SECTION 16111

CONDUIT

PART 1 - GENERAL

1.01 SCOPE

A. The work covered by this section includes furnishing all labor, equipment, and materials required to install electrical conduit and fittings as specified herein and/or shown on the Drawings.

B. The Contractor's attention is called to the fact that all conduits and conduit fittings are not necessarily shown completely on the Drawings, which are more or less schematic. However, the Contractor shall furnish and install all conduit and conduit fittings indicated or required for the proper connection and operation of all equipment and services requiring such conduit.

1.02 SHOP DRAWINGS AND ENGINEERING DATA

Shop drawings and engineering data shall be submitted in accordance with the requirements of the section entitled "Submittals" of these Specifications.

1.03 STORAGE AND PROTECTION

Store and protect conduit and fittings in accordance with the manufacturer's recommendations and the requirements of the section entitled "General Equipment Stipulations" of these Specifications. Conduit shall be stored aboveground and adequately supported.

1.04 GUARANTEE

Provide a guarantee against defective equipment and workmanship in accordance with the requirements of the section entitled "Guarantees and Warranties" of these Specifications.

PART 2 - PRODUCTS

2.01 GENERAL

A. Unless otherwise shown or specified, all conduits shall be rigid metal or intermediate metal conduit.

B. Where specifically indicated on the Drawings, rigid nonmetallic conduit may be used for encased buried power and motor control wiring. Under no circumstances will rigid nonmetallic conduit be used for instrumentation and low-level signal wiring.

C. Conduits carrying instrumentation wiring and conduits carrying low voltage (less than 600 volts) power and control wiring may be run in the same trench if all conduits are rigid metal or intermediate metal.

D. Conduit terminations at electrical equipment such as electric motors and heaters shall be made using liquid-tight, flexible metal conduit.

E. Buried, nonencased rigid metal conduit run along the outside walls of concrete or masonry structures shall be plastic-coated.

F. Damaged, dented, flattened, or kinked conduit shall not be used.

2.02 RIGID METAL CONDUIT

Rigid metal conduit shall be heavy wall, mild steel conduit conforming to ANSI C80.1 and Federal Specification WW-C-581, hot dip galvanized both inside and out. All conduits shall bear the approved stamp of the Underwriters Laboratories and shall be as manufactured by Republic Steel, General Electric, General Cable, or equal.

2.03 INTERMEDIATE METAL CONDUIT

Intermediate metal conduit shall be intermediate wall, high strength steel conduit conforming to Federal Specification WW-C-581E, hot-dip galvanized both inside and out. Intermediate metal conduit shall bear the approved stamp of the Underwriters Laboratories and shall be approved by the National Electrical Code as a direct substitute for rigid metal conduit in all uses and occupancies, including hazardous locations.

2.04 RIGID NONMETALLIC CONDUIT

A. Rigid nonmetallic conduit for voltages 600 volts and less shall be SCH 40 heavy wall polyvinyl chloride (PVC) electrical conduit rated for 90EC conductors and conforming to NEMA TC-2, Type EPC-40-PVC. It shall be listed by Underwriters Laboratories in conformance with the National Electrical Code. Conduit fittings, elbows, and joint cement shall be produced by the same manufacturer as the conduit. Conduits shall be as manufactured by Carlon, Borg-Warner, or equal.

B. Rigid nonmetallic conduit for voltages higher than 600 volts shall be polyvinyl chloride (PVC) power duct rated for 90EC conductors and conforming to NEMA TC-6, Type DB. Conduit fittings, elbows, and joint cement shall be produced by the same manufacturer as the conduit. Conduit shall be as manufactured by Carlon, Olin, or equal.

2.05 PLASTIC-COATED RIGID METAL CONDUIT

A. Rigid metal conduit prior to application of plastic coating shall conform to Part 2.02, Rigid Metal Conduit, of this section.

B. Plastic coating shall be polyvinyl chloride (PVC) bonded to the metal a uniform thickness of 40 mils the full length of the conduit except the threads. The bond between the metal and PVC coating shall be equal or greater than the tensile strength of the PVC coating.

