

SECTION 16110
ELECTRICAL RACEWAY SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Requirements for providing electrical raceway systems as indicated, in accordance with the Contract Documents.
- B. Related Work Specified in Other Sections Includes:
 - 1. Section 09900 – Painting and Coating

1.2 REFERENCES

- A. Codes and standards referred to in this Section are:
 - 1. ANSI C80.1 - Specifications for Rigid Steel Conduit, Zinc Coated
 - 2. ANSI C80.3 - Specifications for Electrical Metallic Tubing, Zinc Coated.
 - 3. ANSI C80.5 - Specifications for Rigid Aluminum Conduit
 - 4. ANSI C80.6 - Intermediate Metal Conduit (IMC) - Zinc Coat
 - 5. ANSI/NFPA 70 - National Electrical Code
 - 6. NEMA RN1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - 7. NEMA TC2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)
 - 8. UL 1 - Flexible Metal Conduit
 - 9. UL 6 - Rigid Metal Conduit
 - 10. UL 360 - Liquid-Tight Flexible Steel Conduit
 - 11. UL 651 - Schedule 40 and 80 Rigid PVC Conduit
 - 12. UL 797 - Electrical Metallic Tubing
 - 13. UL 1242 - Intermediate Metal Conduit

14. Federal Specification WW-C-540C-Conduits, Metal, Rigid (Electrical, Aluminum)

1.3 SUBMITTALS

- A. Provide all submittals, including the following, as specified in Division 1 and Section 16050.

1.4 QUALITY ASSURANCE

- A. Codes: Provide all materials and workmanship to meet the requirements of ANSI/NFPA 70 National Electrical Code.
- B. Regulatory Requirements: Provide UL listed components.

1.5 DELIVERY, STORAGE AND HANDLING

Deliver, store and handle all products and materials as specified in Division 1.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.
 - 1. Rigid steel and intermediate metal conduits and electrical metallic tubing:
 - a. Allied Tube and Conduit
 - b. Wheatland Tube Company
 - c. LTV Steel Tubular Products Company
 - 2. PVC coated steel conduits fitting and boxes:
 - a. Robroy Industries
 - b. Occidental Coating Company
 - c. Perma-Cote Industries
 - 3. Rigid nonmetallic conduits:
 - a. Carlon Company
 - b. Certainteed Corporation
 - c. National Pipe Company
 - 4. Aluminum Conduits:
 - a. V.A.W. of America, Inc.

- b. Easco Aluminum
 - c. Alumex, Inc.
5. Liquidtight flexible steel conduit:
- a. Electri-Flex Company
 - b. The International Metal Hose Co.
 - c. Alflex Corp.
 - d. Anamet, Inc.
6. Conduit Fitting and Connectors
- a. Appleton Electric Company
 - b. Thomas & Betts
 - c. Crouse Hinds Company
 - d. OZ/Gedney
 - e. Killark
 - f. Adulet-PLM
7. Boxes and Enclosures:
- a. Appleton Electric Company
 - b. Raco/Bell
 - c. Crouse Hinds Company
 - d. Steel City
 - e. Hoffman
 - f. Hope
8. Strut Channel and Fittings
- a. Allied Tube & Conduit
 - b. B-Line Systems, Inc.
 - c. Kindorf
 - d. Enduro
 - e. Strut Tech
 - f. Unistrut
9. Fire Stop System
- a. 3M/Electrical Products Division
 - b. International Protective Coatings
 - c. Nelson Electric
10. Terminal Blocks
- a. Phoenix Contact
 - b. Entrelec
 - c. Weidmuller

2.2 RACEWAYS

- A. General: Provide minimum 3/4-inch raceways.
- B. Raceway Requirements: Provide raceways meeting the following requirements:
 - 1. Provide rigid steel, heavy wall, hot-dip galvanized in accordance with the requirements of UL-6 and ANSI C80.1.
 - 2. Provide rigid nonmetallic Schedule 80 PVC electrical conduit in accordance with the requirements of UL Standard 651 and NEMA Standard TC2 with solvent cement joints.
 - 3. Provide liquidtight flexible single strip steel, hot-dip galvanized conduit with PVC jacket in accordance with requirements of UL 1. Provide a continuous copper bonding conductor wound spirally between convolutions on the inside of the conduit meeting requirements of UL 360 for conduit sizes 1-1/4-inch and smaller.

