

SECTION 33 72 33.33 – RACEWAY AND BOXES FOR UTILITY SUBSTATIONS

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes furnishing and installing of all conduit, fittings, boxes, and accessories as specified or indicated.
- B. Related Work Specified Elsewhere:
 - 1. Section 13 34 23 23 - Fabricated Substation Control Enclosures
 - 2. Section 23 75 00 – Substation Enclosure HVAC Equipment
 - 3. Section 26 24 16 – Panelboards
 - 4. Section 26 51 23 - Substation Interior Lighting and Receptacles
 - 5. Section 26 36 00 – Power Switching and Control Devices
 - 6. Section 33 72 43 11 - Substation Wire, Cable and Accessories
 - 7. Section 33 72 33 36 – Cable Tray and Wireway for Utility Substations
 - 8. Section 33 72 33 16 - Relay Switchboards

1.02 REFERENCE STANDARDS:

- A. Applicable Standards (conform to all standards applicable to each item utilized) shall be latest revisions, supplements, and amendments to the following:
 - 1. American Society for Testing and Materials (ASTM):
 - a. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - b. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - c. A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
 - d. A668 - Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.
 - e. A1008 - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable .
 - f. B241 - Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.

SECTION 33 72 33.33 –RACEWAY AND BOXES FOR UTILITY SUBSTATIONS: continued

- g. F512 - Standard Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation.
- 2. Federal Specifications:
 - a. WW-C-540A - Conduit, Metal, Rigid, (Electrical, Aluminum).
 - b. WW-C-566C - Conduit, Metal, Flexible.
- 3. National Electrical Manufacturers Association (NEMA):
 - a. C80.1 - Electrical Rigid Steel Conduit (ERSC).
 - b. C80.3 - Steel Electrical Metallic Tubing (EMT).
 - c. C80.5 - Electrical Rigid Aluminum Conduit (ERAC)
 - d. FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit Electrical Metallic Tubing, and Cable .
 - e. RN 1 - Polyvinyl-Chloride(PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - a. TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit .
 - b. TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
 - c. TC 6 – Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation.
 - d. TC 9 - Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation.
- 4. National Fire Protection Association (NFPA):
 - a. 70 - National Electrical Code (NEC).
- 5. Underwriters Laboratory (UL):
 - a. 1- Standard Flexible Metal Conduit.
 - b. 6 – Electrical Rigid Metal Conduit - .
 - c. 360 - Standard for Liquid-Tight Flexible Metal Conduit.
 - d. 467 - Grounding and Bonding Equipment.
 - e. 514A - Metallic Outlet Boxes.
 - f. 514B – Conduit, Tubing, and Cable Fittings.
 - g. 514C – Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
 - h. 651 - Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
 - i. 651A - Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit.

SECTION 33 72 33.33 - RACEWAY AND BOXES FOR UTILITY SUBSTATIONS: continued

- j. 797 - Electrical Metallic Tubing - Steel.

1.03 SUBMITTALS:

- A. Submittals shall include, but are not limited to, the following:
 - 1. Product Data:
 - a. Submit manufacturer's catalog cuts, technical product data, including specifications and installation instructions, for each type of product required. Include data substantiating that materials comply with requirements.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Subject to compliance with requirements, provide each type of conduit, fittings, boxes, supports, paints and coatings from one of the following:
 - 1. Rigid Steel Conduit (Type RSC):
 - a. Allied Tube and Conduit Corporation.
 - b. Triangle Wire & Cable Inc.
 - c. Wheatland Tube Company.
 - 2. Rigid Steel Conduit with Bonded Polyvinyl Chloride (PVC) Jacket (Type PSC):
 - a. Occidental Coating Company.
 - b. Perma-Cote Industries.
 - c. Plasti Bond
 - 3. Electrical Metallic Tubing (Type EMT):
 - a. Allied Tube and Conduit Corporation.
 - b. Triangle Wire and Cable, Inc.
 - c. Wheatland Tube Company.
 - 4. Rigid Nonmetallic Conduit (Type RNC):
 - a. Carlon Division, Lamson & Session Company.
 - b. CertainTeed Corp.
 - c. Condux International, Inc.
 - 5. Flexible Steel Conduit (Type FSC):
 - a. Alflex Corp (Southwire).
 - b. Anamet, Inc., Anaconda Metal Hose.
 - c. Electri-flex Company.
 - 6. Conduit Fittings for Rigid Metallic Conduit:

