This master should be used by designers working on Port of Portland construction projects and by designers working for PDX tenants (“Tenants”). Usage notes highlight a few specific editing choices, however the entire section should be evaluated and edited to fit specific project needs.

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

1. GENERAL
   * + 1. DESCRIPTION
          1. This section describes raceways, conduits, and boxes for electrical systems wiring, including all fittings, hangers, and appurtenances.
       2. RELATED WORK SPECIFIED ELSEWHERE
          1. Section 260526, Grounding and Bonding for Electrical Systems
          2. Section 260536, Cable Trays for Electrical Systems
          3. Section 260543, Underground Ducts and Raceways for Electrical Systems
          4. Section 260553, Identification for Electrical Systems
          5. Section 262726, Wiring Devices
       3. REFERENCES
          1. ANSI: American National Standards Institute:

ANSI C80.1: Electrical Rigid Steel Conduit

ANSI C80.3: Steel Electrical Metallic Tubing

ANSI C80.4: Fittings for Rigid Metal Conduit and Electrical Meta

* + - * 1. ASTM: American Society for Testing Materials:

ASTM A193: Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications

ASTM E814: Standard Test Method for Fire Tests of Penetration Firestop Systems

* + - * 1. JIC: Joint Industrial Council

JIC EMP-1: Electrical

* + - * 1. NEC: National Electrical Code:
        2. NEMA: National Electrical Manufacturers Association.

NEMA RN 1: Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit

NEMA TC2: Electrical Polyvinyl Chloride (PVC) Tubing and Conduit

NEMA Product and Installation Standards.

* + - * 1. NFPA: National Fire Protection Association:

NFPA 70: National Electrical Code

* + - * 1. TIA: Telecommunications Industry Association/Electronic Industries Association

TIA 569-A: Commercial Building Standard for Telecommunications Pathways and Spaces

* + - * 1. UL: Underwriters Laboratories:

UL 360: Standard for Liquid-Tight Flexible Metal Conduit

UL 651: Rigid Nonmetallic Electrical Conduit

UL 651A: High-Density Polyethylene Conduit

UL 1479: Intermediate Metal Conduit.

* + - 1. DEFINITIONS
         1. “Where subject to physical damage,” is defined as a surface installation within an 8-foot zone above a finished floor, in areas subject to vehicular traffic, including manually operated fork lifts.
      2. SUBMITTALS
         1. Submittals for the following materials shall consist only of a listing of the manufacturer’s name and the applicable catalog numbers of the items to be utilized. Upon review of this list, further information may be requested.

Conduit.

Conduit fittings.

Supports.

* + - * 1. Submittals for the following materials shall be complete with detailed information and cut sheets.

Wireway and wire gutters.

* + - * 1. Provide as-constructed drawing information identifying final conduit routing and box locations upon completion of the work.
      1. QUALITY ASSURANCE
         1. Products shall be new and certified by an approved testing laboratory.

1. PRODUCTS
   * + 1. GENERAL
          1. Materials shall be of current standard design and shall conform to the established standards of an approved testing laboratory. Like items shall be of the same manufacturer and type.
       2. METALLIC CONDUITS
          1. Galvanized Rigid Steel Conduit (GRSC):

Heavy wall construction, manufactured in conformance with ANSI C80.1 and listed as UL 6 approved.

* + - * 1. Electrical Metallic Tubing (EMT):

Thin wall electrogalvanized steel, manufactured in conformance with ANSI C80.3 and listed as UL 797 approved.

* + - * 1. PVC Coated Rigid Steel Conduit and Fittings:

ANSI C80.1 hot-dipped galvanized rigid steel conduit with an external 0.040" minimum PVC protective coating per NEMA Standard RN 1. Both ends of conduit shall be threaded with thread protectors, factory-installed. Fittings shall be threaded type ANSI C80.4, hot-dipped galvanized, with a 0.055” minimum PVC protective coating. PVC coating on fittings shall match the coating on the PVC coated conduit.

* + - * 1. Flexible Metal Conduit:

Manufactured from hot dipped galvanized steel manufactured in conformance with UL standards. Flexible metal conduit shall be a minimum of 1/2‑inch standard trade size.