2.3 FITTINGS

- A. General: Provide fittings of similar material as raceways.
- B. Fittings Requirements: Provide fittings meeting the following requirements:
 - 1. Set screw or indenter type fittings are not acceptable. Use threaded connectors for all rigid or intermediate metal conduits.
 - 2. Use solvent cement connections for all rigid nonmetallic conduits.
 - 3. Use insulated connectors for liquidtight flexible conduit.
 - 4. Expansion/Deflection Fittings: Use a deflection and expansion coupling for rigid and intermediate metal conduits that provide a 3/4 inch movement in all directions from normal and a 30 degree angular deflection. Use coupling that includes internal bonding jumper.

Use a nonmetallic expansion coupling for nonmetallic conduits that provides a 4-inch maximum expansion.
 - 5. Bushings
 - a. Provide insulated nonmetallic bushing rated 105 degrees C for all installations where bonding is not required.
 - b. Provide insulated metallic grounding and bonding bushing rated 150 degrees C where bonding is required.

6. Fittings for Hazardous Locations:
 - a. Provide fittings that conform to the requirements of NEC Chapter 5 for Class I, Division 1, Group D hazardous locations.
 - b. Provide seal fittings suitable for either horizontal or vertical installation.

2.4 WALL AND FLOOR PENETRATIONS

A. Watertight:

1. For individual conduit penetrations in new exterior walls or floors provide watertight sealing sleeves consisting of a steel sleeve with pressure ring and clamps.
2. For individual conduit penetrations in existing walls or floors, provide watertight sealing bushing consisting of a neoprene sealing ring between two PVC coated steel pressure discs. Provide stainless steel captive screws for sealing ring compression.

2.5 BOXES AND CABINETS

A. Outlet Box Requirements:

1. Provide cast aluminum boxes for aluminum conduit systems.
2. Provide galvanized cast iron boxes for galvanized rigid steel conduit systems.
3. Provide nonmetallic boxes and covers in PVC conduit systems.
4. Provide watertight gasketed covers held with nonferrous screws for all cast metal boxes.

B. Junction and Pull Box Requirements:

1. Provide cast aluminum boxes with mounting lugs, threaded hubs and gasket covers for surface mounted boxes
2. Provide fabricated sheet metal boxes when cast metal box weight exceeds 50 pounds. Construct box from 1/8-inch thick galvanized sheet steel or aluminum with sides return channel flanged around cover opening. Provide angle or channel supporting frame. Provide continuously welded and ground smooth seams. Provide mounting lugs and threaded conduit hubs.
3. Provide cast steel or fabricated 10-gauge Type 316 stainless steel for boxes either partially or fully encased in concrete. For partially encased boxes provide sides return channel flanged around cover opening. For fully encased boxes

provide flush covers. Provide continuously welded and ground smooth seams. Provide mounting lugs and threaded conduit hubs.

4. Provide watertight gasketed covers held with nonferrous captive knurled head screw slot bolts.
5. Provide two padlocking hasps for boxes containing medium voltage cables.
6. Construct all fabricated boxes located indoors to NEMA 13 requirements.
7. Manufacture all boxes located outdoors to NEMA 4 requirements.
8. Manufacture all boxes located in hazardous areas to NEMA 7 requirements.