C. A coupling shall be furnished loose with each length of conduit and shall have a PVC sleeve extending one pipe diameter or 2 inches, whichever is least, beyond the end of the coupling. Elbows shall have the same thickness of PVC coating as on the conduit. All threaded conduit and elbow ends shall have plastic thread protectors.

D. The rigid steel galvanized PVC coated conduit and fittings shall be KorKap as manufactured by Plastic Applicators, Houston, Texas; Plasti-Bond as manufactured by Pittsburgh Std. Div. of Robroy Industies, Verone, Pa.; or equal.

2.06 LIQUID-TIGHT FLEXIBLE METAL CONDUIT

Flexible conduit shall have an oil-resistant, liquid-tight jacket in combination with flexible metal reinforcing tubing and shall be designed for use with waterproof fittings. An integral ground wire shall be included. Flexible conduit shall be American Brass Sealtite Type UA as manufactured by Electric-Flex Company; Flexible Metallic Conduit as manufactured by Ideal Industries, Inc.; or equal. Only Underwriter's Laboratories approved fittings shall be used.

2.07 CONDUIT FITTINGS AND BUSHINGS

A. Wherever conduits terminate in sheet steel boxes, double bonding type locknuts and bushings shall be used except when terminating in cast hubs. All bushings shall be insulated metallic type, equal to O. Z. Electrical Manufacturing Company, Type B; T & B Company, 1200 Series; Appleton Electric Company, Type BU-I; or equal.

B. Where conduits terminate in steel or cast NEMA 4 enclosures with no factory-installed threaded hubs, a threaded hub shall be installed equal to Myers Electric Products, Inc., Type ST or STG; Appleton Electric Company, Type HUB; Crouse-Hinds, Type HUB; or equal.

C. All conduits terminating at motor control centers shall be suitably grounded to the motor control center ground bus using grounded type insulated bushings equal to O. Z. Electrical Manufacturing Company, BLB or IGB; Appleton, Type BIB; Thomas and Betts, 3800 Series; or equal.

D. Conduit expansion fittings shall be O. Z. Electrical Manufacturing Company, Type EX with Bonding Jumper, Type XJ; Appleton, Type SJ with Type XJB4 Bonding Jumpers; Crouse-Hinds, Type XJ with GC100 Bonding Jumper; or equal.

2.08 CONDUIT BOXES

Exposed conduit boxes and pulling elbows shall be of die-cast, copper-free aluminum with threaded body and removable neoprene-gasketed cover. Conduit boxes shall conform to Federal Specification W-C-586a and shall be Crouse-Hinds "Condulet," Appleton "Unilet Form 85," or equal.

PART 3 - EXECUTION

3.01 GENERAL

A. Minimum size conduit shall be 3/4 inch aboveground and 1 inch below ground except where noted otherwise, and no conduit shall have more than 40 percent of its internal area occupied by conductors.

B. During construction all installed conduits shall be temporarily plugged, capped, or otherwise protected from the entrance of dust, trash, moisture, etc., and any conduits which may become clogged shall be replaced. No conductor shall be pulled in until all work that might cause damage to the conduit or conductors has been completed.

C. Conduit connections to sheet metal enclosures shall be securely fastened by double lock nuts inside and outside and shall have grounding bushings.

D. Conduit straps or brackets secured to concrete, brick, or masonry shall be by means of expansion bolts, toggle bolts, or approved drill anchors. No wood plugs will be permitted.

E. Conduits supported from building walls shall be installed with at least 1/4-inch clearance from the wall using pipe spacers equal to Appleton Electric Company, T & B Company, Steel City, or equal. Clamp back to prevent the accumulation of dirt and moisture behind the conduit.

F. Unless otherwise shown or specified, exposed rigid conduit shall be installed parallel or at right angles to structural members, surfaces, and building walls.

G. Two or more conduits in the same general routing shall be parallel with symmetrical bends.

H. Conduits shall be at least 12 inches from high temperature piping, ducts, and flues.

I. Conduit installed horizontally shall allow headroom of at least 7 feet, except where it may be installed along structures, piping, equipment, or in other areas where headroom cannot be maintained because of other considerations.

