

SECTION 16110

RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the contract including General and Special Conditions and General Requirements shall apply to all work under this Section.

1.2 DESCRIPTION OF WORK

- A. Provide complete raceways systems, boxes and fittings for all required electrical systems.

1.3 RELATED WORK IN OTHER SECTIONS

- A. Related work in other sections:
 - 1. Electrical General Provisions Section 16010
 - 2. Wiring Devices Section 16140
 - 3. Electrical Identification Section 16195

1.4 STANDARDS

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
 - 1. Rigid Steel Conduit
 - a) U.L. Standard UL-6
 - b) A.N.S.I. C80-1
 - c) Federal Specification WW-C-581E
 - 2. Intermediate Metallic Conduit
 - a) U.L. Standard UL-1242
 - b) Federal Specification WW-C-581E
 - 3. Electrical Metallic Tubing
 - a) U.L. Standard UL-797
 - b) A.N.S.I. C80-3
 - c) Federal Specification WW-C-563
 - 4. Flexible Steel Conduit
 - a) U.L. Standard UL-1
 - 5. Liquid Tight Flexible Conduit
 - a) U.L. Standard UL-360
 - 6. Non-Metallic Conduit
 - a) U.L. Standard UL-651
 - b) A.N.S.I. Standard F512
 - c) N.E.M.A. Standard TC-2
 - d) Federal Specifications GSA-FSS and W-C-1094-A
 - 7. Wireways and Auxiliary Gutters
 - a) U.L. Standard UL-870
 - 8. Rigid Aluminum Conduit
 - a) A.N.S.I. C80.5

1.5 SUBMITTALS

- A. Provide manufacturer's catalog cuts of fittings.
- B. Where wireways and/or auxiliary gutters are employed full erection drawings must be submitted. Drawings to include plan views, elevations, size of wireways, type and quantity of conductors proposed to be installed therein, etc.
- C. Indicate duct banks or multi-trade coordinated shop drawings.

- D. Submit shop drawings or catalog descriptive data on boxes exceeding twenty-four (24") inches for any one dimension.
- E. Submit shop drawings or catalog descriptive for floor boxes and accessories.

PART 2 - PRODUCTS

2.1 RACEWAY TYPES

- A. Standard Threaded Rigid Steel Conduit.
 - 1. Rigid conduit heavy wall galvanized.
 - 2. Threaded type fittings: "Erickson" couplings where threaded cannot be used.
- B. Intermediate Metallic Conduit
 - 1. Light weight rigid steel conduit.
 - 2. Threaded type fittings: "Erickson" couplings where threaded cannot be used.
- C. Electrical Metallic Tubing
 - 1. Continuous, seamless tubing, galvanized or sheradized on the exterior, coated on the interior with a smooth hard finish of lacquer, varnish, or enamel.
 - 2. Couplings and connectors:
 - a) Indoor and two (2") inches in size and smaller, shall be steel set-screw type fittings.
 - b) 2-1/2 inch size and larger must employ steel compression gland fittings.
 - c) Outdoor shall be raintight steel compression gland fittings.
 - 3. Indent type fittings shall not be used.
 - 4. All connectors shall have insulated throat.
 - 5. Where installed in slab or concrete work, provide approved concrete tight fittings.
- D. Flexible Steel Conduit
 - 1. Single strip, continuous, flexible interlocked, double-wrapped steel, galvanized inside and outside, forming smooth internal wiring channel.
 - 2. Maximum length: (six 6) feet, except where fished.
 - 3. Each section of raceway must contain an equipment grounding wire bonded at each end and sized as required. Provide connectors with insulating bushings.
 - 4. Steel squeeze-type or steel set screw type fittings.
- E. Liquid Tight Flexible Electrical Conduit
 - 1. Same as flexible steel conduit except with tough, insert water-tight plastic outer jacket.
 - 2. Cast malleable iron body and gland nut, cadmium plated with one-piece brass grounding bushings which thread to interior of conduit. Spiral molded vinyl sealing ring between gland nut and bushing and nylon insulated throat.
- F. Non-Metallic Raceway
 - 1. Composed of polyvinyl chloride suitable for 90 degrees C.
 - 2. Raceway, fittings, and cement must be produced by the same manufacturer who must have had a minimum of ten (10) years experience in manufacturing the products.
 - 3. Materials must have a tensile strength of 7,000-7,200 psi at 73.4 degrees F., flexural strength of 12,000 psi and compressive strength of 9,000 psi.
 - 4. All joints shall be solvent cemented in accordance with the recommendations of the manufacturer.
- G. Wireways and Auxiliary Gutters
 - 1. Painted steel or galvanized steel.
 - 2. Of sizes and shapes indicated on the Drawings and as required.
 - 3. Provide all necessary elbows, tees, connectors, adapters, etc.
 - 4. Wire retainers not less than twelve (12") inches on center.
- H. Duct Banks
 - 1. Provide duct banks and concrete encasements for both interior and exterior work as indicated on the Drawings and for all circuits in excess of 600 volts and as otherwise indicated.
 - 2. Concrete shall be minimum $f_c = 3,000$ pounds per square inch.