SECTION 33 72 33.33 –RACEWAY AND BOXES FOR UTILITY SUBSTATIONS: continued

- a. Heavy-Duty Fittings:
 - (1) Appleton Electric Company (Emerson Industrial Automation).
 - (2) Crouse-Hinds Company (Cooper).
 - (3) O-Z/Gedney Company (Emerson Industrial Automation).
 - b. Conduit Expansion Fittings:
 - (1) O-Z/Gedney Company (Emerson Industrial Automation).
 - 7. Conduit Boxes for Rigid Metallic Conduit:
 - a. Hoffman Engineering Company.
 - 8. Supports:
 - a. B-Line Systems, Inc.
 - b. GS Metals Corporation.
 - c. Power-Strut Division, Allied Tube and Conduit Corporation.
 - d. Unistrut Corporation.
 - 9. Conduit Identification Tags: KC Plastic Laminating Company, Kansas City, Missouri.
 - 10. Fireproof Coatings:
 - a. Carboline Company - Intumastic 285.
 - b. Flamemaster Corporation - Flamaster 77.
 - 11. Penetration Sealers:
 - a. 3M Corporation - Fire Stop Foam 2001.
 - b. Fireproof coatings listed above when applied as specified.
 - 12. Damming Materials:
 - a. Boards: Thermal Ceramics - Firemaster Board.
 - b. Fiber: Thermal Ceramics - Firemaster Blanket or Fiber.
 - 13. Paint and Coatings:
 - a. Supports:
 - (1) Rust-Oleum.
 - b. Rigid Steel Conduit:
 - (1) Kop-Coat, Carboline Company.
- 2.02 DESIGN REQUIREMENTS (TYPICAL FOR ALL TYPES):
- A. Each length of conduit furnished with coupling on one end and metal or plastic thread protector on other end.
 - B. UL listed and labeled on each conduit length, fitting, and accessory.

SECTION 33 72 33.33 - RACEWAY AND BOXES FOR UTILITY SUBSTATIONS: continued

- C. Sizes of conduit, fittings, and accessories as indicated by construction documents or required by applicable standards.
- D. The CONTRACTOR shall furnish equipment and materials meeting the specified ratings and performance at the altitude and ambient temperatures specified.

2.03 RIGID STEEL CONDUIT (TYPE RSC):

- A. Mild ductile steel, circular in cross section with uniform wall thickness sufficiently accurate to cut clean threads.
- B. Each length threaded on both ends.
- C. All scale, grease, dirt, burrs, and other foreign matter removed from inside and outside prior to application of coating materials.
- D. Galvanized using the hot-dip process.

2.04 RIGID STEEL CONDUIT WITH BONDED POLYVINYL CHLORIDE (PVC) JACKET (TYPE PSC):

- A. Hot-dipped galvanized rigid steel conduit as specified in RIGID STEEL CONDUIT, this Section.
- B. Prior to application of PVC coating, clean interior and exterior surfaces to remove contaminants and treat with chromic acid to provide a suitable surface for bonding.
- C. Adhesive:
 - 1. Heat-polymerized, epoxy-acrylic.
 - 2. Approximately 0.5-mil thickness.
 - 3. To cure, heat the conduit.
- D. Coated externally except for pre-threaded ends with PVC to a nominal 40 mils, 0.035-inch to 0.045-inch.
- E. Uniformly coat around outside diameter and full length of the conduit.
- F. Coating bonded to surface of conduit with adhesion greater than the cohesive strength of the coating.
- G. Each coupling and fitting to include a sleeve that overlaps the conduit.
- H. Length of the overlapping sleeve equals diameter of the conduit or 2 inches, whichever is less.

2.05 ELECTRICAL METALLIC TUBING (TYPE EMT):

- A. High-grade steel manufactured to standards which assure maximum ductility.
- B. Exterior protected by electro-galvanizing process.

SECTION 33 72 33.33 –RACEWAY AND BOXES FOR UTILITY SUBSTATIONS: continued

- C. Interior surface uniformly coated with aluminum lacquer or enamel.
- D. Final treatment of chromic acid to form a corrosion resistant coating of zinc chromate on galvanized surfaces.
- E. Watertight compression-type fittings throughout.

