

## **SECTION 16130 CONDUIT AND FITTINGS**

### **PART 1 – GENERAL**

#### **1.01 DESCRIPTION**

- A. Section includes requirements for conduit and conduit fittings. Conduit types shall be as shown on the Contract Drawings and as specified herein.

#### **1.02 REFERENCE STANDARDS**

- A. American National Standards Institute (ANSI):
  - 1. C80.1 Electrical Rigid Steel Conduit (ERCS)
- B. ASTM International (ASTM):
  - 1. A153 Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
  - 2. D2564 Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems
- C. American Welding Society (AWS):
  - 1. D1.1 Structural Welding Code - Steel
- D. California Code of Regulations (CCR):
  - 1. Title 24, Part 3, California Electrical Code
- E. Institute of Electrical and Electronics Engineers (IEEE):
  - 1. IEEE C2 National Electrical Safety Code (NESC)
- F. National Electrical Manufacturers Association (NEMA):
  - 1. TC2 Electrical Polyvinyl Chloride (PVC) Conduit
  - 2. TC3 Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
- G. National Fire Protection Association (NFPA):
  - 1. NFPA 70 National Electrical Code (NEC)
- H. Underwriters Laboratories Inc. (UL):
  - 1. UL 6 Electrical Rigid Metal Conduit - Steel

2. UL 651 Schedule 40 and 80 Rigid PVC Conduit and Fittings

### **1.03 DESIGN REQUIREMENTS**

- A. In addition to requirements specified in Section 16000, Basic Electrical Requirements, design supports to support the following loads.
  1. Support load equal to sum of weights of conduits and wires, and weight of hanger plus 200 pounds.
  2. Stress at root of thread of hanger rods: Not more than 9475 psi at design load.
  3. Size horizontal member to limit maximum stress of not more than 12,650 psi at design load.

### **1.04 SUBMITTALS**

- A. Refer to Section 16000, Basic Electrical Requirements, for additional submittals and submittal requirements.
- B. Submit manufacturer's product data for all types of conduit and fittings to be used.
- C. Shop drawing information may be combined on a single drawing. Identify each drawing by a number and descriptive title.
- D. Submit records of grout quantity installed in casings.
- E. Submit test reports.

### **1.05 DELIVERY, STORAGE AND HANDLING**

- A. Install thread protectors both ends of galvanized rigid steel conduits for shipment and handling.
- B. Package couplings separately.

## **PART 2 - PRODUCTS**

### **2.01 GENERAL**

- A. Conduit and conduit fittings shall be standard types and sizes as manufactured by a nationally recognized manufacturer of this type of materials, and be in conformity with standards.

### **2.02 RIGID GALVANIZED STEEL CONDUIT (RGS)**

- A. Provide conduit, couplings, elbows, bends, sealing fittings, and nipples conforming to ANSI C80.1 and UL 6, with each length bearing manufacturer's stamp and UL label.
- B. Couplings, locknuts, and all other fittings shall be galvanized, waterproof, and threaded type only.

- C. Bushings shall be nylon insulated metallic and grounding type.
- D. Furnish conduit straps, clamps and clamp backs made of galvanized malleable iron.

### **2.03 POLYVINYLCHLORIDE (PVC) CONDUIT**

- A. Schedule 40 and schedule 80 rigid polyvinyl chloride electrical conduit conforming to the requirements of EPC-40-PVC and EPC-80-PVC conduit of NEMA TC 2 and fittings for EPC-40-PVC and EPC-80-PVC conduit of NEMA TC 3 and listed by UL for direct underground burial, manufactured from high impact, non-conducting, self-extinguishing material.
- B. Couplings, Adapters, Expansion Fittings: Conform to same requirements as rigid PVC conduit. Use solvent cement for PVC joints, as recommended by conduit manufacturer.
- C. Bends: Factory made PVC bends.
- D. PVC conduits shall be Schedule 40 throughout the Work, except at rail crossing, which shall be PVC Schedule 80.
- E. UL 651 listed and in accordance with NEC Article 352 for underground use.
- F. Solvent for welding PVC shall comply with ASTM D 2564 or approved equal.
- G. Minimum 10 foot assembled from factory section, 25 foot assembled from factory section preferred.

### **2.04 PULL CORD**

- A. Pull Cord or Rope: Twisted or braided nylon cordage, 1/4 inch diameter, with a minimum tensile strength of 1000 pounds. Pull cord shall be combination footage measuring tape and pull line.

### **2.05 MANDRELS**

- A. High-strength aluminum alloy with steel center rod and cast iron eyes.
- B. Use solid cylindrical type mandrels, minimum 12 inches long and 1/4 inch less than diameter of duct at center, tapering to 1/2 inch less than duct size at ends.