3. Support raceways installed in duct banks every five (5) feet to assure correct alignment.
 4. Terminate raceways with flared bells to enable ease of pulling cable and to eliminate stress on the cable. Free bells and raceway terminations of burrs and rough edges.
 5. Provide concrete markers at grade where duct banks are stubbed out for future use.
 6. Install utility duct banks not less than thirty (30") inches below grade top elevation.
 7. Provide rigid steel elbows for vertical risers.
 8. Provide vinyl tracer ribbon twelve (12") inches above each duct bank buried in backfill.
- I. Aluminum Conduit
1. Do not use aluminum conduit unless specifically indicated on the drawings for special purposes.
- 2.2 LOCKNUTS AND BUSHINGS
- A. Locknuts shall be steel. Die cast locknuts shall not be used.
- B. All bushings shall be insulated. Use nylon insulated metallic bushings for sizes 1" and larger. Plastic bushings may be used in 1/2" and 3/4" sizes.
- 2.3 OUTLET, JUNCTION, AND PULL BOXES
- A. Cast Type Conduit Boxes, Outlet Bodies and Fittings
1. Provide surface mounted outlet and junction boxes, in indoor locations, where exposed to moisture and in outdoor locations.
 2. Use Ferrous Alloy boxes and conduit bodies with Rigid Steel or IMC.
 3. Use Ferrous Alloy or cast aluminum boxes and conduit bodies with Electrical Metallic Tubing.
 4. Covers: Cast or sheet metal unless otherwise required.
 5. Tapered threads for hubs.
- B. Galvanized Pressed Steel Outlet Boxes
1. General
 - a) Pressed steel, galvanized or cadmium-plated, minimum of four (4") inches, octagonal or square, with galvanized cover or extension ring as required.
 2. Concrete Box
 - a) Four (4") inch octagon with a removable backplate and 3/8" fixture stud, if required. Depth of box shall allow for a minimum of one (1") inch of concrete to be poured above the backplate.
 3. Switch and Receptacle Box, Indoors
 - a) Nominal four (4") inches square, 1-1/2" or 2-1/8" deep as required, with raised cover unless otherwise indicated on drawings. Gangable boxes shall not be used.
 4. Telephone outlet box, Indoors
 - a) Nominal four (4") inches square, 2-1/8" deep, with raised cover unless otherwise indicated on drawings. Gangable boxes shall not be used.
 5. Lighting Fixture Box
 - a) Four (4") inch octagon with 3/8" fixture stud.
 - b) For suspended ceiling work, four (4") inch octagon with removable backplate where required, and two (2) parallel bars for securing to the cross-furring channels and extend flexible conduit to each fixture.
 6. Plug any open knockouts not utilized.
- C. Sheet Steel Boxes Indoors
1. No. 12 USS gauge sheet steel for boxes with maximum side less than forty (40") inches, and maximum area not exceeding 1,000 square inches; riveted or welded 3/4 inch flanges at exterior corners.
 2. No. 10 USS gauge sheet steel for boxes with maximum side forty (40") to sixty (60") inches, and maximum area 1,000 to 1,500 square inches; riveted or welded 3/4 inch flanges at exterior corners.
 3. No. 10 USS gauge sheet steel riveted or welded to 1-1/2 by 1-1/2" by 1/4" welded angle iron framework for boxes with a maximum side exceeding sixty (60") inches and more than 1,500 square inches in area.
 4. Covers