C. Terminal Box Requirements:

1. Provide minimum 12 gauge stainless steel fabricated box with mounting lugs, floor stand, and hinged doors.
2. Equip the door with continuous piano hinge and 3 point lockable latch. Provide print pocket on inside of door.
3. Fabricate back plate of 12 gauge minimum steel with white enamel finish for mounting terminals and wire troughs.
4. Provide wire troughs consisting of plastic ducts with snap slot design and removable covers. Run all wiring within wire troughs.
5. Furnish a schedule of terminals with the following information
 - a. Source
 - b. Type of Signal
 - c. Function
6. Provide removable jumpers to allow operation of the equipment.
7. Separate analog terminals from all other terminals.
8. Provide number of terminals shown. Where the number of terminals are not shown, provide sufficient terminals for each wire entering the terminal box plus 20 percent but not less than 10 spare terminals.
9. Terminals:
 - a. All catalog numbers refer to Phoenix Contact Type for the purpose of establishing the standard of quality and general configuration desired.
 - b. Provide symmetrical type steel mounting rails, DIN-EN50022.

- c. Analog Signals: Provide terminals in enclosed housing suitable for wires from 22 to 12 AWG rated 600 volts with gray body, knife disconnect and test connection socket on both sides of disconnect, Phoenix Contact Type UK 5-MTK-P/P.
- d. Control and Alarm Signals: Provide terminals suitable for wires from 18 to 8 AWG rated 50 amperes at 600 volts, blue body, Phoenix Contact Type UK10.

2.6 SUPPORTING DEVICES

- A. Raceway Supports: Provide raceway supports meeting the following requirements:
 - 1. Do not use perforated straps or plumbers tape for conduit supports.
 - 2. Provide expansion bolts or inserts for fasteners in concrete, toggle bolts for hollow masonry or frame construction, and preset inserts for prestressed concrete.
 - 3. Conduit Straps and Backs:
 - a. For metallic conduits, use steel or malleable iron.
 - b. For nonmetallic and PVC coated conduits, use PVC coated malleable iron.
 - 4. Conduit Hangers
 - a. For metallic conduits, use steel adjustable conduit hangers or clevis hangers.
 - b. For nonmetallic and PVC coated conduits, use PVC coated adjustable conduit hangers.
 - 5. Beam Clamps:
 - a. For metallic conduits, use malleable iron with steel bolt.
 - b. For nonmetallic and PVC coated conduit, use PVC coated malleable iron with stainless steel bolt.
 - 6. Trapeze Hangers:
 - a. For metallic conduits use 12 gauge 1-1/2-inch square steel channels with steel channel straps to secure conduits.

- b. For nonmetallic or PVC coated conduit, use either PVC coated 12 gauge 1-1/2-inch square steel channels or 1-5/8-inch square fiberglass channels. Use PVC coated straps with stainless steel bolts for securing conduits.
 - c. Provide addition channels welded together to limit the deflection to 1/240th of span.
7. Thread Rod
- a. Provide thread rod with the minimum size as follows:
 - (1) Conduit Hangers
 - (a) 3/4-inch to 1-1/2-inch conduit: 1/4-inch thread rod
 - (b) 2-inch to 3-1/2-inch conduit: 3/8-inch thread rod
 - (c) 4-inch and larger: 1/2-inch thread rod
 - (2) Trapeze Hangers: Provide thread rod of sufficient size to support the load. Use a minimum of 3/8-inch thread rod.
 - b. For Metallic Conduit Systems: Use continuous threaded galvanized steel rod.
 - c. For Nonmetallic or PVC Coated Conduit Systems: Use a continuous threaded PVC coated galvanized steel rod.

PART 3 EXECUTION

3.1 PREPARATION

- A. General: Install electrical equipment and material of the size, type and general routing as shown or required.
- B. Coordination with Reinforcing: Install raceway, fittings, boxes and cabinets free from direct contact with reinforcing steel.
- C. Alignment: Provide fasteners, anchor bolts, anchorage items and supports as required to insure proper and rigid alignment. Attach equipment with fasteners sized according to size and weight of the equipment and the thickness of the supporting surface.
- D. Aluminum Coating: Where aluminum is placed in contact with dissimilar metal or concrete, separate contact surfaces with gasket, nonabsorptive tape or coating as specified in Section 09900 to prevent corrosion.

- E. Grounding: Make metallic raceways electrically and mechanically continuous and ground as required. Install conduits continuous between outlets, boxes, cabinets and panels.