J. Wherever necessary and where shown on the Drawings, conduit boxes and pulling elbows shall be inserted in the lines. Gaskets shall be used to ensure a dust and watertight installation on all conduit boxes and fittings.

K. All bends and turns in conduits shall have a bend radius of not less than six (6) times the internal diameter of the conduit. Bends shall be made using an approved bender to provide smooth bends with no kinks, dents, or flattening.

L. All conduit shall be run concealed wherever practical. Unless otherwise shown or required, conduit 2 inches and larger shall be run exposed.

M. All concealed conduit shall be placed in walls, floors, ceilings, or slabs at the proper time in accordance with the progress of meeting schedules and shall not delay the structural work unnecessarily. Conduits embedded in concrete shall be blocked and braced in place by use of adequate conduit separators to prevent displacement during pouring of the concrete. Where conduit interferes with structural steel, steel reinforcement, or in the opinion of the Engineer occupies too much space in the slab, the conduits shall be rearranged or installed exposed as directed by the Engineer or required. No additional payment will be made for such rearrangement of conduit whether or not additional conduit or fittings might be required.

N. Conduit wall seals with water stops shall be installed in outside walls below grade for all incoming or outgoing underground conduit emerging directly into the building area. The conduit wall seals shall have a pressure ring and sealing grommet to ensure a watertight installation.

O. Conduit expansion fittings and ground bonding jumpers shall be installed on all conduits passing through building expansion joints to provide movement in the conduit system.

P. Where groups of conduits terminate together or pass through floors, provide template to hold conduits in proper relation to each other and to building.

Q. Conduits shall be plugged or capped with plastic caps during construction to protect threads and prevent entrance of dirt and water.

R. Conduits shall be adequately supported at intervals as required by the National Electrical Code. One to two exposed conduits running parallel to each other may be supported by strap anchors, or one-hole clamps (walls only). Exposed conduits larger than 2 inches or groups of more than two conduits run parallel shall be supported by means of minimum 12 gauge, slotted steel channels fitted with two-piece, bolted pipe clamps. All conduit supports, clamps, straps and brackets shall be heavily hot dip galvanized for corrosion resistance.

S. Runs of conduit shall not contain more than four 90-degree bends (360 degree total) between conduit boxes panelboards, or terminations. In general and to the extent practical length of conduit runs between conduit boxes or similar means of access shall not exceed 100 feet.

T. Exposed service entrance conduits and main feeder conduits shall be identified using stenciled letters at intervals not to exceed 20 feet. Size of letters shall be equal to one-half the diameter of the conduit or 2 inches, whichever is less.

3.02 INSTALLATION OF RIGID METAL AND INTERMEDIATE METAL CONDUIT

A. Terminations and connections of rigid and intermediate metal conduit shall be threaded. Conduits shall be reamed free of burrs and terminated with insulated metallic conduit bushings.

B. Conduit threads shall be coated with a petroleum base corrosion-inhibitor with low electrical contact resistance before assembly equal to Burndy Engineering Company, Inc., Penetrax "A" or equal screw thread lubricant (zinc-petroleum or zinc-chromate compounds are permissible).

C. All conduits shall be suitably grounded to the plant ground grid using grounded type insulated bushings, O. Z. Electrical Manufacturing Company, Type BLG or IGB; T & B Company; Appleton Electric Company, or equal.

D. Conduit across structural joints where structural movement is allowed shall have bonded, weathertight expansion and deflection fitting the same size as the conduit.

E. Support spacing for conduits 1 inch and smaller shall not exceed 6 feet, and conduits 1-1/4 inches and larger shall not exceed 10 feet. Supports shall be cadmium-plated steel or galvanized iron. Conduits 1-1/2 inch and smaller may be supported by one-hole conduit straps and 2 inch and larger shall be supported by two-hole conduit straps. Conduit racks shall be as manufactured by Unistrut, Kindorf, or equal.

