

SECTION 16111

CONDUIT, FITTINGS AND ACCESSORIES

PART 1 - GENERAL

1.1 Description: This Section includes all conduit, fittings and accessories.

1.2 References

1. American National Standards Institute (ANSI)

ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated.

2. American Society For Testing and Materials (ASTM)

ASTM A123 - Zinc (Hot Galvanized) Coating on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars and Strips.

ASTM A153 - Zinc Coating (Hot Dip) on Iron and Steel Hardware.

3. National Electrical Code (NEC)

4. National Electrical Manufacturers Association (NEMA)

FB1 - Fittings and Supports for Conduit and Cable Assemblies.

RN1 - Polyvinyl-Chloride Externally Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing.

5. Underwriters' Laboratories, Inc. (UL)

1 - Flexible Metal Electric Conduit.

6 - Rigid Metal Electrical Conduit.

263 - Fire Tests of Building Construction and Materials.

360 - Liquid tight Flexible Steel Conduit

514A - Metallic Outlet Boxes, Electrical.

514B - Fittings for conduit and Outlet Boxes.

514C - Nonmetallic Outlet Boxes, Flush Device Boxes and Covers.

6. Steel Structures Painting Council (SSPC)

SP3 - Power Tool Cleaning.

SP11 - Power Tool Cleaning to Bare Metal.

- 7.** All electrical and control equipment and material shall bear the recognized Underwriters Laboratories, Inc. (UL) seal of approval. It is Vendor's responsibility to obtain local inspection approval for all non-UL labeled equipment and pay all fees in connection with the same.

1.3 Submittals

- . Submit as specified in SECTION 1330.

PART 2 - MATERIALS

2.1 Acceptable Manufacturers

A. Rigid Steel Conduit

1. Allied Tube and Conduit Corporation.
2. LTV Steel.

B. Rigid Steel Conduit with Bonded Polyvinyl Chloride (PVC) Jacket

1. OCAL Inc.
2. Robroy Industries.
3. Perma-Cote Industries.

C. Liquid-tight: Flexible Metal Conduit:

1. Anamet, Inc.

2. Electri-Flex Company.

D. Rigid Polyvinyl Chloride (PVC) Conduit

1. Kraloy Plastic Pipe Company.
2. Certain-Teed Products Corporation.
3. Caron Products Division, Continental Oil Company.

E. Rigid Steel Conduit Fittings

1. Heavy-duty Cast Malleable Iron Fittings

- a. Appleton Electric Company.
- b. Crouse Hinds Company.

2. Conduit Expansion and Deflection Fittings

- a. O-Z /Gedney Company.

F. Rigid Steel Conduit Boxes

1. Indoor and Outdoor Boxes

- a. Hoffman Engineering Company of Anoka, Minnesota.

2. Conduit Hubs

- a. Appleton Electric Company.
- b. Myers Industries, Inc. (ITT).
- c. Crouse-Hinds Company.
- d. O-Z /Gedney Company.

G. Supports

1. B-Line Company.
2. Midland-Ross Corporation.

3. Unistrut Products Corporation.
4. U.S. Gypsum Company.
5. Van-Huffel Tube Corporation.

H. Wall Entrance Seals

1. O-Z/Gedney Company.

I. Explosion-proof Fittings

1. Crouse-Hinds Company
2. Appleton Electric Company

J. Fire-stopping Materials

1. 3M, (Minnesota Mining and Manufacturing Company)
2. Thomas and Betts
3. Hilti
4. Dow Corning

K. Duct Seal

1. Ideal Industries
2. 3M, (Minnesota Mining and Manufacturing Company)

2.2 Design Requirements

- A.** Each length of threaded conduit furnished with coupling on one end and metal or plastic thread protector on other end.
- B.** UL listed and labeled conduit, on each length, fittings and accessories.
- C.** Sizes of conduit, fittings and accessories as indicated, specified or as required by Electrical Codes and Standards.
- D.** Provide and meet the requirements of the following sections for the conduit, fittings and accessories indicated.

2.3 Rigid Steel Conduit

- A.** Conform to ANSI C80.1 and UL-6.
- B.** Mild ductile steel, circular in cross section with uniform wall thickness sufficiently accurate to cut clean threads.
- C.** Each length threaded on both ends with threads protected.
- D.** All scale, grease, dirt, burrs and other foreign matter removed from inside and outside prior to application of coating materials.
- E.** Galvanized by the hot-dip process as follows:
 - 1.** Interior and exterior surfaces coated with a solid, unbroken layer of 99% virgin zinc by dipping.
 - 2.** Coating not to show fixed deposits of copper after four 1-minute immersions in a standard copper sulfate solution.
 - 3.** One coat of zinc chromate finish on inside and outside surfaces to prevent oxidation and white rust.
- F.** Couplings and elbows fabricated, coated and finished by the same process as conduit.