### **2.06 CONDUIT SUPPORTS**

- A. Steel shapes, angles and channels: 1 1/2 by 1 1/2 or 1 5/8 by 1 5/8 inches, 12 gauge, cold-formed, lipped channel; designed to accept special spring-held hardened steel nuts for securing hanger rods and other attachments.
- B. Single Conduit Hangers: Steel City No. C-149, Unistrut No. J1205 through J1260, or Engineer approved equal, with 3/8 inch minimum diameter steel rod.

- C. Riser Supports: Steel City No. C-210, or Engineer approved equal.

## **2.07 REINFORCED PLASTIC MORTAR SPACERS (RPM)**

- A. Duct Spacers: Refer to Section 02500, Underground Ductwork and Structures.
- B. Bore spacers shall be made from high density polyethylene (not less than 0.96 specific gravity), as manufactured by Formex Manufacturing, Inc., Underground Devices Inc. make, or Engineer approved equal.
- C. Steel Bands and Polypropylene Straps for Securing Ducts in Bore Spacers: Provide means of securing conduits to bore spacers in accordance the bore spacers manufacturer's written instructions. At minimum provide one of the following means:
  - 1. 5/8 inch by 0.30 inch galvanized steel bands and buckles having a minimum breaking strength of 1405 lbs.
  - 2. 3/4inch wide polypropylene strapping having a 1400 lb breaking strength, 7 percent maximum stretch, and steel seals.

## **2.08 UTILITY MARKER TAPE**

- A. Tracer Tape: As specified in Section 02300, Earthwork. Use in trenches containing electric and power circuit. Tape shall have printed warning that an electric circuit is located below the tape.

## **2.09 CONDUIT EXPANSION FITTINGS**

- A. Fabricate from material similar to type conduit with which used.
- B. Include factory installed packing ring and pressure ring; prevent entrance of moisture.
- C. Include grounding ring or grounding strap for metallic expansion couplings.

## **2.10 INSERTS**

- A. Channel Inserts:
  - 1. Fabricate from cold-formed steel channels 12 gauge or thicker; overall size 1 1/2 inches by 1 1/2 inches or 1 5/8 inches by 1 5/8 inches; lengths as indicated. Hot-dip galvanize after fabrication in accordance with ASTM A153.
  - 2. For Embedding in Concrete:
    - a. Fabricate from channels having a solid base
    - b. Weld concrete anchors to channel during fabrication and before coating
    - c. Clean and galvanize after fabrication

- d. Provide assemblies with minimum pull-out load rating of 4500 pounds per linear foot uniformly distributed.
- e. Furnish channel inserts for embedded installation in concrete with channel interior completely filled with Styrofoam.
- 3. For Surface Mounting:
  - a. Fabricate from channel with 3/8 inch by 3 inches slots on 4 inches centers in base.
  - b. Galvanize inserts for surface mounting on concrete surfaces, and for installation in damp or wet areas in accordance with ASTM A153.
  - c. Use galvanized expansion shield type anchor bolts.
- B. Spot Inserts for Embedding in Concrete:
  - 1. Steel, galvanized after fabrication in accordance with ASTM A 153.
  - 2. Design for maximum loading of 800 pounds with safety factor of three.
  - 3. Knockout openings: Designed to accommodate square or rectangular nuts.

### **2.11 FILLING MATERIALS**

- A. Furnish fire-resistive filling material for openings similar to the material of the floor, wall or ceiling being penetrated, and finish to prevent passage of water, smoke and fumes.
- B. Where conduits passing through openings are exposed in finished rooms, use filling material that matches the adjoining finished floor, ceiling, or wall.

### **2.12 END CAPS**

- A. Provide end caps at both ends of all empty conduits.

### **2.13 CASINGS**

- A. Casing to receive bore spacers and ducts shall be a minimum of 0.375 inch thick steel wall and shall be straight and true.

## **PART 3 – EXECUTION**

### **3.01 GENERAL REQUIREMENTS**

- A. All exposed conduit, conduit embedded in concrete walls and embedded in concrete floor, and conduit from handhole to shelter equipment shall be threaded rigid galvanized steel, except as follows:

1. Rigid PVC conduit may be used:
  - a. For direct earth burial outside of building foundations, only where specifically shown on Contract Drawings and if buried not less than 24 inches below the surface.
  - b. PVC Schedule 80 conduit shall be used at rail crossings. Conduit shall be buried not less than 42" from the top of the rail tie.
- B. For system higher than 150 volts to ground, maintain continuity of equipment ground across flexible conduit connection to motor outlet by installing bonding wire inside conduit and connecting each end of wire to outlet or junction boxes by separate bolt, or use liquid tight flexible conduit approved for this purpose.
- C. For PVC conduits, maintain continuity of conduit system ground by installing copper grounding wire inside PVC conduit, per CCR, Title 24. Ground this wire at each accessible location (manhole, pullbox, cabinet, outlet and junction box, and similar locations) and at each termination.
- D. Check embedded items for correct location and detail before concrete is placed.
- E. Control erection tolerance requirements; do not impair strength, safety, serviceability, or appearance of installations. Determine exact locations of conduit.
- F. Install trade size, type, and general routing and location of conduits, raceways, and boxes as indicated or specified.
- G. When exposed or buried conduit passes through expansion or contraction joint in structure, install conduit at right angles to joint; provide approved conduit expansion fitting at joint.
- H. Provide expansion fittings in conduit runs as required to compensate for thermal expansion.
- I. Conduits exposed to different temperatures: Seal to prevent condensation and passage of air from one area to the other.
- J. When field cutting of conduit is required, remove rough edges. Where conduit enters box or other fitting, provide bushing to protect wire from abrasion.
- K. Provide a minimum slope of three inches to each 100 feet away from buildings and towards manholes or pull boxes; run in straight lines between indicated changes in direction.
- L. Perform welding in accordance with AWS D1.1.

### **3.02 EXCAVATION, TRENCHING, AND BACKFILL**

- A. As specified in Section 02300, Earthwork, and as indicated in the Contract Documents.

### 3.03 REINFORCED PLASTIC MORTAR SPACERS (RPM)

- A. Duct Spacers: Refer to Section 02500, Underground Ductwork and Structures.
- B. Bore Spacers (For ducts installed inside casing):
  - 1. Use one double wall bore spacer for every 5 feet of duct bank.
  - 2. Construct a trough or feeder bridge at the leading end of the casing to support sections of duct bank as they are assembled and pulled into the casing.
  - 3. Use "Off Center Weight Technique" or "Stabilization Cables" to prevent rotating of the duct bank (corkscrew) as it is pulled through the casing.
  - 4. Hold bore spacers in place relative to the conduit to avoid excessive temporary thrust load on each bore spacer while grout is pump into the casing.
  - 5. Hold duct bank in position at both ends to accommodate possible uneven thrust loads that may be generated during the grouting operation.
  - 6. Do not exceed the hydraulic collapse pressure of the conduits during grouting operation.
  - 7. Measure and record actual quantity of grout used.
  - 8. Secure conduits to bore spacers by installing on each side of each bore steel bands and buckles or polypropylene strapping and steel seals.

### 3.04 UNDERGROUND CONDUITS

- A. Refer to 02300, Earthwork, for provisions for trenching, backfilling, and tracer tape.
- B. Verify conduit is continuous and not damaged by pulling mandrel through embedded conduit within five days after concrete placement.
- C. Cap or plug ends of conduit with permanent cap or plug. Do not use duct tape to temporarily seal conduit. Prevent concrete and other materials from entering and obstructing conduit. Do not install bell end fittings on conduits in ungrounded pull boxes.
- D. Sandpaper joints in PVC conduit; remove burrs, clean and dry joints, and brush with solvent cement recommended by manufacturer.
- E. Heating or any other method shall not be used to produce a larger bend. A sweep radius shall never be less than 15 feet in any given section.
- G. Install duct runs straight and true between pull boxes. Do not use bends except where shown on the Contract Drawings. For alignment curves, do not use more than 5 degree segments for each standard straight length.

- H. Conduits smaller than three inches: Make horizontal and vertical changes in direction exceeding 10 degrees by long sweep bends; having minimum radius of 25 feet. Manufactured bends may be used at ends of short runs of 100 feet or less, but only at or within five feet of end of run. Sweep bends may be made up of curved or straight sections, or combinations. Manufactured bends: bend radius to centerline of all conduits not less than 10 times nominal diameter of conduit for ducts of three inches in diameter and larger.
- I. Place underground raceways at minimum depth of 24 inches to top of sand encasement, or to top of conduit (as applicable), unless specifically indicated otherwise.
- J. Plug all ends of unused ducts and conduits in pull boxes/manholes. Use plugs manufactured for the purpose.
- K. Unless otherwise shown on the Contract Drawings, install an expansion joint with minimum range of 5 inches in every 100-foot length of PVC type conduit. Make all joints in PVC conduit with solvent cement, as recommended by conduit manufacturer.
- L. During non-work hours, and at locations where installation of ducts is temporarily suspended or terminated, close ends of ducts with caps or plugs fitted to prevent entry of water or debris. Use caps or plugs designed for purpose by conduit manufacturer.
- M. Inspect ducts and couplings to ensure only clean and undamaged units are incorporated in Work.
- N. Refer to Article entitled Mandrel.
- O. Provide flared bell ends on conduit and ducts entering manholes, handholes, and pull boxes.
- P. Conduit runs shall have no more than three (3) 90 degree bends between pull boxes, between manholes, and from point to point from the last pullbox.