- a) Same gauge steel as box.
 - b) Subdivided single covers so no section of cover exceeds fifty (50) pounds.
 - c) Machine bolts, machine screws threaded into tapped holes, or sheet metal screws as required; maximum spacing twelve (12") inches.
5. Paint
- a) Rust inhibiting primer; ANSI No. 61 light gray finish coat.
6. Where size of box is not indicated, size to permit pulling, racking and splicing of cables.
7. For Boxes over 600 Volts
- a) Provide insulated cable supports and removable steel barriers to isolate each feeder. Stencil cable voltage class in red letters on the front cover of the box.
 - b) Braze a ground connector suitable for copper cables to the inside of the box.
- D. Pull and Splice Boxes, Outdoors
- 1. Aluminum reinforced, with removable covers secured by brass machine screws.
 - 2. Where size of box is not indicated, size to permit pulling, racking, and splicing of the cables.
 - 3. Braze a ground connector suitable for copper cables to the inside of the box.
- E. Junction Box, Sidewalk Type
- 1. Cast iron, hot-dipped galvanized with threaded conduit entrance hubs, flanged, reinforced checkered cover, gasketed with pry bar slots and countersunk stainless steel screws.
- F. Floor Boxes
- 1. General
 - a) Class I, water-tight, normal depth cast iron construction Type I, fully adjustable, for use in concrete.
 - b) Single Gang Round type.
 - c) Multiple Gang or Combination.
 - i) Rectangular type partitions for separating power from communication sections.
 - 2. Floor Box Covers
 - a) Rugged construction, impervious to cleaning detergents.
 - b) Compatible with floor covering.
 - c) Brass or bronze for flush mounting.
 - d) Providing continuous ground path to box.
 - e) Provide carpet flange in carpeted areas.

PART 3 - EXECUTION

3.1 APPLICATION OF RACEWAYS

- A. The following applications must be adhered to except as otherwise required by Code. Raceways not conforming to this listing must be removed by this Contractor and replaced with the specified material at this Contractors expense.
- 1. Rigid Steel - Application: Where exposed to mechanical injury, where specifically required, where required by codes and for all circuits in excess of 600 volts.
 - 2. I.M.C. - Application: Same as standard threaded rigid steel conduit.
 - 3. E.M.T. - Applications: Use in every instance except where another material is specified. EMT shall not be used underground or in slab on grade.
 - 4. Flexible Steel - Applications: Use in dry areas for connections to lighting fixtures in hung ceilings, connections to equipment installed in removable panels of hung ceilings at bus duct takeoffs, at all transformer or equipment raceway connections where sound and vibration isolation is required. Fish in concealed locations of hollow walls and above hard ceilings only when other non-flexible raceway installation is not possible, or would damage building finishes.
 - 5. Liquid-Tight Flexible Conduit - Applications: Use in areas subject to moisture where flexible steel is unacceptable at connections to all motors, and all raised floor areas.
 - 6. Non-Metallic Conduit - Application: Schedule 40 - Where specifically indicated on the drawings and for raceways in slab or below grade. All bends shall be made with wrapped steel elbows unless the bend is encased in concrete.