* + - * 1. Liquid-Tight, Flexible Metal Conduit:

Conduit shall have a ground wire.

Aluminum or galvanized flexible metal conduit shall have a polyvinylchloride chemical resistant jacket in conformance with the requirements of UL 360. Acceptable manufacturers are Sealtight, or equal.

* + - * 1. Explosion-Proof Flexible Conduit:

Watertight flexible conduit shall be suitable for use in Class I, Division 1, Group D hazardous areas as specified in NFPA No. 70.

* + - 1. RIGID NON‑METALLIC CONDUITS

Schedule 80 may be added or substituted for Schedule 40 in 1a below.

* + - * 1. Polyvinylchloride (PVC) Conduit:

PVC conduit shall be Type II, in conformance with NEMA TC2 and the following:

Schedule 40, high impact.

Suitable for use with 90ºC rated wire.

Conform to UL Standard 65l and carry appropriate UL listing for above and below ground use.

* + - * 1. High-Density Polyethylene (HDPE) Conduit:

HDPE conduit shall be the following:

Schedule 40, high impact.

Suitable for use with 90ºC rated wire.

Conform to UL Standard 651A and have appropriate UL listing for below-ground use.

* + - 1. METALLIC BOXES
         1. Flush and Concealed Outlet Boxes:

Galvanized stamped steel with screw ears for device ring mounting, knock‑out plugs, mounting holes, and fixture studs if required. Acceptable manufacturers are RACO, or equal.

* + - * 1. Surface Outlet Boxes (Interior Locations):

Boxes for use on ceilings shall be galvanized stamped steel with screw ears for device ring mounting, knock‑out plugs, mounting holes, and fixture studs if required. Acceptable manufacturers are RACO, or equal.

Boxes for use on walls below 8 feet or where noted on drawings shall be cast steel or aluminum with threaded hubs.

* + - * 1. Large Boxes:

When required, boxes exceeding 4 11/16 inches square shall be welded steel construction with screw cover and painted, steel gauge matching physical size. Acceptable manufacturers are Hoffman, Circle AW, or equal.

* + - * 1. Floor Boxes:

Boxes in concrete floors shall be adjustable flush power floor boxes with aluminum duplex service tops. Acceptable manufacturers are Hubbell 825 29/SA 3925, or equal.

Boxes on flush ducts shall have service fittings as required. Equip outlets with receptacles as specified in Section 262726. Acceptable manufacturers are Hubbell SC‑3900 series, or equal.

* + - 1. BOXES AND FITTINGS
         1. Sheet Metal Boxes and Fittings:

Boxes and fittings installed in areas where electrical metallic tubing is specified shall be standard UL-approved sheet steel type.

* + - * 1. Cast Ferrous Alloy Boxes (Outside Locations):

Hot-dipped galvanized cast ferrous alloy unless otherwise specified.

Conduit entrances shall be integrally cast threaded hubs or bosses and shall provide for full 5-threaded contact on tightening. Drilling and treading shall be done before galvanizing.

Device covers shall be suitable for boxes, with full-body neoprene gaskets to fit the devices and boxes used.

Cover plates shall be hot-dipped galvanized cast ferrous alloy unless the particular device requires a cover that is not manufactured in this material.

Type 304 stainless steel screws shall be provided for covers.

Where two or more devices are located together, outlet and device boxes shall be gang type.

Device boxes shall be FD boxes as manufactured by Crouse-Hinds, Appleton, or equal.

* + - * 1. Floor Boxes:

Hot-dipped galvanized cast boxes with a NEMA 4 rating.

Boxes shall have a recessed ring neoprene gasket, and checker plate covers.

Cover fasteners shall be 316 stainless steel machine screws of not less than 1/4-inch diameter. The cover screws shall be flathead socket-type recessed screws, countersunk below the level of the cover.

