

## SECTION 16110 RACEWAYS

## PART 1 GENERAL

## 1.1 SUMMARY:

- A. Extent of raceway work is indicated by drawings and schedules. Provide complete conduit systems for all conductors unless otherwise specified.
- B. Types of raceways specified in this section include the following:
  - 1. Electrical metallic tubing (EMT).
  - 2. Flexible metal conduit.
  - 3. Intermediate metal conduit (IMC).
  - 4. Liquid-tight flexible metal conduit.
  - 5. Non-metallic Conduit and Ducts.
  - 6. Rigid metal conduit (RGC).
  - 7. Surface metal raceways.
  - 8. Wireways.
  - 9. Rigid Aluminum Conduit.

## 1.2 QUALITY ASSURANCE:

- A. Manufacturers: Firms regularly engaged in manufacture of raceway systems of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with electrical raceway work similar to that required for this project.

## 1.3 SUBMITTALS:

- A. Product Data: Submit manufacturer's technical product data, including specifications and installation instructions, for each type of raceway system required. Include data substantiating that materials comply with requirements.
- B. Shop Drawings: Submit dimensioned drawings of surface metal raceway systems showing layout of raceways and fittings, spatial relationships to associated equipment, and adjoining raceways, if any. Show connections to electrical power panels and feeders.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS:

- A. Subject to compliance with requirements, provide products by the following:
  - 1. Rigid Metal Conduit:
    - a. Allied
    - b. Wheatland
    - c. Triangle
    - d. Western Tube & Conduit

2. Intermediate Metal Conduit (IMC):
  - a. Allied
  - b. Triangle
  - c. Western Tube & Conduit
3. PVC Coated:
  - a. Rob Roy
  - b. Perma Cote
  - c. OCAL
4. EMT Conduit:
  - a. Allied
  - b. Republic
  - c. Triangle
  - d. LTV
  - e. Western Tube & Conduit
5. Non-Metallic Conduit:
  - a. Carlon
  - b. MPF
  - c. Can-Tex
  - d. PW
6. Steel Fittings:
  - a. O/Z Gedney
  - b. Raco
  - c. Appleton
  - d. EPT
  - e. Midwest
  - f. Picoma
  - g. Steel City
7. Die-cast Fittings:
  - a. Regal
  - b. Bridgeport
  - c. Halex
  - d. Raco
8. Conduit Bodies:
  - a. O/Z Gedney
  - b. Killark
  - c. Regal
  - d. Appleton
  - e. Crouse Hinds
9. Surface Metal Raceways:
  - a. Wiremold Co.
  - b. Airey Thompson Co.

- c. B-Line Systems, Inc.
- d. Isoduct Energy Systems
- e. Square D. Co.
- f. Mono-Systems, Inc.

10. Wireway:

- a. Square D. Co.
- b. Circle AW Products
- c. Erickson Electric Equipment Co.
- d. G.S. Metals Corp.
- e. Hoffman Engineering Co.
- f. Wadsworth Electric Mfg. Co., Inc.

2.2 METAL CONDUIT AND TUBING:

A. Rigid Galvanized Steel Conduit (RGC):

- 1. Conduit: Rigid steel, zinc-coated inside and outside, threaded ends.
- 2. Fittings: Threaded galvanized steel, bushings shall have nylon insulated throat.

B. Intermediate Metal Conduit (IMC):

- 1. Conduit: Rigid intermediate grade galvanized inside and outside, threaded ends.
- 2. Fittings: Threaded galvanized steel, bushings shall have nylon insulated throat.

C. PVC Externally Coated Rigid Steel Conduit:

- 1. Conduit: Rigid steel zinc-coated with external coating of PVC.
- 2. Fittings: Threaded galvanized steel with external PVC coating, bushings shall have nylon insulated throat.

D. Electrical Metallic Tubing (EMT):

- 1. Conduit: Galvanized steel tubing.
- 2. Fittings: Steel compression fittings for all applications. Bushings shall be threaded and have nylon insulated throat or nylon bushing.
- 3. Die-cast compression fittings will not be permitted.

E. Rigid Aluminum Conduit:

- 1. Not allowed unless otherwise noted.

F. Flexible Metal Conduit:

- 1. Conduit: Continuous spiral wound, interlocked, zinc-coated steel, approved for grounding.
- 2. Fittings: Cadmium plated, malleable iron. Straight connector shall be one-piece body, female end with clamp and deep slotted machine screw for securing conduit, and threaded male end provided with a locknut. Angle connectors shall be two piece body with removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and threaded

male end provided with a locknut. All fittings shall be terminated with threaded bushings having nylon insulated throats.