2.06 RIGID NONMETALLIC CONDUIT (TYPE RNC):

- A. Fabricated from self-extinguishing high-impact polyvinyl chloride designed for aboveground and underground installations.
- B. Fittings and accessories fabricated from same material as conduit.
- C. Solvent-cement-type joints as recommended by manufacturer.
- D. Inside diameter no less than that of rigid steel conduit.
- E. Dielectric strength a minimum of 400 volts per mil.
- F. Rated and labeled for use with 90-degree C rated conductors.
- G. Schedule 40 PVC conduit required for direct burial applications.
- H. Type A PVC thin wall conduit may be used in concrete encased applications only. Type EB conduit will not be acceptable.

2.07 FLEXIBLE STEEL CONDUIT (TYPE FSC):

- A. Liquid-tight conduit with flexible galvanized-steel core and a polyvinyl chloride covering.
- B. Spiral encased copper bonding conductors for conduit in sizes 1-1/4 inches and smaller.
- C. Special grade polyvinyl chloride (PVC) jacket, suitable for use in -50 degrees F through 220 degrees F areas.
- D. Special grade polyvinyl chloride (PVC) jacket, suitable for oil-resistant applications.

2.08 CONDUIT FITTINGS FOR RIGID METALLIC CONDUIT:

- A. Heavy-duty cast malleable iron or aluminum for All types of fittings.
- B. Mogul type for conduit sizes 1-1/2 inches and larger.
- C. LBD or roller action type LB for right angle fittings for conduit sizes 2 inches and larger.
- D. Full-threaded hubs and rubber-gasketed covers.
- E. Zinc, cadmium-plated, or bronze hardware, bolts, screws, and bushings for assembly.
- F. Iron fittings to be cadmium plated or galvanized.
- G. Standard and junction fittings.
- H. Couplings and elbows fabricated from the same material as conduit and each treated as required for the conduit.

SECTION 33 72 33.33 - RACEWAY AND BOXES FOR UTILITY SUBSTATIONS: continued

2.09 CONDUIT BOXES FOR RIGID METALLIC CONDUIT:

- A. Steel Boxes:
 - 1. Electro-galvanized steel boxes.
 - 2. Galvanized steel covers.
 - 3. Cadmium-plated or bronze screws and bolts.
- B. Minimum gauge requirements:

<u>No Surface Area Exceeds</u>	<u>No Single Dimension Exceeds</u>	<u>Steel (MSG)</u>
360 sq in	24 in	16
1,000 sq in	40 in	14
1,500 sq in	60 in	12
over 1,500 sq in	over 60 in	10

- C. Threaded conduit entrances or waterproof hubs outdoors and in other areas subject to moisture.
- D. Include provisions for mounting cable supports where indicated in contract documents or as required by NEC.

2.10 SUPPORT SYSTEM:

- A. Use galvanized steel conduit clamps to support all exposed metallic conduit.
- B. Use nonmagnetic clamps to support nonmetallic conduits.
- C. Fabricated from structural steel or manufactured framing members equal to "Unistrut" P-3000 series as manufactured by Unistrut Corporation unless otherwise indicated.
- D. Provide all necessary rods, anchors, inserts, clamps, spacers, shims, bolts and miscellaneous steel.
- E. Galvanized or cadmium-plated members.
- F. Where exposed to weather or high humidity, use noncorrodible, galvanized or cadmium-plated metal for nuts, bolts, washers, shims, and other small accessories.

2.11 CONDUIT IDENTIFICATION TAGS:

- A. Gothic, 3/4-inch, black characters on white background.
- B. Made of white flame-retardant PVC, with "Perma-stik" adhesive and peel-off backing.

SECTION 33 72 33.33 –RACEWAY AND BOXES FOR UTILITY SUBSTATIONS: continued

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS:

