SECTION 20 50 13

RACEWAYS FOR FACILITY SERVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Conduit

B. Conduit hangers

C. Inserts

D. Surface mounted metal raceways and fittings

E. Outlet boxes; junction and pull boxes

F. Metallic cable trays

G. Fiberglass cable trays

H. Underfloor duct system

1.02 RELATED SECTIONS

A. Interface and coordinate with the work of Section 26 05 26 - Grounding and Bonding for Electrical Systems, for electrical continuity and grounding of the system.

B. Interface and coordinate with the work of Section 20 70 26 - Common Materials and Methods for Electrical Systems, Section 26 05 24 - Low and Medium Voltage Wires and Cables, and Section 20 50 16 - Underground Ductwork and Structures for Facility Services, as required for a complete electrical installation.

1.03 MEASUREMENT AND PAYMENT

A. General: Raceways, as specified herein, will not be measured separately for payment but will be paid for as part of the Contract lump sum price for the related item of work as indicated in the Bid Schedule of the Bid Form.

1.04 REFERENCES

A. American National Standards Institute (ANSI):

1. ANSI C80.1 Rigid Steel Conduit - Zinc Coated

B. American Society for Testing and Materials (ASTM):

1. ASTM A123 Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

2. ASTM A153 — Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

3. ASTM D149 — Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

4. ASTM D570 — Test Method for Water Absorption of Plastics

5. ASTM D638 — Test Method for Tensile Properties of Plastics

6. ASTM D695 — Test Method for Compressive Properties of Rigid Plastics

7. ASTM D790 — Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

8. ASTM D2240 — Test Method for Rubber Property - Durometer Hardness

C. National Electrical Manufacturers Association (NEMA):

1. NEMA FG 1 — Fiberglass Cable Tray Systems

2. NEMA RN 1 — Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit

3. NEMA TC 2 — Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)

4. NEMA TC 3 — PVC Fittings for Use with Rigid PVC Conduit and Tubing

5. NEMA VE 1 — Metallic Cable Tray Systems

D. National Fire Protection Association (NFPA):

1. NFPA 130 — Fixed Guideway Transit Systems

2. NFPA 70 — National Electrical Code

E. Underwriters Laboratories Inc. (UL):

1. UL 5 — Surface Metal Raceways and Fittings

2. UL 6 — Rigid Metal Conduit

3. UL 50 — Enclosures for Electrical Equipment

4. UL 514B — Fittings for Conduit and Outlet Boxes

5. UL 651 — Schedule 40 and 80 Rigid PVC Conduit

6. UL 797 — Electrical Metallic Tubing

F. California Code of Regulations:

1. Title 24, Part 3 California Electrical Code

2. Title 24, Part 2 California Building Code

1.05 REGULATORY REQUIREMENTS

A. Refer to Section 20 70 26 - Common Materials and Methods for Electrical Systems, for requirements.

1.06 SUBMITTALS

A. General: Refer to Contract Specifications Section 01 33 00 - Submittal Procedures, and Section 01 33 23 - Shop Drawings, Product Data and Samples, for submittal requirements and procedures.

B. List of Materials: At least 30 days before beginning the work of this Section, submit a list of materials and equipment proposed for use together with applicable standards. Give name of manufacturer, brand name, and catalog number of each item. Submit the list complete at one time, with items arranged and identified in numerical sequence by Specification Section and Paragraph number.

C. Compliance with Applicable Standards:

1. Where equipment or materials are specified to conform to the standards of organizations such as ANSI, ASTM, NEMA, and UL, submit evidence of such conformance for review and record purposes.

2. The label or listing of the specified agency will be acceptable evidence.

3. Instead of the label or listing, the Contractor may submit a written certificate from an approved, nationally recognized testing organization, adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the specified standard.

4. Submit evidence of compliance with the seismic safety requirements of the California Building Code.

5. Equipment design and layout shall comply with the latest NFPA and NEC codes

D. Factory Test and Inspection Certification:

1. Except as otherwise specified herein, where factory tests and inspections for materials and equipment for which tests and inspections specified in referenced documents are waived, provide certified copies of reports for tests performed on previously manufactured identical materials or equipment within the previous 12 months.