3.2 INSTALLATION

- A. General: Unless otherwise indicated, install conduits exposed, parallel or perpendicular to building floors, ceilings and walls, and to avoid interference with other work. In architecturally finished areas, conceal conduits within finished walls, ceilings and floors. Cut conduits square and deburr the cuts to the same degree as the conduit manufacturer. Saw cut aluminum conduit to prevent reduction in internal area. Fasten conduit securely to outlets, junction, pull and terminal boxes. Provide caps and seals to prevent the entrance of foreign material and moisture during installation and before pulling wire.
 1. Where conduit size is not shown, provide conduits one size larger than indicated in Table 4, Chapter 9 of the NEC.
 2. Support raceways concealed above suspended ceilings from the slab above suspended ceiling in same manner as exposed raceways. Do not support raceways from suspended ceiling supports.
 3. Keep conduit at least six inches away from high temperature piping, ducts, flues and surfaces. For mounting on concrete and masonry surfaces provide a minimum of 1/4 inch air space between conduit and mounting surface. Support and fasten conduit to building structural members spaced in accordance with electrical codes. Support conduit at least every eight feet or less in accordance with NEC requirements.
 4. When two or more exposed conduits are in the same general routing, provide parallel installation with symmetrical bends and for three or more provide trapeze hangers. Size trapeze hangers with space for 25 percent additional conduits.
 5. Make changes in direction with bends or fittings. Make field bends and offsets with a hand bender or conduit-bending machine.
 6. Run conduit in buildings with no more than the equivalent of (three) 90 degree bends between pull points. Provide no more than (125) feet of conduit runs between pull points. Provide pull boxes where shown, specified or wherever required to install conductors and to meet the above requirement.
 7. Install pull and junction boxes in accessible locations with working space in front of and around the installation. Obtain approval to locate boxes in finished areas.
 8. Install an expansion fitting when a conduit crosses a building structural expansion joint.

9. Unless otherwise approved, install conduits to cross at right angles to building structural expansion joints.
 10. Where approved for encased installation, install conduits in slabs as close to the middle of concrete slabs as practicable without disturbing reinforcement. Do not use conduit with an outside diameter exceeding one-third of the slab thickness. Do not place conduits closer than three diameters on centers, except at cabinet locations where the slab thickness is increased.
 11. Pitch conduits to outlet boxes to avoid trapping moisture. Where dips are unavoidable in exposed conduit runs, install drain fitting at low point.
- B. Conduit Material Types: Provide conduit as follows:
1. Use rigid steel conduits in all indoor and outdoor installations or concrete encased within building structures.
 2. Install rigid nonmetallic Schedule 80 conduits underground and in wet well structures, unless specifically detailed otherwise.
 3. Hazardous Locations:
 - a. Hazardous locations include the existing and new wet well and are classified Class 1, Division 1, Group D as defined by NEC.
 - b. Install all conduits and appurtenances in accordance with the requirements of Chapter 5 in NEC.
 - c. Provide seal fittings for all conduits that enter or leave a hazardous location.
- C. Connections to Equipment
1. Use double locknuts and bushing for all boxes, enclosures and cabinets located in dry areas.
 2. Use watertight hub fittings for all boxes, enclosures and cabinets located below grade and in wet, damp or corrosive areas.
 3. Provide rigid conduit connection where equipment is fixed and not subject to adjustment, mechanical movement or vibration. Provide union fittings to permit removal of equipment without cutting or breaking conduit.
 4. Use liquidtight flexible conduit connection where equipment is subject to adjustment, mechanical movement or vibration.

5. Coat all threads in steel conduit runs with zinc dust in oil or other corrosion-preventive compound before making connections.
6. Coat all threads in aluminum conduit runs with graphite or other corrosion preventive compound.

3.3 CLEANING AND PAINTING

- A. Shop Paint: Paint conduits meeting the requirements of Section 09900.

END OF SECTION

(NO TEXT FOR THIS PAGE)