* + - * 1. Steel Sheet Boxes (Outside Locations):

Boxes larger than Type FD shall be fabricated from steel plating and shall be hot-dipped galvanized. The thickness of the steel plating shall conform to the requirements of JIC. Before finish galvanizing, furnish and install a grounding pad drilled for two-bolted grounding lugs or with a grounding stud welded to the inside of the box.

Provide 316 stainless steel hardware.

Boxes shall, as a minimum, meet NEMA 12 and JIC requirements and shall be NEMA 4 where exposed to weather or water.

Galvanized sheet steel boxes may be used in protected areas where electrical metallic tubing is specified. Boxes shall be a minimum of 4 inches square.

* + - * 1. Boxes and Fittings for Hazardous Locations:

In locations specified as Class I, Divisions 1 or 2, hazardous, boxes and fittings shall be NFPA No. 70, explosion-proof, in addition to the requirements specified above.

Seals for conduit systems shall be hot-dipped galvanized cast ferrous alloy, and each seal shall be of suitable configuration for the individual circumstance. Sealing compound shall be hard type, Chico A, or equal, and shall be UL listed for explosion-proof sealing fittings.

* + - * 1. Boxes and Fittings in Corrosive Locations:

Surface boxes and fittings located in areas specified as corrosive shall be NEMA 4X. Conduit entering plastic boxes and exposed metal on plastic boxes which are not isolated from the interior of the box shall be bonded together with a suitable grounding conductor.

Seals for entry in corrosive locations shall be oblong conduit bodies filled with soft non-setting compound.

* + - * 1. Terminal Cabinets:

Meet NEMA 12 and JIC requirements as a minimum, be made from sheet steel, and have hinged doors. Cabinets exposed to weather or moisture shall meet NEMA 4X requirements.

Except for those located in electrical equipment rooms, cabinets shall be finished inside and out with a powdered thermosetting resin system resistant to abrasion, moisture, acids, alkalies, high temperatures, and flame.

Exterior color shall be gray. Interior color shall be white.

Before finish is applied, a copper grounding pad for a two-bolt grounding lug or grounding stud shall be provided inside the cabinet.

Provide 316 stainless steel hardware.

Terminal cabinets shall have terminal blocks of size and capacity for the required loads and shall be rated 30 amperes, 600V AC minimum. Contacts shall be No. 8 minimum strap screw of a type suitable for ring tongue or locking spade terminals. Similar cabinet with a mounting panel shall be provided for mounting miscellaneous field equipment.

* + - * 1. Hubs:

Hubs for connection of conduit to junction, device, or terminal boxes shall be made of cast ferrous alloy, electroplated with zinc and shall have insulating bushings.

Hubs shall contain a neoprene O-ring and shall provide a watertight connection.

* + - 1. CONDUIT FITTINGS
         1. GRSC:

Fittings, including couplings, shall be threaded unless otherwise approved by the Port.

Threadless Couplings and Connectors:

GRSC couplings and box connectors may be steel threadless, compression ring, or set screw type for use with conduits 1 inch and smaller installed in poured concrete locations where limited working space makes threaded fittings impractical.

Threadless fittings are not acceptable for use with GRSC conduits except as allowed above. They may, however, be used with EMT type conduits.

Myers hubs or equal shall be used with NEMA 2, 3, 3R, 4 and 12 enclosures.

Threaded Locknuts:

Sealing type may be used with NEMA 2, 3, 3R, 4 and 12 enclosures at bottom penetrations.

Extra-heavy electrogalvanized steel for sizes up to 2 inches. Locknuts larger than 2 inches shall be electrogalvanized malleable iron.

Threaded Bushings:

1 1/4 inch and larger, insulated, grounding type as required in Section 260526.

Electrogalvanized malleable iron with insulating collar.

Locking type and provided with a feed-through compression lug for securing the ground cables.

Unions shall be electrogalvanized ferrous alloy type. Acceptable manufacturers are Appleton, UNF or UNY; Crouse-Hinds, UNF or UNY; or equal.

Conduit bodies shall be ferrous alloy type (malleable iron), with clamp type fastening covers.

Gaskets shall be neoprene.

* + - * 1. EMT:

EMT couplings and connectors shall be watertight compression type or set screw type with steel bodies, zinc or cadmium coated. Die cast fittings will not be permitted.