2. Accompany test reports by signed statements from the manufacturer certifying that the previously tested material or equipment is physically, mechanically, and electrically identical to that proposed for the project. Include wiring and control diagrams.

E. Shop Drawings:

1. Submit Shop Drawings for review showing the exact location and arrangement of conduits stubbed into future equipment, cross sections of ductbank with conduit sizes, cabinet, pull boxes and assigned spaces, conduit sleeves for future exposed conduits, and for fabricated work being furnished and installed under these Specifications. Submit such drawings before rough-in work, fabrication, and within ample time to prevent delays in the Work.

2. Submit detailed drawings of reinforced cast-in-place and pre-cast concrete cable trenches, wireways, covers, divider partitions, support structures, anchors, and related metal work. Include installation and abutting joint details and instructions. Include transitions and connections at splice and pull boxes, wireways, cable trenches, and other related elements.

F. Field Test Reports: Submit certified field test reports of field tests, verifying electrical continuity of the raceway systems and grounding in accordance with Specifications requirements and applicable NEC Code sections.

PART 2 - PRODUCTS

2.01 CONDUIT

A. Galvanized Rigid Steel (GRS) Conduit and Accessories:

1. Provide conduit, couplings, elbows, bends, sealing fittings, and nipples conforming to ANSI C80.1 and UL 6, with each length bearing manufacturer's stamp and UL label.

2. Provide only GRS conduit and accessories for power, control, and communications, except in underground or concrete encased duct banks.

3. Provide only GRS conduit and accessories for all installations in tunnels, station under platform chase, subway, and subway passenger stations including ventilation fans, lighting and sump pumps, except when conduits are embedded in concrete.

4. Fittings and Accessories:

a. Provide separable watertight hub fittings with a gasket, separate nylon insulated throat, and a casehardened locknut.

b. Provide bushings of nylon-insulated metallic and grounding type.

c. Provide conduit straps, clamps, and clamp backs made of galvanized malleable iron.

d. Rigid steel conduit shall be a minimum of 3/4-inch diameter at exposed portions and 1 inch diameter at embedded portions.

B. Electrical Metallic Tubing: Provide electrical metallic tubing (EMT) conforming to UL 797. Provide raintight connectors and couplings with insulated throat.

C. Polyvinyl Chloride (PVC) Coated Conduit:

1. Provide PVC-coated conduit conforming to NEMA RN 1, Coating Type A-40.

2. Thread protectors installed on both ends of conduit for shipment and handling, with couplings packaged separately.

3. Provide PVC-coated metallic conduit and adapter for the transition of a PVC conduit embedded in slab and the aboveground metallic conduit. Ensure that the aboveground PVC-coated metallic conduit is 2 feet minimum above ground.

D. Liquid-tight Flexible Metallic Conduit and Fittings:

1. Provide conduit consisting of a core of flexible galvanized steel with an extruded liquid-tight plastic or neoprene jacket overall. Jacket shall be moisture- and oil-proof, capable of conforming to the minimum radius bends of flexible conduit without cracking.

2. Provide conduits with a continuous copper bonding conductor spiral wound between the convolutions, as required by California Electrical Code, and in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems.

3. Conduit and fittings shall be of self-extinguishing type with low halogen containing material.

4. Provide fittings conforming to UL 514B, zinc-coated.

E. PVC Electrical Conduit and Fittings:

1. Provide heavy wall, high impact strength, rigid PVC conforming to the requirements of EPC-40-PVC conduit of NEMA TC 2 and fittings for EPC-40-PVC conduit of NEMA TC 3.

2. Conduit and fittings shall be UL 651 listed and shall conform with Article 347 of the California Electrical Code for underground and exposed use.

3. Conduit and fittings shall be flammability rated as self-extinguishing, and shall have the following minimum properties:

a. Tensile strength, ASTM D638 at 78 degrees C: 6,000 psi.

b. Flexural strength, ASTM D790: 11,000 psi.

c. Compressive strength, ASTM D695: 8,500 psi.

d. Hardness (Durometer D), ASTM D2240: 77.

e. Water absorption, percent maximum in 24 hours at 72 degrees C, ASTM D570: 0.03.

f. Dielectric strength, ASTM D149: 1.1 kV/mil.

g. Thermal conductivity: 1.3 Btu/sq. ft./deg. F/in.