### **3.05 UNDERGROUND CONDUITS FOR COMMUNICATIONS**

- A. Conduit bends shall be in accordance with NEC and the California Electrical Code, with not more than 120 degrees in bend. Where more bends are required in a particular run, install pull boxes as required to facilitate pulling conductors. For straight conduit runs, maximum length without a pull box/manhole shall not exceed 500 feet. For conduit runs with some bends, maximum length without a pull box/manhole shall not exceed 400 feet.
- B. Conduit stacks shall begin sweeps a minimum of 10 feet from exterior pull box face, leaving 10 feet of straight conduit perpendicular to cored entrance holes of pull box.



- C. When conduit stack enter or exit in a straight line to a pull box face, conduit stack shall separate from common trench at a minimum distance of 30 feet from entrance to pull box.
- D. When conduit stack enter or exit from sweep to a manhole, conduit stack shall separate from common trench at a minimum distance of 35 feet perpendicular to entrance of pull box.
- E. Communication conduit stack shall contain a minimum of 4 - four inch conduits.
- F. All conduits shall be 15-foot minimum radius in any given section of the 90 degrees conduit sweep. 90 degrees conduit sweep shall be manufacturer-supplied bends of 20 foot length. Determine the total sweep radius by the maximum natural bending capability of each twenty-foot section.
- G. Terminate underground conduit stubs with coupling and threaded plug.

### **3.06 EXPOSED CONDUITS**

- A. Use galvanized rigid steel (GRS) for exposed conduits.
- B. Install conduits straight and true with respect to each other and adjacent construction.
- C. Exposed conduits on Public Areas shall be painted to match surrounding areas.
- D. Route exposed conduits in such a manner as to obtain the least visibility from public view, along columns and beams, and similar features. Verify routing with the Engineer.
- E. Provide separable watertight hub fittings with gasket, separate nylon insulated throat and case hardened locknut.

### **3.07 SUPPORTS**

- A. Support conduits in vertical runs not to exceed 5-foot intervals. Use riser supports with clamps for vertical conduit risers.
- B. For single conduit runs, use pipe straps with single conduit hangers. Single hole malleable iron clamps may be used for horizontal runs on vertical surfaces. Perforated strap (plumber's tape) is not acceptable.
- C. Multiple Pipe Hangers (Trapeze Type):
  - 1. Fabricate two or more steel hanger rods, a steel horizontal member and U-bolts, clamps, and/or other attachments necessary for securing hanger rods, cable trays and conduits.
  - 2. Hanger Rod – Not smaller than 1/4 inch diameter, threaded full length.

3. Horizontal Member: Steel angles, and channels. Two or more channels may be welded together to form horizontal members of greater strength.

### **3.08 MANDREL**

- A. As each section of conduit and duct line is completed between manholes, handholes, and pull boxes, pull mandrel and swab through conduit or duct to remove foreign matter.
- B. Draw mandrel through completed conduit run manually without mechanical assistance. If obstructions are encountered which cannot be removed or if conduits do not pass the "usable capacity" mandrel, correct or replace conduit.
- C. Correct or replace conduits which have a consistent "hard spot" (indicating possible separation), conduits where joints may damage cable sheaths, or conduits with misaligned junctions or poor conduit joints.
- D. During construction, protect partially completed duct lines from entrance of debris by means of suitable caps or plugs.

### **3.09 PULL CORDS**

- A. Install pull line in empty (unused/future) conduits. Make pull-line continuous from outlet to outlet, with two (2) feet of slack at each outlet.
- B. After conduits are cleaned and mandrelled, install rope and securely seal both ends of conduit with caps.
- C. Do not splice pull cords. Leave ample slack length at each end of pull cords.

### **3.10 FILLING OF OPENINGS**

- A. Wherever slots, sleeves or other openings are provided in floors or walls for the passage of raceways, including bus ducts, fill such openings as follows:
  1. Install fire-resistive filling material to prevent passage of water, smoke and fumes.
  2. Where conduits passing through openings are exposed in finished rooms, use filling material that matches, and is flush with, the adjoining finished floor, ceiling or wall.

### **3.11 CASINGS**

- A. Install casing in which bore spacers and ductwork will be installed so that inside walls are smooth and free from ridges, projections and seams that might impede the rolling of wheels of bore spacers.

### **3.12 FIELD QUALITY CONTROL**

- A. Notify the Engineer for inspection and sign-off of the following installations:

1. Conduits to be direct buried: Notify the Engineer prior to covering.
  2. Completed underground installations: Obtain the Engineer's inspection and acceptance before installation of cable and equipment.
  3. Conduits to be embedded in concrete: Obtain the Engineer's inspection and acceptance before issuing concrete pouring permit.
  4. Mandrelling and swabbing (to be witnessed by the Engineer).
  5. Installation of pull cords (to be witnessed by the Engineer).
- B. Document each mandrelled or swabbed conduit and submit test report.

**END OF SECTION**