Connectors shall be steel compression ring or set screw type for conduit termination, with insulated throat, suitable for the application.

Couplings shall be steel compression ring or set screw type.

* + - * 1. Flexible Metal Conduit:

Fittings shall be 2-screw steel body type, zinc, or cadmium coated. Die cast fittings will not be permitted.

* + - * 1. Liquid-Tight, Flexible Metal Conduit:

Fittings for liquid-tight conduit shall have a cadmium-plated malleable iron body and gland nut with cast-in lug, brass grounding ferrule, threaded to engage conduit spiral and o-ring seals around the conduit and box connection and insulated throat. Use 45-degree and 90-degree fittings where necessary.

Fittings shall be threaded and compression type for polyvinyl jacketed flex.

* + - * 1. Weatherproof Connectors:

Provide threaded connectors.

* + - * 1. Expansion Couplings:

Provide O.Z. type EX couplings with jumper. Gedney, or equal.

* + - * 1. Seal‑Offs:

Provide seal-offs with filler fiber, compound, and removable cover.

* + - * 1. HDPE Conduit:

HDPE couplings and connectors shall be UL listed and specifically designed for HDPE applications.

HDPE connectors and joints shall be made by a method approved by the Port. PVC glue is not permitted on HDPE.

* + - 1. METALLIC RACEWAYS
         1. Surface Metal Raceway (SMR):

Provide raceway with snap‑on cover, sized as shown on the drawings. Acceptable manufacturers are Wiremold, Walker, or equal.

* + - 1. RACEWAY SUPPORTS
         1. Conduit Supports:

Hot-dipped galvanized (exterior) or electrogalvanized (interior) steel framing channel to support groups of conduit.

Use one-hole galvanized malleable iron pipe straps with galvanized clamp backs and nesting backs where required.

Use one-hole galvanized steel pipe straps on studs for interior applications.

Supports for PVC coated rigid steel shall be PVC coated straps, struts, or hangers.

* + - * 1. Ceiling Hangers:

Adjustable galvanized carbon steel rod hangers in conformance with ASTM A193. Rods shall be minimum 1/2 inch in diameter, threaded continuously.

Use stainless steel hanger rods where rods will be located in corrosive areas and exposed to the effects of weather or moisture.

Use the following for PDX tenant spaces only.

Steel support wire hangers with fastening devices and clips designed as applicable to the work.

* + - * 1. Structural Attachments (Racks):

Hot-dipped galvanized steel framing channel.

Treat field cuts with zinc-enriched paint.

* + - 1. WIREWAYS
         1. Wireway and auxiliary gutters shall meet JIC, EMP-1 standards, shall be sectional flanged oil‑tight type with hinged covers, and shall be 8 inches in cross section unless otherwise specified.
         2. Troughs shall be painted steel, square in cross section, with screw covers. Use gasketed, weatherproof type for exterior applications.
         3. Fittings, tees, elbows, and couplings shall be as needed for configurations shown on the drawings.
      2. MISCELLANEOUS PRODUCTS
         1. Provide watertight seals at penetrations though exterior walls or walls exposed to moisture. Acceptable manufacturers are type CSMC by O.Z. Gedney Co., Link Seal by Thunderline Corp., or equal.
         2. Provide waterproof firestops and seals in specified locations. Acceptable manufacturers are Flamemastic 71A, Vimasco No. 1-A, or equal.

1. EXECUTION
   * + 1. INSTALLATION
          1. General:

Existing boxes and raceways, exposed under this contract, shall be properly supported per NEC before cover approval.

All conduit and wireway installations shall comply with NEMA, “Standards of Installation.”

Cutting or notching shall be kept to a minimum, using only approved methods. Structural members shall not be disturbed or cut in any way without specific written approval from the Port, on a case-by-case basis. Patch and correct finished surfaces damaged by electrical work. Fire barriers shall be returned to their original condition using materials of equal or higher fire rating and specifically designed for that use.

