation. Remove liquid and moisture from the raceways. Blow out until raceway is dry, sufficiently that the installed cables will not be subjected to any contact with fluid or moisture. Seal and protect raceways and boxes from moisture infiltration. Provide watertight fittings. Do not begin installation of conductors and cables until electrical raceways are complete and until installation locations (end to end) are in a weatherproof environment.
  31. Arrange stub-ups so curved portions of bends are not visible above finished grade or slab.
  32. Install no more than the equivalent of three 90-degree bends in any conduit run. Support within 12 inches of changes in direction.
  33. Support conduit within 12 inches of enclosures to which attached. Properly support and anchor raceways for their entire length using structural materials. Do not span any space unsupported.
  34. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
  35. 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. Fasten conduit terminations in sheet metal enclosures with two locknuts. Install locknuts inside and outside enclosure.
  36. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
  37. 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.
  38. 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. Cut conduits straight, properly ream, and cut threads for heavy wall conduit deep and clean. Field-bend conduits with benders designed for purpose so as not to distort, nor vary, internal diameters. Bring joints to a shoulder. Provide suitable supports and fasteners for conduit.
  39. Conceal conduit and tubing within finished walls, ceilings, and floor cavities unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
  40. Install exposed conduits, and extensions from concealed conduit systems, neatly parallel and perpendicular to walls, and plumb on walls. Secure to walls at intervals not exceeding six feet, supported by approved straps and fasteners.

- Secure to overhead structure at intervals not exceeding six feet. Support conduit by approved straps, fasteners and hangers. Provide hangers suspended from rods. Space wall brackets supporting conduits not more than 4 feet 6 inches on center. Install exposed conduit work so there is no interference with ceiling inserts, lights, or ventilation ducts or outlets.
41. 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, using properly selected and attached manufactured cap (tape of any sort is not permissible). Provide finished wall/cover plate on unused outlet boxes.
  42. 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.
  43. Mount boxes at heights indicated on Drawings and elsewhere in Division 26 specifications. 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. In cases where using center of box for measurement would result in a switch-height device having an operable component higher than 48 inches above finished floor, install boxes lower as needed so that uppermost part of operable component is no higher than 48 inches.
  44. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block (do not over-cut), 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.
  45. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel. Coordinate all such separations with Design Professional in advance to ensure boxes are located properly for each application.
  46. Locate boxes so that cover or plate will not span different building finishes.
  47. Support boxes from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
  48. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
  49. Provide properly wired electrical connections within enclosures. Anchor enclosures ensuring that they are level, and permanently and mechanically secure.
  50. Provide conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) for applications as needed to render electrical work fully operational.
  51. Mechanically fasten together metal conduits, enclosures, and raceways to form continuous electrically conducting equipment grounding path. Connect to electrical boxes, fittings and cabinets to provide electrical continuity and firm mechanical assembly. Conduit shall be continuous between outlets to make a complete installation and to provide a continuous ground.

52. Do not use dissimilar metals throughout the systems to eliminate possibility of electrolysis. Where dissimilar metals will be unavoidably in contact, coat surfaces with corrosion inhibiting compound before assembling.
53. Use rough-in dimensions of electrically operated equipment furnished by equipment installer. Install conduit and boxes for connection to equipment only after reviewing respective equipment and clearance dimensions, and after coordinating with other trades.
54. Do not use electrical "handy/handee" boxes.
55. Do not use running threads at conduit joints and terminations - use 3-piece union, or split coupling.
56. Provide joints made tight with water-tight couplings matching conduit. Install offsets with long radius sweep bends, except conduit sizes 1 inch and over where standard elbows may be used.
57. Where moisture conditions within conduits are encountered above grade, drill a hole at the lowest point in the conduit run so that drainage will not interfere with conditions below.
58. Where conduit is capped at wall for future additions, do not extend more than threads-length past wall (maximum of 3/4-inch past wall for EMT).
59. Where conduits for outlets on waterproof walls must be installed exposed, set anchors for supporting conduit on waterproof wall in waterproof cement.
60. Requirements for exposed conduits also apply to conduits installed in space above hung ceilings, and in crawl spaces.
61. Provide a 4-inch reinforced casing of concrete (3000-PSI minimum) around conduits that are installed in cinders or cinder concrete, to protect them.
62. Support raceway components directly from structural building systems, not from ceiling suspensions systems. Provide supplemental supports for junction or pull boxes.
63. Support single conduits 1-1/2 inches and larger by means of rod and ring hangers. Support multiple runs in similar manner or use a common trapeze hanger system.
64. Pinch type hangers similar to Minerallac may only be used at heights greater than 8 feet, and only in unfinished areas where the work could be installed concealed.
65. Protect conduits during construction with temporary plugs or caps. Securely cap conduits until pull string, or cable is installed.
66. Conduit Routing: If specific routing information appears on the Drawings, route and maintain conduits as shown. Should interference or a conflict arise, consult the Design Professional before proceeding with the Work. If specific routing information does not appear on the Drawings, or if routing shown on Drawings is schematic in nature, determine the best route for the conduit in accordance with code and other project guidelines.
67. Conduit bends: Bends shall be made so that the conduit will not be flattened or kinked and so that the internal diameter of the conduit is not reduced. The radius of the curve of the inner edge of any bend shall not be less than indicated by the National Electrical Code and TIA/EIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces. In no case shall any conduit be bent or shall any fabricated elbow be applied to a conduit that will impose less than the minimum allowable bending radius specified by the manufacturer of cable that