F. Conduit Expansion Fittings:

1. Fabricate expansion fittings from material similar to the type of conduit with which they are to be used.

2. Include a factory installed packing ring, designed to prevent the entrance of moisture, and a pressure ring.

3. Include a grounding ring or a grounding conductor for metallic expansion couplings.

4. Fittings shall maintain a constant inside diameter in every position and shall provide a smooth wireway for protection of wire insulation.

2.02 CONDUIT HANGERS

A. Provide trapeze type multiple conduit hangers and supports as indicated or required.

B. Fabricate hangers from two or more steel hanger rods, a steel horizontal member, U-bolts, clamps, and other attachments as necessary for securing hanger rods, and conduits.

C. Provide galvanized hanger rods not smaller than 3/8-inch diameter, threaded either full length or for a sufficient distance at each end to permit at least 1-1/2 inches of adjustment.

D. Provide horizontal member meeting the following requirements:

1. Standard structural steel shapes such as angles or channels, 1-1/2 by 1-1/2 inches or 1-5/8 by 1-5/8 inches, 12 gage, cold-formed, lipped channel, and designed to accept special spring-held hardened steel nuts for securing hanger rods and other attachments. Nuts and clamps shall be compatible with the channel.

2. Two or more channels may be welded together to form horizontal members of greater strength.

3. All members shall be hot-dip galvanized after fabrication in accordance with ASTM A123 or ASTM A153, as applicable.

E. Design of conduit hangers shall meet the following requirements:

1. Conduit hangers shall be capable of supporting a load equal to the sum of the weights of the conduits and wires, the weight of the hanger itself, plus 200 pounds.

2. The stress at the root of the thread of the hanger rods shall be not more than 9,475 psi at design load.

3. Size the horizontal member such that the maximum stress will be not more than 12,650 psi at design load.

4. Conduit support system shall be designed to withstand the seismic loads specified in the California Building Code and the California Electrical Code.

2.03 INSERTS

A. Channel Inserts:

1. Fabricate from not less than 12 gage steel channel having an overall size of 1-5/8 by 1-5/8 inches with continuous 7/8-inch wide slot, in lengths as indicated. Galvanize after fabrication.

2. Inserts for embedding in concrete shall conform to the following requirements:

   a. Fabricate from channels having a solid base.

   b. Weld concrete anchors to the channel during fabrication and before coating.

   c. Clean and galvanize after fabrication.

   d. Provide assemblies with a minimum pull-out load rating of 2,000 pounds per linear foot uniformly distributed, with a safety factor of three.

   e. Furnish channel inserts for installation embedded in concrete with the channel interior completely filled with styrofoam to prevent seepage of concrete into the channel during installation.

3. Inserts for surface mounting shall conform to the following requirements:

   a. Fabricate from channel having 3/8-inch by three-inch slots on four-inch centers in the base.

   b. Galvanize, in accordance with ASTM A123 or ASTM A153, as applicable, inserts for surface mounting on concrete surfaces and for installation in damp or wet areas.

B. Spot Inserts for Embedding in Concrete:

1. Steel, galvanized after fabrication, in accordance with ASTM A153.

2. Design for a maximum loading of 800 pounds with a safety factor of three.

3. Knockout openings to accommodate either square or rectangular nuts.

2.04 SURFACE-MOUNTED METAL RACEWAYS AND FITTINGS

A. Provide surface-mounted metal raceways and fittings, where indicated, conforming to UL 5 and California Electrical Code.

2.05 OUTLET BOXES; JUNCTION AND PULL BOXES

A. Provide outlet boxes, junction boxes, and pull boxes conforming to California Electrical Code, Article 370.

B. Electrical boxes shall conform to UL 50 and UL 514B.

C. Provide electrical boxes of the material, finish, type, and size indicated and as required for the location, kind of service, number of wires, and function. Boxes shall have mounting holes for No. 10-24 machine screws.