- A. Location:
 - 1. Install conduit as near as possible to the routing indicated on contract drawings. Owner's Representative shall be notified of any deviations from indicated routing.
 - 2. Shift locations as required to avoid interference with other equipment. Coordinate relocation with other work in area.
 - 3. Where routing of conduit is not indicated, such as for lighting, home run circuits and other systems requiring small conduit runs, route conduit as specified subject to approval by Owner's Representative.
- B. Furnish conduit in sizes indicated on contract drawings. Where sizes are not indicated, minimum conduit size shall be 3/4-inch.
- C. Size conduit in accordance with NEC requirements. Where larger sizes are indicated in contract documents, the contract documents shall prevail.
- D. No conduits shall be routed through cable tray or cable trench openings located in walls, floors, etc.
- E. Seal around wire and cable and empty conduits in all equipment terminal cabinets and all conduits routed through floors, walls and ceilings of control buildings with duct and conduit sealer.
- F. Make connections including any required punching to boxes, panels and other equipment as follows:
 - 1. Indoors: Double locknuts, one inside and one outside.
 - 2. Outdoors: Use threaded conduit fittings or waterproof hubs.
- G. Drill and tap motor main and auxiliary terminal boxes as required, and make connections as follows:
 - 1. Indoors: Double locknuts, one inside and one outside.
 - 2. Outdoors: Use threaded conduit fittings or waterproof hubs.
- H. Make connections to cable trays as follows:
 - 1. Attach to tray with cable tray conduit clamps specifically designed for this application.
 - 2. Attach to top of tray where tray covers are not required and to bottom of tray where covers are required.
 - 3. Do not cut or punch tray side rails to install conduit.

SECTION 33 72 33.33 - RACEWAY AND BOXES FOR UTILITY SUBSTATIONS: continued

- I. Terminate all conduit runs with insulated bushings.
- J. Running threads will not be permitted.
- K. Coat all field cut threads, scars, or wrench abrasions in galvanized conduit with one coat of zinc-rich coating at 3 mils dry:
 - 1. Carboline Carbozinc 658.
 - 2. Keeler & Long KL4400
 - 3. Tnemec 90-97.
- L. Do not exceed the following number of bends between cable pulling points:

<u>Max. Length of Run in Feet</u>	<u>Max. No. of 90-Degree Bends</u>
0-49	4
50-99	3
100-149	2
150-199	1

- M. Place drainage fittings or weep holes (for boxes only) at low points where moisture can collect, except in hazardous areas.
- N. Metallic conduit systems shall be electrically continuous in their entirety, with bonding jumpers provided as required by NEC.
- O. Provide suitable protection for conduit risers against damage during construction.
- P. Test conduits (witnessed by the Owner's representative) required to be installed but left empty with ball mandrel. Clear any conduit which rejects ball mandrel. Pay costs involved for restoration of conduit and surrounding surfaces to original condition. Provide 200-pound tensile strength nylon conduit fish line throughout the entire length of all empty conduits. Leave 12 inches of slack at each end.
- Q. Carefully ream ends of all conduit lengths after cutting to eliminate sharp burrs.
- R. Clean inside of all conduit before pulling wire.
- S. In finished rooms, install conduit concealed in walls, floors and above suspended ceilings (or in ceiling slab where suspended ceiling is not specified).

3.02 EXPOSED INSTALLATION:

SECTION 33 72 33.33 –RACEWAY AND BOXES FOR UTILITY SUBSTATIONS: continued

- A. Install in building interior spaces where specified or indicated in contract documents.
- B. Install above grade outdoors.
- C. Install horizontal runs as high above floor as possible, and in no case lower than seven feet above floor, walkway, or platform in passage area.
- D. Run conduit parallel or perpendicular to walls, ceilings, beams and columns unless indicated otherwise.
- E. Route to clear all doors, windows, access wells and openings.
- F. Group parallel runs in neatly aligned banks where possible with minimum of one-inch clearance between conduits.
- G. Maintain six-inch clearance between conduit and coverings on all hot lines; steam, hot water, etc.
- H. Do not exceed a distance of eight feet between supports on horizontal or vertical runs.

3.03 CAST-IN-CONCRETE INSTALLATION:

- A. Install where specified or indicated in contract documents.
- B. Do not install conduit in concrete when conduit diameter exceeds one-third of concrete thickness.
- C. Install parallel runs with a minimum spacing of three conduit diameters between conduits.
- D. Install in floor slabs maintaining a route as straight as possible.
- E. Use long radius elbows except on risers where curved portion of elbow would extend above the finished floor or foundation.
- F. Make all joints watertight after installation by coating all finished joints with Kop-Coat Bitumastic No. 50 or equivalent waterproof paint.
- G. Tie securely in place to prevent movement when concrete is poured.
- H. Cap ends of all conduit before concrete is poured.
- I. Slope finished floor away from conduit risers.
- J. Clean out all conduits immediately after concrete work is finished.