will be installed within the conduit. When it is necessary to make field bends, use tools manufactured for conduit bending. Heating of metallic conduit to facilitate bending is not permitted. Constructing an outside entrance to a building from buried conduit to penetrate above the ceiling line will allow an exception for a 4 inches LB fitting at one end to allow placement of the conduit flat to the building outside wall; apply this only if conduit could not be concealed.

68. 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.
69. Install above-ceiling conduits as high as possible, with a minimum of 8 inches above ceiling tiles so as to permit ceiling tile removal.
70. Provide flashing and counter flashing or pitch pockets for waterproofing of raceways, outlets and fittings that must penetrate the roof. Coordinate all related work with roofing installer and provide means and methods based on roofing installers recommendations.
71. Provide sleeves and sleeve seals at penetrations of exterior floor and wall assemblies, at penetrations of abutted perimeter walls for building expansions/additions, and where expansion joints are used at walls. Provide oversized sleeves in forms for new concrete walls, floor slabs, and partitions to allow for the passage of raceways. Provide waterproof sleeved raceways below grade and in areas prone to high moisture and condensation. Provide sleeves in member for conduits passing through structural members.
72. Install each branch of power, including each branch of power backed up via generator, in separate raceways from each other.
73. Do not install conduit horizontally in concrete slabs on grade. Do not install or embed conduits horizontally within any other slabs.
74. Do not install branch circuit conduits beneath slabs on grade, except where specifically indicated otherwise on drawings, or unless special case by case permission is obtained from Owner's Representative in the field.

**B. Stub-ups To Above Accessible Ceilings (TAAC):**

1. Use EMT, IMC, or GRC/RMC for raceways as applicable for respective locations.
2. Provide sweep bends and drag line for each application.
3. Use a conduit bushing or insulated-throat fitting to terminate stub-ups.
4. Extend conduits to joist space above an accessible ceiling system.
5. Permanently identify the purpose of the conduit stub at the end of the conduit above the ceiling.

**C. Pull Boxes and Junction Boxes:**

1. Provide each pull box indicated on the Drawings.
2. Provide additional pull boxes: Every 180 degrees of raceway bend; Every 100 feet of raceway; As additionally required by Code.

3. Provide pull and junction boxes in areas that will be accessible after installation. Accessible areas include spaces above removable tile ceilings and behind access doors that are installed expressly for this purpose. Do not install pull-boxes in locations that will not be accessible after construction is complete and is not accessible after permanently installed work is complete.
  4. Size boxes in accordance with the NFPA 70 (NEC). Use larger boxes where so specified.
  5. Support boxes rigidly. Land conduits on the boxes so that conduits enter and exit across from each other on opposite sides of the box so as to facilitate straight line pulling of cable through the box. Do not use pull boxes in lieu of conduit bends, except as necessary by design or to meet constructability constraints.
  6. When directional transition of the cables is necessary through a box, land conduits on the box so that they permit the largest possible bending radius for those cables that will pass through the box.
  7. Coordinate all work with all other trades prior to commencement of the work. Do not use access doors unless special prior written permission is granted from the Owner's Representative. Install pull boxes, junction boxes, etc. in areas that are accessible after construction. Do not install pull boxes or junction boxes above gypsum board, plaster or similar ceiling systems, nor above ductwork or equipment that renders them inaccessible.
  8. Record junction and pull boxes on record drawings. Permanently mark and label (using methods approved by Owner's Representative) junction/pullboxes as to which types of electrical services are within.
- D. **Repair and Patching:** Holes and other penetrations into building surfaces or structure that are created to facilitate pathway installation but that are not ultimately used shall be filled, repaired, and restored to their original strength, appearance and integrity. Damage to building or property that occurs during the course of pathway installation shall be repaired and restored to its original condition prior to damage. Obtain review and approval of penetration sizes, means and methods from Design Professional and Owner's Representative for all proposed penetrations of structural elements prior to commencing with any related work.
- E. **Cover Plates:** Provide gasketed stainless steel or post-fabrication hot-dipped galvanized steel cover plates over the openings of junction boxes and pull boxes. Provide blank wall plates for unused wall outlet openings, to match style and finish used for active wiring device locations in the same respective area.
- F. **Seals for Common Conduit and Raceways in Dissimilar Environments:** 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: Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces; Where an underground service raceway enters a building or structure; Where otherwise required by NFPA 70.
- G. **Insulation for Common Conduit and Raceways in Dissimilar Environments:** Provide insulation on the exterior of conduit on the warm side of penetrations between



dissimilar environments to prevent condensation from forming. Insulate with 1.5-inch polyisocyanurate closed cell pipe insulation with an overall PVC jacket for a minimum distance of 48" from the penetration. Applications include, but are not limited to, the following: Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces; Where otherwise required by NFPA 70.