Unless otherwise noted on the drawings, all conduit work in finished spaces shall be concealed. Exposed conduit is acceptable only when and where prior specific authorization for use is obtained from the Port.

Conceal all conduits in finished spaces and elsewhere so far as practicable. Concealed conduits shall run in a direct line with long sweep bends and offsets. Where conduit runs between junction boxes and/or devices, route conduit vertically below ceiling level. Where horizontal runs are required, route above ceiling level for future flexibility.

Route exposed conduit parallel or at right angles to structural building lines and neatly offset into boxes. Conduits attached directly to building surfaces shall closely follow the surfaces. Conduit fittings may be used to “saddle” under beams.

Keep the subparagraph below if work is in the PDX terminal and above the baggage handling system, otherwise delete.

Where possible, do not install conduit above baggage conveyor or catwalk. Where conduit must cross above conveyor or catwalk, locate conduit perpendicular to the conveyor or catwalk and install tight to the structure and ceiling deck even if installation creates vertical bends in the conduit. When crossing above conveyor, the conduit bottom shall never be less than 34 inches above the conveyor bed.

Route conduit in existing racks whenever possible.

Cut conduits square, ream smooth, and draw fittings up tight with at least five threads fully engaged.

Conduits, whether exposed or concealed, shall be securely supported and fastened within 18 inches of each outlet, elbow, fitting, panel, etc. Support suspended conduits with metal ring or trapeze hangers on threaded, steel rods having a safety factor of four.

During construction, keep conduit and raceways closed with suitable plugs or caps to prevent entrance of dirt, moisture, concrete, or foreign objects. Raceways shall be clean and dry before installation of wire and at the time of acceptance.

Pack spaces around conduits with oakum and seal to prevent entrance of moisture where conduits are installed in sleeves or block‑outs which penetrate moisture barriers.

Install intumescent material around ducts, conduits, etc. to prevent spread of smoke or fire where installed in sleeves or block‑outs which penetrate rated fire barriers. The penetration sealing system shall be capable of passing a 3‑hour test per ASTM E814 (UL 1479) and shall consist of a material capable of expanding when exposed to temperatures of 250‑350ºF. An alternate method utilizing intumescent materials in caulk and/or putty form may be used.

Provide GRSC on underground conduit runs at 60-degree and larger bends, and where conduits exit concrete.

Underground stub-ups shall use wrapped or PVC coated rigid steel galvanized 90-degree elbows with a minimum radius not less than that permitted by code, or as noted on the drawings. Conduit risers from these elbows shall be wrapped or PVC coated rigid steel galvanized conduit. Extend GRSC 18 inches beyond penetrations.

Existing raceways exposed under this contract shall be properly supported per NEC before cover approval.

* + - * 1. Conduit Runs Between Pull Boxes:

Limit the number of directional changes of the conduit to a maximum total of 270 degrees in any run between pull boxes.

Limit the number of directional changes of the conduit to a maximum of 180 degrees in any run between pull boxes for communications conduits, unless otherwise approved by the Port.

Limit conduit runs to 400 feet, less 100 feet for each 90 degrees of change in direction.

Avoid bends and offsets whenever possible. However, when bends and offsets are necessary they shall be factory bends or bends made with a hickey or conduit bending machine. Heating, welding, or brazing the conduit for bends is not acceptable.

* + - * 1. Junction and Pull Boxes:

Where required for pulling cable and as necessary to meet NFPA No. 70, provide cast junction boxes or pull boxes. Pull boxes used for multiple conduit runs shall not combine circuits fed from different MCC’s, switchboards, or switchgear.

* + - * 1. Conduit Terminations:

Conduit entering sheet steel boxes or cabinets shall be secured by locknuts on both the interior and exterior of the device and shall have an insulating grounding or bonding bushing constructed over the conduit end.

Conduit entering top or sides of NEMA 3R, 4, and 12 boxes shall be terminated with a rain-tight hub having an insulated liner.

Surface-mounted cast boxes and plastic enclosures shall have threaded hubs.

Joints shall be made with standard couplings or specified unions.

Metal parts of plastic or coated control stations and coated boxes shall be bonded to the conduit system.