D. Provide boxes complete with accessible covers designed for quick removal and suitable for the purpose for which they will be used, except that boxes in which, or on which, no devices or fixtures are to be installed shall be equipped with flat or raised blank covers as required. Ceiling fixture outlet boxes shall be equipped with 3/8-inch boltless fixture studs.

E. Boxes below 100 cubic inches in size shall be cast metal. Boxes over 100 cubic inches in size shall conform to the requirements for cabinets, except boxes in interface pull boxes shall be cast metal boxes with gasketed cast metal covers. Boxes for surface mounted wiring devices shall be NEMA Type FD.

F. Covers shall be of same thickness as boxes and shall be secured in position by means of No. 10-24 stainless steel machine screws. Arrange covers to be readily and conveniently removed.

G. Junction boxes shall be zinc-coated (galvanized) inside and outside. Outlet boxes used as junction boxes shall not be smaller than 4 inches square by 1-1/2 inches deep. Provide such boxes with flat blank covers.

H. Outlet boxes for exposed installation shall be cast metal, not smaller than 4 inches square by 2-1/8 inches deep. For embedded or concealed installation, use cast metal boxes approved for intended purpose. Outlet boxes exposed to the public shall have tamper proof screw covers.

I. Concealed, flush or surface-mounted switch boxes shall be not less than 4 inches square by 1-1/2 inches deep for two devices, unless otherwise indicated. Provide covers with openings of proper size and shape. Provide special boxes as required to suit the kind of service and location requirements.

J. Provide brackets, supports, hangers, fittings, bonding jumpers, and other installation accessories as required.

K. Provide neoprene gaskets 1/8-inch thick for boxes subjected to weather. Provide fire resistant gaskets for pull boxes installed at the conduits for emergency equipment, feeder cables, and fire protection circuits.

L. Provide each box with a grounding terminal as follows:

1. Provide grounding terminal of either a green-colored washer-in- head machine screw not smaller than No. 10-32 in a drilled, tapped, and threaded hole in the back of the box, or a grounding bushing with green-colored machine screw terminal attached to one of the conduits.

2. Provide grounding terminals in motor connection boxes.

3. Install grounding jumpers as specified in Section 26 05 26 - Grounding and Bonding for Electrical Systems.

M. All boxes for systems control and communications applications shall conform to NEMA Type 4 and shall be provided with NEMA Type 4 labels.

N. Pull boxes for ENT installation shall be no more than 100 feet apart.

O. Pull boxes on sidewalks and planter areas shall be made of fiberglass and reinforced polymer concrete and UL listed. Pull box lids shall have a non-skid surface. Boxes shall have bolted down covers and inscribed with "**ELECTRICAL**" where shown on the Contact Drawings. Heavy-duty H20 loading Traffic Boxes with steel checker plate screw down covers shall be provided where pull boxes are used on roadways or parking lots. The checker plate covers shall be inscribed with "**ELECTRICAL**."

2.06 METALLIC CABLE TRAYS

A. General: Provide metallic cable tray systems conforming to NEMA VE 1, except for modifications indicated. Cable tray system shall be designed to withstand the seismic load specified in the California Building Code and the California Electrical Code.

B. Cable Tray System Components:

1. Provide components of hot-dip galvanized steel in accordance with ASTM A123, or stainless steel Type 304 or Type 316, as indicated.

2. Install bonding jumpers at all cable tray connections. Bonding jumpers shall be sized to withstand maximum short circuit current.

C. Dimensions: Straight sections and fittings shall have inside clear width as indicated, measured between the rails. Width of tray shall be 6 inches minimum. Overall width shall not exceed inside width by more than 2-1/2 inches. Loading depth of tray shall be 3 inches minimum. Inside nominal depth shall be 5 inches minimum. Overall tray depth shall be 6 inches.

D. Fabrication:

1. Provide straight sections and fittings consisting of stiffened channel rungs located between channel-shaped side rails having outward projecting flanges.

2. Rungs shall be positioned to provide a flat, cable support surface at least 1-1/8 inches wide, excluding corner radii, and shall be 0.060 inch thick. MIG-weld rungs to side rails and clean welds. Tray rungs shall be spaced 6 inches on center.