7. Wireways and Auxiliary Gutters - Application: Where indicated on the Drawings and as otherwise specifically approved.

3.2 RACEWAY SYSTEMS IN GENERAL

- A. Provide raceways for all wiring systems, including security, data transmission, paging, low voltage et. al. 277/480 volt wiring shall be kept independent of 120/208 volt wiring. Emergency system wiring shall be kept independent of the normal system wiring. Where non-metallic raceways are utilized, provide sizes as required with the grounding conductor considered as an insulated additional conductor. Wiring of each type and system must be installed in separate raceways.
- B. Install capped bushings on raceways as soon as installed and remove only when wires are pulled. Securely tie embedded raceway in place prior to embedment. Lay out the work in advance to avoid excessive concentrations of multiple raceway runs.
- C. Locate raceways so that the strength of structural members is unaffected and they do not conflict with the services of other trades. Install one (1") inch or larger raceways, in or through structural members (beams, slabs, etc.) only when and in the manner accepted by the Architect/Engineer. Draw up couplings and fittings full and tight.
- E. Above-grade raceways to comply with the following:
 1. Install raceways concealed except at surface cabinets and for motor and equipment connection in electrical and mechanical rooms. Install a minimum of six (6") inches from flues, steam pipes, or other heated lines. Provide flashing and counter-flashing for waterproofing of raceways, outlets, fittings, etc., which penetrate the roof. Route exposed raceways parallel or perpendicular to building lines with right-angle turns and symmetrical bends. Run concealed raceways in a direct line and, where possible, with long sweep bends and offsets. Provide sleeves in forms for new concrete walls, floor slabs, and partitions for passage of raceways. Waterproof sleeved raceways where required.
 2. Raceways shall not be run on roofs or exposed on the outside of the buildings unless specifically noted as exposed on the drawings or approved by the Architect/Engineer.
 3. Provide raceway expansion joints for exposed and concealed raceways with necessary bonding conductor at building expansion joints and between buildings or structures and where required to compensate for raceway or building thermal expansion and contraction. Provide expansion fittings every 200 feet on outdoor conduit.
 4. Provide one (1) empty 3/4 inch raceway for each three (3) spare unused poles or spaces of each flush-mounted panelboard. Terminate empty 3/4 inch conduit in a junction box, which after completion, is accessible to facilitate future branch circuit extension.
 5. Provide raceway installation (with appropriate seal-offs, explosion-proof fittings, etc.) in special occupancy area, as required. Provide conduit seal-offs where portions of an interior raceway system pass through walls, ceiling, or floors which separate adjacent rooms having substantially different maintained temperatures, as in refrigeration or cold storage rooms.
 6. Provide pull string in spare or empty raceways. Allow five (5) feet of slack at each end and in each pull box. Tie each end of the string to a washer or equivalent that does not fit into the conduit. Tag both ends of string denoting opposite end termination location.
- F. Below Grade
 1. Below grade raceways to comply to the following:
 - a) Do not penetrate waterproof membranes unless proper seal is provided.
 2. Protect steel raceway in earth or fill with two (2) coats of asphalt base paint. Touch up abrasions and wrench marks after conduit is in place.
 3. In lieu of the above, protect steel raceways with a minimum of ten (10) mil tape approved for the purpose and overlapped a minimum of one-half tape width to provide a minimum twenty (20) mil thickness.
- G. No raceway may be installed in a concrete slab or members except with the permission of the Structural Engineer and with the written consent of the Owner.

1. Conduits embedded in structural concrete slabs shall have an outside diameter less than one third of the thickness of the concrete slab and shall be installed entirely within the center one third of the concrete slab.
 2. Raceways embedded in concrete slabs shall be spaced not less than eight (8") inches on centers and as widely spaced as possible where they converge at panels or junction boxes.
 3. In no case will installation of raceways be permitted to interfere with the proper placement of principal reinforcement.
 4. Raceways running parallel to slab supports, such as beams, columns, and structural walls, shall be installed not less than twelve (12") inches from such supporting elements.
 5. To prevent displacement during concrete pour of lift slab, saddle supports for conduit, outlet boxes, junction boxes, inserts, etc., shall be secured with suitable adhesives.
- H. Non-metallic raceway installation shall conform to the following:
1. All joints are to be made by the solvent cementing method using the material recommended by the raceway manufacturer. To insure good joints, components shall be cleaned prior to assembly.
 2. Raceway cut-offs shall be square and made by handsaw or other approved means which does not deform the conduit. Raceway shall be reamed prior to solvent cementing to couplings, adapters, or fittings.
 3. Electrical devices which are served by PVC raceways shall be grounded by means of a ground wire pulled in the raceway.
 4. Bends shall be made by methods that do not deform or damage the conduit. The radii of field bends shall not be less than those established by the N.E.C.
 5. Raceway expansion fittings shall be provided where necessary. The position of the expansion fitting shall be adjusted proportional to the temperature at installation.
 6. Raceway supports shall be installed, in such a manner, to allow the PVC conduit to slide through the supports as the temperature changes.
 7. Elbows must be galvanized rigid steel, intermediate metallic conduit or concrete encased.
- I. Raceways in hung ceiling shall be run on and secured to slab or primary structural members of ceiling, not to lathing channels or T-bars, Z-bars, or other elements which are the direct supports of the ceiling panels. Secure conduit firmly to steel by clips and fittings designed for that purpose. Install as high as possible, but not less than 1'-0" above hung ceilings.
- J. Exposed raceways shall be run parallel or at right angles with building lines. Secure raceway clamps or supports to masonry materials by toggle bolts, expansion bolts, or steel inserts. Install raceway on steel construction with approved clamps which do not depend on friction or set screw pressure alone.
- K. Clear raceway of all obstructions and dirt prior to pulling in wires or cables. This shall be done with ball mandrel (diameter approximately 85% of conduit inside diameter) followed by close fitting wire brush and wad of felt, or similar material. This assembly may be pulled in together with, but ahead of, the cable being installed. All empty raceways shall be similarly cleaned. Clear any raceway which rejects ball mandrel.
- L. Support raceways at intervals no greater than ten (10) feet and with one support within three (3) feet of each coupling, box, fitting, or outlet box. Provide one support within three (3) feet of each elbow or bend.