Running threads shall not be used in lieu of nipples, nor shall excessive thread be used on any conduit.

The ends of conduit shall be cut square, reamed, and threaded with straight threads.

Male threads on rigid steel conduit shall be coated with electrically conductive, zinc rich paint.

Steel conduit shall be made up-tight, with thread compound.

* + - * 1. Conduit Support:

Exposed metallic conduit shall be run on supports spaced not more than 6 feet apart unless noted otherwise on the drawings, and shall be constructed with runs parallel or perpendicular to walls, structural members or intersections of vertical planes and ceiling.

Exposed PVC conduit shall be run on supports spaced not more than 3 feet apart for conduits up to 1 inch, 5 feet apart for conduits 1 1/4 inches to 2 inches, and 6 feet apart for conduits 2 1/2 inches and larger.

No conduit shall approach closer than 6 inches to any object which operates above the rated temperature of the cable insulation it contains.

Conduit, except PVC, supported directly from the concrete structure shall be spaced at least 1/4 inch using one-hole, hot-dipped galvanized, malleable iron straps with nesting backs or, if three or more conduits are located in parallel run, they may be spaced from the wall approximately 5/8 inch to 1 inch by means of framing channel.

Runs of individual conduit suspended from the ceiling shall be supported with galvanized carbon steel rod hangers. Where three or more conduits are suspended from the ceiling, steel racks shall be constructed.

PVC conduit supported directly from the concrete structure shall be spaced out at least 1/4 inch using PVC conduit wall hangers.

Conduit rack and tray supports shall be secured to concrete walls and ceilings by means of cast-in-place anchors, die-cast rust-proof expansion shields, or cast flush anchors. Wooden plugs, plastic inserts or gunpowder-driven inserts are not acceptable as a base to secure conduit supports.

Use the following for PDX tenant spaces only.

Runs of individual conduit suspended from the ceiling shall be supported with galvanized carbon steel rod hangers or wire hangers. Where three or more conduits are suspended from the ceiling, steel racks shall be constructed.

* + - * 1. Conduit Penetrations:

Conduit routed through floors, walls, or other concrete structures shall pass through cast-in-place openings wherever possible. In cases where cast-in-place openings are not possible, use appropriately sized holes which will not impair the structure’s integrity. After completion, grout and caulk surface to be watertight and refinish to match existing surroundings.

Install watertight seals wherever conduits penetrate concrete wall panels or walls to the outdoors.

Install firestops and seals at penetrations through building floors, walls, or where required by fire codes.

Provide waterproof firestops and seals in specified locations.

* + - * 1. Raceway Separation:

Whenever possible, separate signal raceways from AC power or control raceways a minimum of 12 inches.

* + - * 1. Conduit Seals for Hazardous Areas:

Each conduit passing from a hazardous or corrosive area into a non-hazardous or non-corrosive area shall be provided with a seal fitting which may be located on either side of the boundary. The seal shall be located at the boundary in accordance with NEC requirements.

* + - * 1. Expansion Joints and Expansion Couplings:

At expansion joint crossings and where noted on the drawings, verify maximum design deflection. Use expansion coupling fittings. At crossings of expansion joints with 1 1/2‑inch conduit and smaller, flex conduit may be used where acceptable.

* + - * 1. PVC Coated Conduit:

Conduit and fittings shall be installed such that the PVC coating is continuous and watertight and that no portion of the metal conduit or fittings is exposed to moisture. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

When clamping PVC coated conduit in a pipe vise, replace the jaw assembly with special vise adapters that do not damage the coating. When clamping in a chain vise for diameters less than 2 inches, wrap the clamp area with emery cloth (coarse surface against the coating). Use half-shell clamps for 2-inch and larger diameter PVC coated conduit.

Cut PVC coated conduit using a roller cutter and remove about a 1/4 inch of the exterior PVC coating to aid in threading the conduit. Use a reamer to remove any rough internal edges.

After threading is complete, clean the threads and conduit interior with a degreasing spray to prepare for the application of the touchup compound to ensure good adherence to the unprotected metal substrate.