- H. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semi-recessed luminaires, for equipment subject to vibration, noise transmission, or movement, and for transformers and motors. Use LFMC in damp or wet locations.
- I. Expansion-Joint Fittings:
  - 1. Provide UL listed and labeled expansion fittings and appropriate couplings in metal raceways wherever structural expansion joints are crossed, wherever deflection is expected, where environmental temperature change may exceed 100 deg F with straight-run lengths that exceeds 100 feet, and as otherwise required to accommodate similar movement. Provide expansion fittings with ground bonding jumpers that are long enough to accommodate respective expansions and movement.
  - 2. Provide expansion fittings with ground bonding jumpers that are long enough to accommodate respective expansions and movement. Install in each run of aboveground EMT, GRC/RMC and IMC conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
  - 3. Install type and quantity of fittings that accommodate temperature changes of 155 deg F.
  - 4. 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.
  - 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.
  - 6. Type LFMC conduit may be used instead of expansion fittings in unfinished areas, using lengths of at least two (2) feet and no more than six (6) feet. Provide bonding jumpers.
  - 7. 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 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.

### **3.3 INSTALLATION OF EXPOSED CONDUIT/RACEWAY SYSTEMS**

- A. General:

1. Review proposed installation materials, methods, routing, etc. case-by-case and area-by-area for each application with the Design Professional and Owner prior to installation. Accordingly, prepare installation drawings and submit to Design Professionals for review and comment. Revise and resubmit as required based on comments from Design Professionals. Coordinate with all trades while preparing the installation drawings. Show elevations and routes relative to adjacent work of all trades.
2. Group conduits together in tight banks when routed in the same direction in a given space. Coordinate with mechanical trades and route the conduit banks along common paths wherever possible, and at common elevations unless the conduit banks can be installed directly above or below the mechanical work. Review proposed routes and elevations with Design Professionals prior to installation.
3. Install conduits that peel off from banks in a manner that results in the conduits being progressively taken off from the sides of the banks, one at a time without crossing over or under other conduits in the bank. Rise and drop conduits at the same elevation in areas with common visibility.
4. Provide clean, tight and uniform bends and offsets for all conduits and conduit banks.
5. Route overhead work perpendicular and parallel to architectural and structural building lines in the respective surrounding space. Do not install work below skylight assemblies or in front of clerestory window assemblies.
6. Provide surface conduit and raceway for wall-mounted applications only where it is impossible to fish or cut/patch, or only where specifically indicated on drawings, or only where specifically directed by Design Professional. Improper sequencing of work at walls shall not be used as a reason to surface-mount conduit, boxes or raceways; install all such work concealed as the walls are constructed. Provide conduit in areas that are exclusively utilitarian, such as dedicated mechanical or electrical rooms. Provide finished surface raceway systems for applications in all other areas. Consult with Design Professionals in advance of any installation for final direction on where to use conduit versus surface raceway systems.
7. Install conduits and raceways in a manner that minimizes detrimental effects on room aesthetics. For instance, as applicable, rise from below for wall switches, general receptacle outlets and communications wall outlets; drop from above for wall mounted lights, and other system outlets that are installed high on wall; make drops near corners, window casings, door casings, etc.).
8. Install conduits and raceways as out-of-site as reasonably possible. For instance if an receptacle outlet needs to be installed at the center of a wall and there is no possibility of feeding from below the floor, route the drop in a corner of the room then transition and run horizontally to the outlet location.
9. Install conduit and raceway with a minimum 2-inch radius control at bend points.
10. Secure conduit and raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight section. Support according to manufacturer's written instructions.
11. Utilize supports for wall-mounted applications that cleanly conform to the shape of the conduit or raceway and do not in any way protrude out past the outer

contours of the conduit or raceway. As an example, install wall-mounted conduit using two-hole straps instead of conduit hangers. Tape, glue, tie-wraps, clips, wedges, etc. are not acceptable support methods.

12. Review all proposed mounting means and methods with Design Professionals for luminaires, devices, outlets, equipment, etc. that will be suspended overhead.
13. Do not use “trapeze” mounting methods for suspensions unless case-by-case permission is granted by Design Professionals.