2.4 Rigid Steel Conduit and Fittings with Bonded Polyvinyl Chloride (PVC) Jacket

- A.** Conform to hot-dipped galvanized rigid steel conduit as specified in NEMA-RN1, RIGID STEEL CONDUIT, this Section, and as follows.
- B.** Prior to application of PVC coating, clean interior and exterior surfaces to remove contaminants to provide a suitable surface for bonding.
- C.** Bond the PVC coating to the conduit. Extruded PVC jackets are unacceptable.
- D.** Coated externally 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. Coat the prethreaded ends with a urethane coating having a nominal thickness of 2 mils (0.002-inch).
- G. Coat the interior surfaces of all conduits and feed-through fittings (except where prohibited by design) with a two-part, chemically cured, urethane coating having a nominal thickness of 2 mils (0.002-inch).
- H. Exceed the tensile strength of coating with bond between metal and jacket.
- I. Couplings, elbows, and other conduit fittings, boxes, cover-plates, supports, hardware and related items shall be treated and coated with the same process as conduit.
- J. Each coupling and fitting shall include a PVC sleeve that overlaps the conduit.
- K. Length of the overlapping sleeve equals diameter of the conduit or 2 inches, whichever is least.
- L. Final cured PVC coating capable of withstanding a minimum electrical potential of 2000V.
- M. All conduit accessories, clamps, and hardware that are uncoated shall be stainless steel.

2.5 Liquid-Tight Flexible Metal Conduit

- A. Conform to UL-360.
- B. Liquid-tight conduit with flexible galvanized-steel core and a synthetic rubber, polyvinyl chloride, or thermoplastic covering.
- C. Spiral encased copper bonding conductors for conduit in sizes 1-1/4 inches and smaller.
- D. External grounding jumper as required.
- E. Polyvinyl chloride (PVC) jacket, Type HA or Type O.R. "Seal-Tite" for oil-resistant applications.

2.6 Rigid Polyvinyl Chloride (PVC) Conduit

- A. Fabricated from self-extinguishing high-impact polyvinyl chloride designed for aboveground and underground installations.
- B. Type EPC Schedule 80 heavy-wall rigid conduit.
- C. Fittings and accessories fabricated from same materials as conduit.
- D. Solvent-cement-type joints as recommended by manufacturer.

2.7 Rigid Steel Fittings

A. Heavy-Duty Cast Malleable Iron Fittings

- 1. Mogul type for conduit sizes 1-1/2 inches and larger.
- 2. LBD or roller action type LB for right angle fittings for conduit sizes 2 inches and larger.
- 3. Full-threaded hubs and rubber-gasketed covers.
- 4. Zinc, cadmium-plated or bronze hardware bolts and screws for assembly.
- 5. Finish with cadmium-plated or galvanizing.
- 6. Standard and junction fittings.

B. Conduit Expansion Fittings

1. Line of Conduit Type

- a. Galvanized expansion fittings for rigid conduit movement up to 4 inches.
- b. Insulated metal bushing on ends of the conduit, bonding jumper, and with expansion head sealed with a high-grade graphite packing.
- c. O-Z/Gedney Company, Type AX with Type AJ bonding jumper or Thomas and Betts Corporation, Type XJG.

2. End Type

- a. For conduit terminating in a junction box.

- b. O-Z/Gedney Company, Type EXE with Type BJ-E bonding jumper.

C. Conduit Expansion and Deflection Fittings

1. Provide for movement of 3/4-inch from normal in all directions between two rigid conduits.
2. Integral bonding jumper.
3. O-Z/Gedney Company, Type DX.

D. Conduit Wall Entrance Seals

1. Provide where required or indicated.
2. O-Z/Gedney Company Type FSK.

- E.** Conform to NEMA Type 3R enclosure in all nonhazardous areas except as specified or indicated otherwise.

2.8 Fittings, Couplings and Boxes for Rigid Steel Conduit

A. Fittings

1. Explosion-proof or weather-proof as specified.
2. Cast malleable iron.
3. Threaded cover to conform to NEC.
4. Full thread hubs.
5. Seal compound well for seal.
6. Drain seals as indicated or required to provide a continuous automatic drain of water.
7. Chico compound for all sealing fittings.
8. PVC jacketed in corrosive areas and where indicated.