3.04 RIGID STEEL CONDUIT (TYPE RSC):

- A. Install as specified or indicated in contract documents.
- B. Permitted for exposed, concealed, and cast-in-concrete applications.
- C. Permitted for buried applications if encased with a minimum of 3 inches of concrete.
- D. Use anti-seize compound on conduit threads.

SECTION 33 72 33.33 - RACEWAY AND BOXES FOR UTILITY SUBSTATIONS: continued

- E. Use bender per manufacturer's instructions.

3.05 RIGID STEEL CONDUIT (ELBOWS) WITH BONDED POLYVINYL CHLORIDE (PVC) JACKET (TYPE PSC):

- A. Install as indicated in contract documents.
- B. Permitted for buried application.
- C. Tighten conduit with strap wrench and repair any damaged coating with a liquid patching compound as recommended by manufacturer.

3.06 ELECTRICAL METALLIC TUBING (TYPE EMT):

- A. Install as specified or indicated in contract documents.
- B. Permitted for exposed, concealed, and cast-in-concrete applications with the following restrictions:
 - 1. Use only for lighting and convenience power circuits.
 - 2. For exposed applications use indoors only and only where protected by flanges of columns, beams, or other protective structures.
 - 3. Install concealed in walls, floors, and above suspended ceilings where possible.
 - 4. Do not use where conduit passes through floors or to support light fixtures.
 - 5. Do not install in hazardous locations.

3.07 RIGID NONMETALLIC CONDUIT (TYPE RNC):

- A. Permitted for cast-in-concrete and buried applications. Bury conduits at least 24 inches below finish grade unless indicated otherwise.
- B. Make all joints watertight with cement compound furnished by conduit manufacturer.
- C. Slope conduits away from conduit risers where possible.
- D. Maintain six-inch separation from underground piping.
- E. After trench bottom has been finished to grade, lay conduit, then carefully backfill trench in layers of four to eight inches of dry unfrozen material, and tamp each layer with a power tamp.

3.08 FLEXIBLE STEEL CONDUIT (TYPE FSC):

- A. Install as specified or indicated.
- B. Permitted for exposed and concealed applications.
- C. Do not install underground or cast-in-concrete.

SECTION 33 72 33.33 –RACEWAY AND BOXES FOR UTILITY SUBSTATIONS: continued

- D. Install at all points of connection to equipment mounted on supports to allow for expansion and contraction.
- E. Install at locations where rigid conduit connections are impractical.
- F. Maximum length shall be six feet.
- G. Install an external bonding jumper to conform to NEC on conduit sized 1-1/2 inches and larger.
- H. Use for conduit expansion joints where practical.

3.09 CONDUIT FITTINGS: Install as specified, indicated, or necessary.

3.10 BOXES:

- A. Install boxes as specified, indicated, or as required by NEC.
- B. Provide with 1/4-inch drain holes where installed at indoor termination of duct banks or outdoor conduit run.
- C. Indoors, conform to NEMA Type 1 enclosure in all nonhazardous locations.
- D. Outdoors, conform to NEMA Type 3R except in manholes and handholes NEMA Type 4.

3.11 SUPPORTS:

- A. Construct with sufficient rigidity to hold all mounted equipment and material in permanent and neat alignment.
- B. Design to provide 1/4-inch space between equipment housings and walls or columns upon which they are mounted.
- C. Do not exceed load requirements in NEC and NEMA standards.
- D. Paint all field cuts or welding of supports with one coat of zinc-rich coating at 3 mils dry:
 - 1. Carboline 658.
 - 2. Keeler & Long KL4400.
 - 3. Tnemec 90-97.
- E. Use electrogalvanized steel conduit clamps and nonmagnetic conduit clamps to support electrogalvanized steel conduit and nonmagnetic conduit respectively.

3.12 CONDUIT IDENTIFICATION TAGS:

- A. Install on all scheduled conduit at time of installation.
- B. Clean the conduit surface and install a tag at each conduit termination in such a manner that the tag is readable from the floor, platform, or other vantage point.

SECTION 33 72 33.33 - RACEWAY AND BOXES FOR UTILITY SUBSTATIONS: continued

- C. Provide temporary conduit identification until the permanent conduit identification can be installed. An acceptable method is the use of a broad-tipped permanent ink marker.

3.13 HOME RUNS: Where routing of conduit is not indicated, such as for lighting, convenience power, and other systems, field route conduit as specified in this Section.

END OF SECTION 33 72 33.33