G. Liquid-Tight Flexible Metal Conduit:

1. Conduit: Continuous spiral wound, interlocked zinc-coated steel with polyvinyl chloride (PVC) jacket, approved for grounding.
2. Fittings: Cadmium plated malleable iron. Straight and angle connectors shall be the same as used with flexible metal conduit but shall be provided with a compression type steel ferrule and neoprene gasket sealing rings.

2.3 NON-METALLIC CONDUIT AND DUCTS:

A. Rigid Non-Metallic Conduit (RNC):

1. Conduit: Schedule 40 or 80 polyvinyl chloride (PVC), 90°C for direct burial or concrete encasement.
2. Fittings: Mate and match conduit type and material. Cement as recommended by manufacturer.

B. PVC and ABS Plastic Utilities Duct:

1. Conduit: Type 2 (EB) for encased burial in concrete; Type II (DB) for direct burial.
2. Fittings: Mate and match conduit type and material. Cement as recommended by manufacturer.

2.4 CONDUIT BODIES:

- A. General: Types, shapes and sizes, as required to suit individual applications and NEC requirements. Provide matching, gasketed covers secured with corrosion-resistant screws.
- B. Metallic Conduit and Tubing: Use malleable iron conduit bodies. Use bodies with threaded hubs for threaded raceways and in hazardous locations.
- C. Nonmetallic Conduit: Use nonmetallic conduit bodies.

2.5 WIREWAYS:

- A. General: Provide electrical wireways of types, grades, sizes, and number of channels for each type of service as indicated. Provide complete assembly of raceway including, but not limited to, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other components and accessories as required for complete system.
- B. Lay-In Wireways: Construct lay-in wireways with hinged covers in accordance with UL 870 with components UL listed. Construct units to be capable of sealing cover in closed position with sealing wire. Provide wireways with knockouts.
  1. Connectors: Provide wireway connectors suitable for "lay-in" conductors, with connector covers permanently attached so that removal is not necessary to utilize the lay-in feature.

2. Finish: Protect sheet metal parts with rust inhibiting coating and baked enamel finish. Plate-finish hardware to prevent corrosion. Protect screws installed toward inside of wireway with spring nuts to prevent wire insulation damage.
- C. Rain-tight Troughs: Construct in accordance with UL 870, with components UL listed.
1. Construction: 16-gauge galvanized sheet metal parts for 4" x 4" to 6" x 6" sections, and 14 gauge parts for 8" x 8" and larger sections. Provide knockouts only in bottom of troughs, with suitable adapters to facilitate attaching to other NEMA 3R enclosures. Do not use gasket material that can rip or tear during installation, or would compromise rain-tight capability of the trough. Do not use cover screws that will protrude into the trough area and damage wire insulation.
  2. Finish: Provide 14-gauge and 16-gauge galvanized sheet metal parts with corrosion-resistant phosphate primer and baked enamel finish. Plate-finish hardware to prevent corrosion.
- 2.6 SURFACE METAL RACEWAYS:
- A. General: Sizes and channels as indicated. Provide fittings that match and mate with raceway. All circuits either factory or field installed shall have a separate neutral conductor.
1. Type 1: Multi-outlet assembly with pre-wired outlets, 3-wire, single circuit with single outlets on 6 / 9 / 12 / 18 inch centers.
  2. Type 2: Multi-outlet assembly with pre-wired outlets, 2-circuit with single outlets wired alternately on 6 / 9 / 12 / 18 inch centers.
  3. Type 3: Single compartment, multi-outlet assembly, nominal 2-3/4" x 1-7/16" with flush, snap-on cover. Install devices and circuits as indicated on the drawings.
  4. Type 4: Multi-outlet assembly, divided for power and communication, nominal 4-3/4" x 1-3/4" with (2), 2-3/8" compartments and flush, snap-on cover. Install devices and circuits as indicated on the drawings.
  5. Type 5: Single compartment, multi-outlet assembly, nominal 4-3/4" x 3-9/16" with flush, snap-on cover. Install devices and circuits as indicated on the drawings.
  6. Surface Metal Raceway: Galvanized steel with snap-on cover. Finish in manufacturer's standard prime coating suitable for field painting. Provide raceways of suitable size based on fill for circuits indicated on the drawings. Provide all necessary boxes, covers, extensions, fittings, etc. to form a complete assembly.
- B. Boxes for Surface Raceways: Designed, manufactured and supplied by raceway manufacturer for use with specified raceway.
- 2.7 CONDUIT SIZES:
- A. Conduit sizes shall be as shown on the drawings. If the conduit size is not given on the drawings, the conduit shall be sized in accordance with NEC based on the number

of conductors enclosed plus a parity sized equipment ground conductor and be subject to the following minimum sizes:

1. Rigid, Intermediate, and EMT Conduit: 3/4 inch for all runs except lighting switch legs, 277 volt lighting branch circuits, temperature control and fire alarm which may be 1/2inch.
2. Flexible and Liquid-Tight Flexible Conduit: 1/2inch for all runs.
3. MC Cable: 3/8 inch to under-cabinet luminaires, 1/2inch for all other runs.
4. Underground or Concrete Encased Nonmetallic Conduit: 3/4inch for all runs.
5. Conduits used for home runs shall contain only the conductors for the circuits indicated on the drawings. Combining multiple home runs into a single conduit will not be permitted.
6. All fire alarm system conduit shall be 3/4", minimum.

#### 2.8 RACEWAY SEALING COMPOUND:

- A. Non-hardening, safe for human skin contact, not deleterious to cable insulation, workable at temperatures as low as 35 deg F (1 deg C), withstands temperature of 300 deg F (149 deg C) without slump, and adheres to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials and the common metals.

### PART 3 - EXECUTION

#### 3.1 INSPECTION:

- A. Examine areas and conditions under which raceways are to be installed, and substrate which will support raceways. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

#### 3.2 CONDUIT SCHEDULE:

- A. Buried Raceways: PVC Coated rigid steel galvanized conduit or Schedule 40 or 80 rigid PVC plastic conduit. All underground/buried 90deg ELLS shall be rigid type fittings.
- B. Raceways embedded in concrete slabs or walls in contact with earth: Schedule 40, PVC plastic conduit. PVC coated rigid steel galvanized conduit, OR PVC coated intermediate metal conduit.
- C. Raceways embedded in concrete slabs above grade level: Rigid steel galvanized conduit or Schedule 40 or 80 rigid PVC plastic conduit in slab.
- D. Raceways Penetrating Through Foundation Walls, Below Grade: One 10 foot section of PVC coated rigid steel galvanized, extending from 1 foot inside the foundation wall.
- E. Hazardous areas: Rigid steel galvanized conduit.
- F. Raceways in locations subject to mechanical injury: Rigid steel galvanized conduit OR intermediate metal conduit. Locations subject to mechanical injury include, but are not limited to, the following:
  1. Exposed conduits outdoors.

2. Exposed conduits in dock areas and high/medium bay locations up to 25 feet above finished floor.
  3. Exposed conduits in parking garages.
  4. Exposed conduits in a Fire Pump Room.
  5. Exposed feeder and control conduits from engine generators to distribution equipment.
  6. Exposed service entrance feeders.
- G. Motor and equipment connections: Flexible metal conduit OR PVC jacketed liquid-tight flexible metallic conduit with liquid tight connectors.
- H. Raceways in all other areas shall be electrical metallic tubing unless otherwise noted.
- I. Use flexible metal conduit inside movable partition wireways, from junction boxes to devices and between devices in casework, from outlet boxes to recessed luminaires, and for "fishing" of existing walls.
- J. Under raised computer floor: Jacketed liquid-tight flexible metallic conduit with liquid tight connectors. Jacket shall be rated for plenum application.
- K. Emergency Circuits: All emergency circuits shall be run totally in metal conduit and shall be in a completely separate raceway system from non-emergency circuits.
- L. Rework or extensions of existing conduit shall include the use of similar materials to the existing conduit type unless otherwise noted.

### 3.3 INSTALLATION OF CONDUITS:

- A. General: Install electrical raceways in accordance with manufacturer's written installation instruction, applicable requirements of NEC, and as follows:
1. Conceal all conduit unless indicated otherwise, within finished walls, ceilings, and floors. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install raceways level and square and at proper elevations.
  2. Elevation of Raceway:
    - a. Where horizontal raceway is installed near water and steam piping, route raceway above piping and as close to structure as possible and practical.
    - b. Route raceway as close to structure as possible.
  3. Complete installation of electrical raceways before starting installation of conductors within raceways.
  4. Provide supports for raceways as specified elsewhere in Division 16.
  5. Prevent foreign matter from entering raceways by using temporary closure protection.
  6. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bend is not visible above the finished slab.

7. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel. Bends in conduit larger than 1-1/4 inch shall be factory-made elbows unless otherwise specifically approved. Bends in 1-1/4 inch and 1 inch runs shall be made in an approved bending machine or factory made. Hickey bends will not be permitted in conduits larger than 3/4 inch.
8. Use raceway fittings that are types compatible with the associated raceway and suitable for the use and location. Install expansion fittings across all structural construction joints and expansion/deflection couplings across all structural expansion joints and in every 200 foot of linear conduit run. A flexible bonding jumper at least three-times the nominal width of the joint shall be installed.
9. Run raceways parallel and perpendicular to building elements and other equipment with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions except as otherwise indicated.
10. Raceways embedded in slabs: (Allowed only by written authorization of Structural Engineer/Architect): Install with a minimum of bends, in the shortest practical distance, in middle third of the slab thickness where practical, and leave at least 1 inch concrete cover. Tie raceways to reinforcing rods or otherwise secure them to prevent sagging or shifting during concrete placement. Space raceways laterally to prevent voids in the concrete. Run conduit larger than 1 inch trade size, parallel with or at right angles to the main reinforcement; where at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab. Where nonmetallic conduit is used, raceways must be converted to PVC coated rigid steel conduit before rising above floor.
11. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical.
12. Install vertical feeder conduits in exterior walls, core walls, or chase spaces. Do not install in interior wall partition areas.
13. Run exposed and parallel raceways together. Make bends in parallel runs from the same center line so that the bends are parallel. Factory elbows may be used only where they can be installed parallel. In other cases provide field bends for parallel raceways.
14. Make raceway joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Make raceway terminations tight. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors. Joints in non-metallic conduits shall be made with solvent cement in strict accordance with manufacturer's recommendations.
15. Tighten set screws of threadless fittings with suitable tool.
16. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished surface against the box. RGC and IMC shall be secured with double locknuts and an

insulated metallic bushing. EMT shall be secured with one locknut and shall have nylon insulated throats or threaded nylon bushings from 1/2" to 1". 1-1/4" and above shall be metal with nylon insulated throats. Use grounding type bushings for feeder conduits at switchboards, panelboards, pull boxes, transformers, motor control centers, VFD's, etc.

17. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.
18. Provide nylon pull string with printed footage indicators having not less than 200 pounds tensile strength. Leave not less than 12 inches of slack at each end of the pull string. Identify with tags at each end the origin and destination of each empty conduit and indicate same on all empty or spare conduits on the as-built drawings.
19. Telephone and Signal System Raceways: Install raceways with maximum lengths at 100 feet and with a maximum of two, 90 degree, radiused bends or equivalent. Install 2' x 2' pull boxes where necessary to comply with these requirements. Install long sweep bends for all data and voice raceways.
20. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:
  - a. Where conduits enter or leave hazardous locations.
  - b. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces.
  - c. Where conduits enter through a foundation wall or stub-up through a slab on grade floor.
  - d. Where required by the NEC.
21. Install raceway/duct sealing compound inside of all underground stub into a building through a foundation wall or through a slab on grade floor.
22. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this contract, install screwdriver-operated threaded plugs flush with floor.
23. Flexible Connections: Use short length (maximum of 6 feet) of flexible conduit for recessed and semi-recessed luminaires, for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquid-tight flexible conduit in wet locations. Install separate ground conductor across flexible connections.

24. PVC externally coated rigid steel conduit: Patch all nicks and scrapes in PVC coating after installing conduit.
25. Where conduits are to be installed through structural framing members, the Contractor shall provide sleeves. The Architect/Engineer's written approval must be obtained prior to cutting, notching or drilling of structural framing members.
26. Ream the ends of all cut and/or threaded conduit. Ends shall be cut square.
27. Use of running threads for rigid or intermediate metallic conduit are not permitted. When threaded couplings cannot be used, provide 3 piece union or solid coupling.
28. Route conduit through roof openings for piping and ductwork where possible; otherwise, rout through jack with pitch pocket.
29. Conduit stub-ups from below grade or thru the slab shall be PVC coated rigid steel galvanized conduit and shall extend 6 inches above grade.
30. Wherever conduits enter a structure through a foundation or basement wall below grade, grout around the conduit with water-proof grout or install entrance seals. Seals shall be OZ Type WS or approved equivalent for new construction and OZ type CSM Series for existing structures.
31. Conduits shall not cross pipe shafts or ventilation duct openings. Where conduits must penetrate air-tight spaces or plenums, seal around the conduit with mastic acceptable to the Architect/Engineer.
32. Install an insulated ground conductor in all conduits.
33. Where individual conduits penetrate existing fire-rated walls and floors, pack void around conduit with fire rated insulation and seal opening around conduit with UL listed forma silicone elastomer compound. Where conduits penetrate exterior walls, new floors, or roof, provide pipe sleeve one size larger than conduit, pack void around conduit with fire rated insulation, and seal opening around conduit with UL listed foam silicone elastomer compound. Conduits on trapeze type support system shall require fire taping only.
34. Where conduit sleeves penetrate fire rated floors or walls for installation of system cables, AC or MC cables, or modular wiring cables pack void around cables or empty sleeve with fire rated insulation and fill ends with fire-resistive compound. Seal opening around sleeve with UL listed foam silicone elastomer compound.
35. Use PVC-coated rigid steel factory elbows for bends in plastic conduit runs longer than 100 feet, or in plastic conduit runs which have more than two bends regardless of length. Use long sweep bends for wiring larger than 350 MCM.
36. Wipe plastic conduit clean and dry before joining. Apply a full, even coat of cement to entire area that will be inserted into fitting. Let joint cure for 20 minutes minimum.