3.3 OUTLET, JUNCTION, AND PULLBOXES

- A. Provide outlet, junction, and pullboxes as indicated on the drawings and as required for the complete installation of the various electrical systems, and to facilitate proper pulling of wires and cables. J-boxes and pullboxes shall be sized per electrical code minimum. Boxes on empty conduit systems shall be sized as if containing conductors of #4 AWG.
- B. Install boxes and covers for wiring devices so that the wiring devices will be installed with a vertical orientation unless otherwise noted on the drawings.
- C. The exact location of outlets and equipment is governed by structural conditions and obstructions, or other equipment items. When necessary, relocate outlets so that when fixtures or equipment are installed, they will be symmetrically located according to the room

layout and will not interfere with other work or equipment. Verify final location of outlets, panels equipment, etc., with Architect.

- D. Back-to-back outlets in the same wall, or "thru-wall" type boxes not permitted. Provide twelve (12") inch (minimum) spacing for outlets shown on opposite sides of a common wall to minimize sound transmission. Provide twenty four (24") inch (minimum) horizontal spacing for outlets shown on opposite sides of a fire rated wall to maintain fire rating.
- E. Fit outlet boxes in finished ceilings or walls with appropriate covers, set flush with the finished surface. Where more than one switch or device is located at one point, use gang boxes and covers unless otherwise indicated. Sectional switch boxes or utility boxes will not be permitted. Provide Series "GW" (Steel City) tile box, or as accepted, or a four (4") inch square box with tile ring in masonry walls, which will not be plastered or furred. Where drywall material is utilized, provide plaster ring. Provide outlet boxes of the type and size suitable for the specific application. Where outlet boxes contain two (2) or more 277 volt devices, or where devices occur of different applied voltages, or where normal and emergency devices occur in same box, provide suitable barrier.
- F. Pull Box Spacing
 - 1. Provide pull boxes so no individual conduit run contains more than the equivalent of four (4) quarter bends (360 degrees total).
 - 2. Conduit Sizes 1-1/4" and Larger.
 - a) Provide boxes to prevent cable or wire from being excessively twisted, stretched, or flexed during installation.
 - b) Provide boxes for medium voltage cables so that maximum pulling tensions do not exceed cable manufacturer's recommendations.
 - c) Provide support racks for boxes with multiple sets of conductors do not rest on any metal work inside box.
 - 3. Conduit Sizes one (1") inch and smaller, low voltage wire and cable (maximum distances)
 - a) 200 feet straight runs.
 - b) 150 feet runs with one 90 degree bend or equivalent.
 - c) 125 feet runs with two 90 degree bends or equivalent.
 - d) 100 feet runs with three or four 90 degree bends or equivalent.
- G. Floor Boxes
 - 1. Prior to Concrete Pour
 - a) Firmly support boxes.
 - b) Adjust leveling screws to insure box covers are flush with finished floor.
 - c) Plug unused opening with proper fittings and seal joints with compound for exclusion of concrete and moisture.
 - 2. After Concrete Pour
 - a) As soon as traffic is permitted on slab, remove any accumulation of water and foreign matter to avoid corrosion and rust.
 - b) Insure covers are flush with finished floor.
 - c) Install cover plates and accessories after floor finishing materials have been installed.

-- End of Section --