B. Couplings

1. Explosion-proof or weather-proof as specified.
2. Flexible.
3. Conform to NEC.
4. Threaded, steel or bronze end fittings securely fastened to the core and braided to ensure electrical continuity.
5. Vinyl plastic coating in severely corrosive locations as indicated.

2.9 Rigid Steel Conduit Boxes

A. Indoor Boxes

1. Hot-dipped galvanized steel.
2. Galvanized steel covers.
2. For special boxes where it is not possible to provide hot-dip galvanizing, apply organic zinc-rich primer at 3 mils dry film thickness after SSPC-SP3 Power Tool Cleaning.
3. Minimum gage requirements:

No surface area exceeds	No single dimension exceeds	Steel Gage
1000 sq in.	40 in.	14
1500 sq in.	60 in.	12
over 1500 sq in.	over 60 in.	10

4. Explosion-proof or weather-proof as specified.
5. Threaded conduit entrances or rigid conduit hubs on all boxes.
6. Include piano-hinged, gasketed cover, and interior mounting panel when used for enclosing terminal blocks and control relays.

9. Oiltight JIC boxes modified for NEMA Type 3R or Type 4 enclosure for non-explosion-proof areas.

B. Outdoor Boxes

1. 11-gauge minimum galvanized steel with drip lip and galvanized-steel covers fastened with bronze or cadmium-plated screws or bolts, or cast iron with galvanized finish and flanged bolted covers.
2. For special boxes where it is not possible to provide hot-dip galvanizing, apply organic zinc-rich primer at 3 mils dry film thickness after SSPC-SP3 Power Tool Cleaning.
3. Threaded conduit entrances or rigid conduit hubs on all boxes.
4. Rubber or neoprene gasket for cover.
5. Explosion-proof or weather-proof as specified. Conform to NEMA Type 3R enclosure for non-explosion-proof applications in all outdoor installations unless indicated otherwise.
6. Include piano-hinged, gasketed cover, and interior mounting panel when used for enclosing terminal blocks and control relays.
7. Oiltight JIC boxes modified for NEMA Type 3R or Type 4 enclosure in non-explosion-proof applications.

B. Metallic Barriers

1. Designed not to separate phases of a power circuit.
2. Provide as indicated for the isolation of power circuits from other type circuits.

C. Box size as required, or as indicated, for each particular installation.

D. Include provisions for mounting cable supports where indicated, specified or as required by NEC.

E. Provide as required for cable pulling, junctions, terminals, and for mounting of switches, outlets and control devices.

2.10 Support System

- A.** Fabricated from structural steel or manufactured framing members equal to "Unistrut" P-3000 series as manufactured by Unistrut Corporation.
- B.** Minimum 12 gage.
- C.** Construct as required to rigidly support all conduit runs and boxes.
- D.** Hot-dip galvanized steel conduit clamps or stainless steel, sized for the specific conduit size, to support all exposed metallic conduit.
- E.** Nonmagnetic clamps to support nonmetallic conduits.
- F.** Provide stainless steel rods, anchors, inserts, bolts, washer, and nuts.
- G.** Materials shall be compatible with the equipment supported.
- H.** Manufactured Framing Members

1. Wet Locations

- a.** Channel hot-dipped galvanized after all manufacturing operations are completed.
- b.** Galvanizing zinc weight of 2 ounces per square foot on surface to conform to ASTM A123 and ASTM A153.

2.11 Fire-stopping and Duct Seal

A. Fire-stopping

- 1. Weather-resistant silicone sealant.
- 2. Provide 4-hour fire rating.
- 3. UL tested system.

B. Duct Seal

- 1. Non-corrosive, permanently soft compound.
- 2. Nontoxic.

3. Provide flexible re-enterable and repairable seal around cables in conduit.
4. Prevent air movement and drafts through conduits.
- 5.

PART 3 - EXECUTION

3.1 Preparation

- A. Provide suitable protection for conduit risers against damage during construction.
- B. Cap ends of all conduits before concrete is poured.
- C. Cap all conduits and provide pullstring after cleaning where conduits are to be left empty by this contract.
- D. Carefully ream ends of all conduit lengths after cutting to eliminate sharp burrs.
- E. Clean out all conduit before pulling wire.
- F. Clean out all conduits immediately after concrete work is finished.