### **3.4 INSTALLATION OF EXPOSED CONDUIT OUTDOORS**

- A. Only install conduit exposed outdoors when it is impossible to do otherwise, or only if specifically indicated for such installation case-by-case elsewhere in documents. Installation convenience, financial considerations, lack of coordination with other trades and similar rationale are not sufficient reasons for doing so. In cases where conduits must be installed at outdoor locations, de-rate conductors and modify conduit sizes per NFPA 70 (National Electrical Code, NEC). Provide expansion fittings, which are Listed and labeled for the respective applications, at all building expansion joints and at maximum distances of 100 feet. Paint all such conduits with at least two coats of UV-resistant weatherproof paint. Provide colors to match respective surrounding surfaces; submit colors to Design Professional for review in advance of procuring paint.

### **3.5 INSTALLATION OF EXPOSED CONDUIT ON ROOFS**

- A. Only install conduit exposed on rooftops when it is impossible to do otherwise, or only if specifically indicated for such installation case-by-case elsewhere in documents. Installation convenience, financial considerations, lack of coordination with other trades and similar rationale are not sufficient reasons for doing so. In cases where conduits must be installed on rooftops, de-rate conductors and modify conduit sizes per NFPA 70 (National Electrical Code, NEC). Provide expansion fittings, which are Listed and labeled for the respective applications, at all building expansion joints and at maximum distances of 100 feet. Paint all such conduits with at least two coats of UV-resistant weatherproof paint. Provide white paint on flat rooftops that have finishes white in color, and for otherwise-colored roof finishes that are not visible from the building interior or from the ground outdoors. Elsewhere select colors to match surrounding surfaces; submit colors to Design Professional for review in advance of procuring paint.

### **3.6 INSTALLATION OF UNDERGROUND CONDUIT**

- A. Direct-Buried Conduit:
  1. Coordinate trench locations in reference to other underground utilities. Ensure no other utilities are placed directly above or below, when parallel to conduits.
  2. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
  3. Excavate trench bottom to provide firm and uniform support for conduit. Also see details and/or notes on drawings for additional trench-related information and for applications where concrete (or other) encasement is required.

4. 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.
5. Install manufactured RNC duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Provide GRC/RMC for risers, beginning below grade or slab and excluding the 90 degree fittings that connect to horizontal conduits below grade or slab, to above grade and slab except where terminating at utility poles, in utility pad-mounted transformer enclosures and cable pits, and in utility company pedestals. Couple GRC/RMC conduits to RNC ducts with adapters designed for this purpose.
6. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."
7. Provide underground conduits at minimum of 24" below grade, slab or pavement as applicable (deeper where required by local utility company or prevailing codes and regulations), securely mounted on chairs when banked, with base in newly disturbed earth. Properly align ducts on chairs before backfilling. Provide heavy nylon pull-cord/drag-line (200 pound minimum strength) in empty conduits. Do not embed in slabs or pavement. Do not "scratch-in" just below slab or pavement.
8. Make changes in direction of raceway run with proper fittings that match raceway manufacturer.
9. Properly support and anchor raceways for their entire length with factory bases and intermediate spacers. Provide spacers at each coupling location, at each termination location, and at maximum five foot intervals between. Do not span any space unsupported. Provide end bells with rounded pulling surfaces at manholes, pull boxes and other end points of underground raceways.
10. Apply corrosion inhibiting compound before couplings are assembled for applications where metallic raceways are installed underground, in floors below grade, or outside. Draw up couplings and conduits sufficiently tight to ensure water-tightness. Provide steel rigid metallic conduit for applications where metallic conduits are installed below grade or slab.
11. Extend underground conduits that are capped at wall for future additions five feet beyond building.
12. Arrange excavation for exterior conduits so that:
  - a. The lines are straight and true
  - b. Grades required for drainage are maintained
  - c. The tops of buried raceways are not less than 24" below finished grade
13. Seal PVC joints with product equivalent to Carlon Cement. Make solvent cemented joints in accordance with recommendations of manufacturer.
14. Install work in accordance with NFPA 70 and in compliance with local utility practices.

15. Provide full parity size green insulated ground wire in PVC runs, except for those used exclusively for optical fiber cables.
16. Do not field bend raceway sections, unless required radius exceeds that available from manufacturer. Where field bends cannot be avoided, use factory kit to perform the bends and follow factory instructions.
17. Encasement: See details and/or notes on drawings for applications where encasement is required.
18. Pressure or vacuum test below-grade conduits before and after concealing the conduits to ensure resistance to moisture ingress.

### **3.7 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. 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. Install so cover surfaces will be flush with finished grade or pavement as applicable. Install service/feeder scale handholes with bottom below frost line below grade. Field-cut openings for conduits in closed-bottom units and in walls of units according to enclosure manufacturer's written instructions. Cut 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.

**END OF SECTION 260533**