37. No PVC conduit shall be run exposed or inside stud or masonry walls unless specifically called for on the drawings. Transition from PVC to metal conduit shall be made below grade.
  38. Provide separate raceway systems for each of the following:
    - a. Lighting
    - b. Power Distribution
    - c. Communications and Data
    - d. Emergency (When Emergency Power Generator is utilized)
    - e. UPS (When shown on Construction Documents as a system)
    - f. Fire Alarm
    - g. Temperature Control
    - h. Paint new exposed conduits to match existing exposed conduits where installed in areas with existing painted conduits or where otherwise indicated.
  39. Provide rebar and tie downs for all conduits and conduit racks to be installed with concrete or slurry to prevent conduit "float".
- B. Install buried electrical line warnings per Division 16 section - "Electrical identification".
- C. Install labeling as required in Division 16 section - "Electrical Identification".
- 3.4 INSTALLATION OF SURFACE RACEWAYS AND WIREWAYS:
- A. Surface Raceways and Wireways: Mechanically assemble metal enclosures and raceways to form continuous electrical conductor and connect to electrical boxes, fittings and cabinets as to provide effective electrical continuity and rigid mechanical assembly.
1. Where practicable, avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat all surfaces with corrosion inhibiting compound before assembling.
  2. Install expansion fittings in all raceways wherever structural expansion joints are crossed.
  3. Make changes in direction of raceway run with proper fittings, supplied by raceway manufacturer. Field bends of raceway sections are not permitted.
  4. Properly support and anchor raceways for their entire length by structural materials. Raceways are not to span any space unsupported.
  5. Use boxes as supplied by raceway manufacturer wherever junction, pull or device boxes are required. Standard electrical "handy" boxes, etc., are not permitted for use with surface raceway installations.
  6. Install an insulated grounding conductor in all wireways and surface raceways. Bond grounding conductor to all wireways and surface raceways.
  7. Paint new exposed surface metal raceway to match adjacent surfaces where raceway is installed in finished areas such as lobbies, corridors, and normally occupied spaces.

8. Surface raceways and wireways are acceptable only where specifically indicated on the drawings. The proposed use of surface raceways and wireways shall be submitted for review by the Engineer prior to installation.
9. Common wireways are not acceptable for convergence of multiple circuits unless specifically indicated on the drawings. The proposed use of a common wireway shall be submitted for review by the Engineer prior to installation.
10. The proposed use of wireways above or below panelboards, switchboards, motor control centers, and other electrical equipment shall be submitted along with a layout drawing for review by the Engineer prior to installation.
11. Surface metal raceways shall be Wiremold #700 Series or equivalent. Manufacturer's other than Wiremold #700 Series shall be approved by LPS Property Management Services.

### 3.5 ELECTRICAL PROVISIONS FOR ROOF PENETRATIONS:

- A. Raceways penetrating the roof structure shall be installed in a manner to preserve the integrity of the roof. Provide flashing and counter flashing for all roof penetrations required for the work.
- B. Conduits routed above the roof shall be installed a minimum of twelve (12) inches above the finished roof surface, supported on unistrut metal stands installed with flashing and counter flashing, with maximum spacing 8'-0" on center.
- C. Provide weatherproof GFCI duplex receptacle within 25'-0" of all roof top equipment.
- D. Provide steel fittings and support property "Erico" roof stands, model #PP50H6 for 50 pounds, #PP300H4 for 300 pounds or equivalent.
  1. Frame style roof stands are not an acceptable means of support. Fabrications may be submitted for LPS Property Management Services approval. All roof penetrations shall be approved by LPS Property Management Services prior to installation.

### 3.6 ADJUSTING AND CLEANING:

- A. Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt and construction debris.

END OF SECTION 16110