When utilizing a hydraulic bender, use equipment designed to bend PVC coated conduit. If using a conventional hand bender, use the next larger size bending shoe to allow space for the coating. Make hand bends using a specially coated bending hickey to reduce the potential coating damage when making sharp bends, saddles, or offsets.

Use special Z wrenches or strap wrenches (in lieu of standard adjustable pliers) to assemble PVC coated conduit and fittings to prevent damage to the coating. For small conduit sizes, Spin-It tools may be used to assemble the conduit and fittings. Apply touchup compound to any exposed threads, joints, scrapes, or nicks.

* + - * 1. Epoxy Coated Conduit:

Make conduit up-tight with strap wrenches. Do not use pipe wrenches and channel locks for tightening. Patch damaged areas with the manufacturer’s recommended materials. Build the patched area up to the full thickness of the original coating.

* + - * 1. Liquid-Tight, Flexible Metal Conduit:

Use liquid-tight in accordance with JIC standards and the following:

Where specified or indicated on the drawings.

Where flexibility is required for electrical raceways on equipment.

For motor mounts.

The maximum length of conduit shall be 24 inches for conduits 1 1/2 inches or smaller and 36 inches for conduits 2 inches or larger. The terminating fittings and sealing shall be as specified.

* + - * 1. Non-Metallic Conduit:

Elbows, offsets, or 60-degree and larger bends in direct buried or concrete embedded conduit runs shall be galvanized rigid steel. The final length of conduit runs which rise up through concrete slabs or curbs shall be galvanized rigid steel, provided with grounding bushing.

Make connections with waterproof solvent cement.

PVC conduit entering fiberglass boxes or cabinets shall be secured by threaded bushings on the interior of the device and shall be terminated with a threaded male terminal adapter having a neoprene O-ring. Joints shall be made with standard couplings.

* + - * 1. Galvanized Rigid Steel Conduit (GRSC):

GRSC embedded in concrete below grade or in damp locations shall be made watertight by painting the entire male thread with metal primer paint before assembly.

* + - 1. INSTALLATION OF RACEWAYS FOR COMMUNICATIONS
         1. Comply with TIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.
         2. Communications conduit bends shall be large-radius field bends or manufactured conduit sweeps and long-radius elbows. Do not install cast type fittings or sharp bends.
         3. Installation in Equipment Rooms:

Protect existing telephone terminals and equipment which will remain in service during construction from mechanical injury and dust entry.

Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.

Install cable runway to route cables if conduits cannot be located in these positions.

Secure conduits to backboard when entering room from overhead.

Extend conduits 6 inches above finished floor or 12 inches down from ceiling, terminating in insulating bushings.

Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

* + - 1. INSTALLATION OF RACEWAYS AND BOXES FOR FIRE ALARM.
         1. Fire alarm conduit and boxes installed in concealed locations or located in stairwells, storage rooms, electrical rooms, mechanical rooms, and utility rooms shall be factory-painted red.
         2. Exposed fire alarm conduits in finished spaces shall be painted to match adjacent wall and ceiling finishes.
      2. BOXES
         1. Installation:

Mount boxes and outlets at center line, at heights shown on the drawings.

Install outlet boxes, sized by code, large enough to accommodate all wires, fittings, and devices.

Install multi‑gang boxes as required to accept devices with no more than one device per gang.

Equip all metallic boxes with grounding provisions.

Flush wall switch, and receptacle outlets used with conduit systems shall be a minimum of 4 inches square, 1 1/2 inches or more deep, with a one- or two‑gang plaster ring mounted vertically. Where three or more devices are at one location, use a one-piece multiple gang tile box or a gang box with a suitable device ring.

Wall bracket and ceiling, surface-mounted lighting fixture outlets shall be a minimum of 4 inches square and 1 1/2 inches deep with a 3/8‑inch fixture stud where required. Wall bracket outlets shall have a single-gang opening where required to accommodate fixture canopy. Provide larger boxes or extension rings where the quantity of wires installed requires more cubic capacity.

Boxes for communication systems shall be a minimum of 4 11/16 inches square and 3 1/2 inches deep. Provide communication outlet boxes with a one-gang plaster ring mounted vertically.