3.2 Installation

A. General Requirements

1. Location

- a. Install conduit as near as possible to the routing indicated.
- b. Shift locations as required to avoid interference with other equipment and piping being installed.
- c. 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 Engineer.

2. Do not use conduit in sizes smaller than 3/4-inch, except 1/2-inch may be used for connections to control devices and thermocouples where necessary.

3. **Holes and Sleeves**

a. Provide through floors, walls and roofs as necessary for conduit runs, including approved flashing and weather proofing at outside walls and on roofs.

b. Install sleeves or forms for all openings in new work.

c. Provide the required inserts and holes, completely sleeved, bonded, curbed, flashed and finished off in an approved manner, whether in concrete, steel grating, metal panels or roofs.

d. Core-drill all holes required in existing building work using a dustless method.

e. Place nonshrinking grout or Dow Corning 3-6548 Silicone RTV (or equivalent General Electric RTF 762) foam as specified, in the following locations:

(1) All holes in concrete, walls, floor and roof slabs after installation of conduit.

(2) All unused holes and sleeves as approved by Engineer.

f. Install wall entrance seals where conduit enters the building or vaults from exterior underground.

g. Install fire-stopping at all conduit penetration of fire rated walls, ceilings and floors. Fire-stopping shall equal or exceed the fire rating of the wall, ceiling or floor in which it is installed.

4. Make connections to boxes, panels, and other equipment as follows:

a. **For Indoor Dry Locations:** Double locknuts, one inside and one outside.

- b. **For Outdoor and Damp Locations:** Rigid weather-proof conduit hubs.
 - c. **For Explosion-proof Locations:** Use conduit connector seals approved for the hazardous location specified.
 - d. **Bushings**
 - (1) Threaded malleable iron or steel.
 - (2) Insulated with Bakelite, molded and bonded into the bushing.
 - (3) Placed on end of conduit in addition to locknuts.
 - (4) Install with integral grounding connector and conductor where all conduits pass through multiple concentric panel knockouts and where the conduit must be bonded to equipment it is not attached to.
 - e. Install duct seal in conduits around cables in non-hazardous locations at all conduit terminations at control panels and boxes containing terminations and splices.
5. Running threads will not be permitted.
 6. Coat all field cut threads in galvanized conduit with aluminum paint.
 7. Comply with applicable requirements of NEC pertaining to installation of conduit systems.
 8. Place drainage fittings or weep holes at unavoidable low points where moisture can collect.
 9. Install an entire conduit system that is electrically continuous with bonding jumpers provided as necessary to conform to NEC.
 10. Install expansion fittings at all building expansion joints and every 100 feet of continuous conduit.

11. Provide all spare or empty conduits with pullstrings for future use.

B. Rigid Steel Conduit

1. Exposed

- a. Install where specified or indicated on drawings.
- b. Install above grade outdoors.
- c. Install horizontal runs as high above floor as possible and in no case lower than 7 feet above floor, walkway or platforms in passage areas.
- d. Run conduit parallel or perpendicular to walls, ceiling, 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 1-inch clearance between conduits.
- g. Maintain 6-inch clearance between conduit and coverings on all hot lines; steam, hot water, etc.
- h. Do not exceed a distance of 8 feet between supports on horizontal or vertical runs.
- i. When terminating at cable tray, attach conduit to tray and electrically bond conduit with ground wire to the cable tray. Install duct seal in conduits around cables to prevent ingress of water.

2. Concealed

- a. Conceal conduit for lighting, convenience outlets, and other circuits in walls, ceiling and floors where possible.
- b. Do not install conduit in concrete where conduit outside diameter exceeds one-third of concrete thickness.

- c. Install parallel runs with a minimum spacing of three conduit diameters between conduits.
- d. Use expansion and deflection fitting with bonding jumpers at all concrete expansion joints.
- e. Tie securely in place to prevent movement when concrete is poured.
- f. Install in floor slabs in as straight a run as possible. Conduit crossovers are not permitted unless conduit total outside diameter is one-third of the concrete thickness or less.
- g. Use long radius elbows except on risers where curved portion of elbow would extend above the finished floor or foundation.
- h. Make all joints watertight after installation by coating all finished joints with coal tar solution applied at 15 mils minimum dry film.

(1) Kop-Coat - No. 50.

(2) Tnemec - 46-449.