F. Conduit joints shall be made up tight using a pipe wrench. Channel lock pliers will not be permitted, and unions shall be used as necessary to aid in the installation. Conduits shall be cut square and the ends reamed smooth after threading to prevent injury to conductors. Conduit joints in concrete or exposed to weather or damp locations shall be drawn up tight and coated with insulating paint before casting in concrete or painting exposed conduit system.

3.03 INSTALLATION OF RIGID NONMETALLIC CONDUIT

A. Field bending of polyvinyl chloride conduit shall be made with appropriate equipment. No torches or flame-type devices shall be used.

B. When joints are to be made with polyvinyl chloride conduit, the conduit shall be cut with a fine-tooth saw and deburred. Conduit ends shall be wiped clean of dust, dirt, and shavings and shall be dry. A solvent cement shall be applied to bond the joint. The joint should be watertight.

C. Polyvinyl chloride conduit shall be installed in accordance with the manufacturers' specifications and recommendations.

3.04 INSTALLATION OF LIQUID-TIGHT FLEXIBLE METAL CONDUIT

A. Terminations at motors shall be made with flexible liquid-tight metal conduit from conduit stub to terminal box; flexible connection shall be made as short as possible. Flexible conduit shall be Type UA, black. Underwriter's Laboratories approved flexible liquid-tight conduit connectors shall be as manufactured by Thomas and Betts Company, Appleton Electric Company, or equal.

B. Uncoated flexible metal conduit may be used for short connections between junction boxes and lighting fixtures or speakers installed in suspended ceiling systems. Flexible metal conduit shall be connected using Underwriters Laboratories approved grounding connectors.

3.05 INSTALLATION OF PLASTIC-COATED RIGID METAL CONDUIT

A. Conduits shall be installed per manufacturer's recommendations.

B. Joints shall be drawn up tight using a strap wrench. Touch up any damage to the polyvinyl chloride coating with a liquid polyvinyl chloride patching compound.

C. Support spacings and spacers shall conform to Part 3.02 of this section.

3.06 INSTALLATION OF UNDERGROUND CONDUIT

A. All underground conduits shall be concrete-encased unless otherwise noted on the Drawings or directed by the Engineer. No conduit shall be concealed or encased until the Engineer has inspected the conduit for proper installation and accurate placement.

B. The Contractor shall be responsible for all excavating, draining, trenches forming of duct assembly and protective concrete envelope, backfilling, and removal of excess earth.

C. Underground conduit shall be installed with a minimum 3-inch per 100-foot downward slope for drainage. Drains shall be provided at all low points.

D. Bends and turns shall be made using long sweeps. Ninety-degree bends will be used only where required and shall be kept at a minimum.

E. Where rigid nonmetallic conduits emerge from underground, an adapter from rigid nonmetallic conduit to rigid metal conduit shall be installed and all exposed conduit shall be rigid metal conduit.

F. All rigid metal conduit risers shall be protected with two coats of a Bitumastic compound before concrete is poured from a point 12 inches below grade to a point not less than 6 inches above grade or surface of concrete. All stub-ups shall extend upward with one length of rigid metal conduit until after concrete is poured to assure vertical alignment.

G. Conduits shall be backfilled with crushed stone (pug 33P, Type A, Grade D).

H. All underground conduit runs for voltages less than 600 volts shall be at least 24 inches below grade and shall have a minimum conduit separation of 3 inches.

I. All underground conduit runs for voltages over 600 volts shall be at least 36 inches below grade and shall have a minimum conduit separation of 6 inches. Conduit shall have a minimum 6-inch concrete cover on all sides.

J. All underground conduit runs shall be rodded and a mandrel drawn through followed by a swab to clean out any obstructions which may cause cable abrasions. The mandrel shall be 12 inches in length and the diameter 1/2 inch less than the inside diameter of the conduit.

K. All underground conduit runs shall be marked by a strip of permanently-colored red polyethylene tape, 0.004 inch thick and 6 inches wide, buried above the conduit and 6 inches below finished grade.

L. Unless otherwise shown, at least 20 percent spare conduits, but not fewer than one, of each size required shall be provided with water-proof plugs at stub-ups and shall be furnished with No. 8 aluminum pulling wire.

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