Boxes for special systems shall be suitable for the equipment installed. Coordinate size and type with the system supplier.

Install pull boxes where shown on the drawings or required by code. Use galvanized boxes of the size required by code with removable covers installed so that covers will be accessible after work is completed.

Install boxes flush with finished surfaces or not more than 1/8‑inch back, and install boxes level and plumb. Long screws with spacers or shims for mounting devices are not acceptable. Do not expose combustible materials to wiring at outlets.

Extend covers for flush mounted boxes in finished spaces a minimum of 1/4‑inch beyond the box edge to provide a finished appearance. Finish edge of cover to match cover face.

Mount cast boxes or plaster trims for weatherproof outlets horizontally.

* + - 1. CONDUIT TYPE REQUIREMENTS
         1. Galvanized Rigid Steel Conduit (GRSC). Uses permitted:

Direct-buried.

Embedded or encased in concrete.

Exiting concrete (extend GRSC 18 inches beyond penetration).

Exposed in buildings from floor level to a height of 8 feet, except as noted below.

Exposed to weather, corrosive, or hazardous conditions, including interior exposures.

Use only for PDX.

Used for baggage conveyors.

* + - * 1. PVC Coated Rigid Steel Conduit. Uses permitted:

Embedded or encased in concrete.

Exposed to weather, corrosive, or hazardous conditions.

* + - * 1. Electrical Metallic Tubing (EMT). Uses permitted:

In dry, protected locations.

Exposed at a height more than 8 feet above floor level, or more than 18 inches above floor level in HVAC equipment rooms, utility tunnels, communication equipment rooms, electrical rooms, or unoccupied spaces, unless otherwise noted on the drawings.

* + - * 1. Flexible Metal Conduit.

Use where flexibility is necessary, as at motors, transformers, recessed light fixtures, etc. Flexible conduit terminations at motors, transformers, etc., shall be limited to 18 inches. Use flexible conduit for other purposes only after obtaining Port approval.

* + - * 1. Polyvinylchloride Conduit (PVC), Schedule 40. Uses permitted:

Embedded or encased in concrete (use GRSC where conduits exit concrete work).

Direct-buried 18 inches or more below grade.

* + - * 1. Polyvinylchloride Conduit (PVC), Schedule 80. Uses permitted:

Direct-buried 18 inches or more below grade.

Embedded or encased in concrete (use GRSC where conduits exit concrete work and extend GRSC 18 inches beyond penetration).

Exposed to corrosive conditions inside building.

* + - * 1. Metal Raceway.

Use in dry, protected locations for equipment requiring multi-connection wiring or where subject to physical damage.

* + - * 1. High-Density Polyethylene Conduit (HDPE). Uses permitted:

Horizontal directional drilling installations.

* + - 1. RACEWAY AND CONDUIT SIZES
         1. Size raceways and conduits as indicated on the drawings. Where no size is indicated, size as follows:

Larger conduits shall be sized to code. Size for the quantity of conductors installed, based upon NEC tables.

Conduit installed underground or in concrete shall be 1 inch or larger.

Conduits shall be 3/4-inch minimum size with larger sizes as indicated on the drawings. Conduits with tenant lease space buildouts may use conduits smaller than 3/4-inch.

Communications conduit runs may be combined as follows:

Two outlets: 1 1/4-inch size.

Three outlets: 1 1/2-inch size.

* + - 1. FITTINGS
         1. Assemble metallic raceways and conduits in one continuous piece and secure to boxes, panels, etc. with appropriate fittings to maintain electrical continuity. All conduit joints shall be cut square and reamed smooth with all fittings drawn up tight.
      2. PULL LINES
         1. Install nylon pull lines in all empty conduits where routing includes 25 feet or more in length or includes 180 degrees or more in bends.
         2. Where conduits requiring pull lines are stubbed out and capped, coil a minimum of 36 inches of pull line and tape at termination of conduit for easy future access. Label pull lines as to conduit starting or termination point or intended future use.

END OF SECTION 260533