3. Buried

- a. Place where indicated.
- b. Use PVC jacketed conduit or rigid PVC Schedule 80 as indicated.
- c. Make all joints watertight by field-applied coat of vinyl plastic compound or PVC welding solution furnished by the conduit manufacturer.
- d. Use bender one size larger for conduit sized 1 inch or less and conventional bender for conduit sized above 1 inch.

- e. Use strap wrench to tighten conduit. Repair damaged coating with liquid patching compound recommended by conduit manufacturer.
- f. Install in as straight a run as possible between termination points of exact routing to be determined in the field and subject to approval by Engineer.
- g. Bury conduits a minimum of 24 inches (to top of conduit) below finish grade unless indicated otherwise or required by code.
- h. Slope conduit away from conduit risers where possible.
- i. Maintain 6-inch separation from underground piping.
- j. Use long radius bends at all risers unless indicated otherwise.
- k. After trench bottom has been finished to grade, lay conduit. Backfilling shall be as specified in DIVISION 2.
- l. Cap ends of all conduit risers before backfilling.
- m. Provide watertight seal around wires where conduit terminates in pull box.
- n. Use PVC coated rigid galvanized steel conduit when making transitions from buried to above ground conduit runs.

C. Liquid-Tight Flexible Metal Conduit

- 1. Use between rigid conduit and motor terminal boxes except where conduit runs down from above and cannot be conveniently supported by a floor flange.
- 2. Place between rigid conduit or conduit box and control device cases where direct connection is not desirable for reasons of equipment movement, vibration, or for ease of maintenance.
- 3. Install at all points of connection to equipment mounted on supports to allow for expansion and contraction.

4. Conform to NEC with installation of conductors.
5. Install at locations where rigid conduit connections are impractical.
6. Use minimum length consistent with manufacturer's standard lengths, the acceptable bending radius, and with required movement of equipment.
7. Maximum length of 3 feet unless otherwise approved by Engineer.
8. Install an external bonding jumper to conform to NEC on conduit sized 1-1/2 inches and larger.

D. Flexible Metal Conduit

1. Use between rigid conduit and devices, except in hazardous areas and areas subject to dampness, water, and corrosive fumes. Do not use with vapor-tight fixtures. Use in accordance with the National Electrical Code Article 350.
2. Use in lieu of direct connection of rigid conduit where it is not desirable for reasons of equipment movement, vibration, or for ease of maintenance.
3. Install as required for expansion and contraction.
4. Use minimum length consistent with manufacturers' standard lengths, the acceptable bending radius, and with required movement of equipment.
5. Maximum length of 3 feet unless otherwise approved by Engineer.
6. Install in sizes smaller than 3 inches.
7. Install an external bonding jumper to conform to the National Electrical Code on conduit sized 1-1/2 inches and larger.

E. Conduit Fittings

1. Installations of special fittings as required.

2. All materials shall be compatible.
3. Install as required.

F. Boxes

1. Install special boxes as indicated of size required for conduits and cables entering and leaving box.
2. Install where required for pull or junction boxes and for mounting or connecting to switches, outlets, intermediate terminal blocks or control devices.
3. Provide 1/4-inch weep holes in interior boxes where conduits enter from exterior or buried installation.

G. Supports

1. Construct with sufficient rigidity to hold all mounted equipment and material in permanent and neat alignment.
2. Design to provide 1/4-inch space between equipment housings and walls or columns upon which they are mounted.
3. Do not exceed load requirements in NEC and NEMA standards.
4. After Power Tool Cleaning SSPC-SP11, paint all welds, field cuts and damaged areas with organic zinc-rich primer at 3 mils dry film thickness.
 - a. Ameron - 68HS.
 - b. Carboline - Carbozinc 858.
 - c. Porter - Zinc-Lock 308.
 - d. Tnemec-Tneme Zinc 90-93.
5. Use electrogalvanized steel conduit clamps and nonmagnetic conduit clamps to support electrogalvanized steel conduit and nonmagnetic conduit, respectively.

6. Provide stainless steel rods, anchors, inserts, bolts, washers and nuts.

I. Explosion-proof Fittings

1. Install explosion-proof fittings in the rigid steel conduit system as required by the NEC.
2. Install necessary fittings where not indicated, but required by code.

PART 4 MEASUREMENT AND PAYMENT

4.1 Measurement

- A.** No measurement will be made for this item.

4.2 Payment

- A.** Payment will be made at the contract lump sum price bid and shall be considered full payment for providing labor and materials to perform this work.

**** END OF SECTION 16111 ****