3. Provide straight-section side rails having a top flange not to exceed 1-1/4 inches wide and a minimum 3/8-inch vertical stiffening lip.

4. The radius of curved fittings shall be 24 inches minimum, unless otherwise approved by the Engineer.

5. Where indicated, provide solid bottom type straight sections and fittings consisting of two-sided rails with a solid corrugated bottom welded to the side rails. Provide solid flanged covers to match solid bottom tray construction.

E. Test Requirements:

1. The metallic cable tray system shall be capable of supporting a total cable load of 55 pounds per linear foot for cable tray of 30 inches wide or less and 88 pounds per linear foot for cable tray over 30 inches wide on a maximum span of 8 feet including a static concentrated load of 200 pounds as specified below, with a safety factor of two based on the destructive load, regardless of the type of splice plates or type of span, when tested in accordance with load test procedure specified in NEMA VE 1, Section 4.

2. Straight sections and fittings shall not permanently deform under a 200 pound static concentrated load applied vertically along a four inch length for both of the following conditions:

a. Load applied to center of one tray section having specified cable load and support spacing. Load shall be applied at midpoint between supports over a splice connection.

b. Load applied to one rung of empty tray section having specified support spacing. Load shall be located at midpoint between side rails and supports.

F. Cable Tray Supports:

1. The cable tray system shall be supported at five-foot spans and shall be capable of carrying a working load of 100 pounds per linear foot, with a safety factor of 3.0 when loaded in accordance with NEMA VE 1, Section 3, and tested in accordance with NEMA VE 1, Section 4. All fittings, supports, and accessories shall be manufactured or fabricated in accordance with the cable tray manufacturer's recommendations.

2. Cable tray supports fabricated from minimum 12 gage steel channel, 1-5/8 inches by 1-5/8 inches, with a continuous 7/8-inch wide slot, hot-dip galvanized after fabrication will be acceptable.

3. Provide assembled supports, fittings, brackets, and hardware to carry the loads as indicated with a factor of safety of three or greater.

4. Supports shall provide at least 1-1/8 inch bearing length for each rail and shall have provision for tray hold-down clamps and fasteners.

5. Anchorages and fastenings to underside of roof or ceiling require approval of the Engineer before they may be used in the work. Anchorage and fastening to pre-stressed girders, beams, and slabs will not be permitted.

2.07 FIBERGLASS CABLE TRAYS

A. Where the cable tray system is indicated or required to be fiberglass-reinforced plastic (FRP), provide such FRP cable tray system conforming to NEMA FG 1, except for modifications indicated. Use metallic hardware, units and bolts, if required. Conform with all requirements of the herein specified metallic cable trays as applicable to plastic systems. Provide special

grounding and bonding in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems, as required for plastic systems.

2.08 UNDERFLOOR DUCT SYSTEM

A. Provide underfloor duct system consisting of junction boxes, ducts, extension rings, hold-down straps, and accessory parts to form complete assemblies, made watertight with sealing compound. Fabricate primary components of the system of 14 gage steel, with an approved corrosion-resistant coating.

B. Provide junction boxes with openings on each of the four sides to receive two ducts, each 1-1/2 inches high by 6-1/2 inches wide; and having a round top cover of approximately 22 inches in diameter for access to cables. Fit junction boxes with interior partitions which isolate each duct and concurrently form a continuous raceway through the box in both directions.

C. Each raceway shall have a minimum inside area of 8.5 square inches for large duct or 3.3 square inches for small duct. Close off unused junction box openings with blank panels. Fit boxes with four pad-and- screw assemblies for bolting boxes to the structure and for leveling and height adjustments.

D. Provide extension rings matching the junction boxes, if required, in a height which, along with heights of the junction box and cover, combine to bring the total height of the assembly to 4-1/2 inches, the approximate thickness of the finish floor. The leveling and height adjustment screws in the junction box shall have a minimum upward adjustment of 3/8-inches and shall be used for final adjustment to bring the top of the cover plates level and flush with the top of the finish floor.

E. Provide junction box cover plates of stainless steel or brass and recess 3/4-inches minimum to hold a section of paver matching adjacent pavers in the station finish floor. Provide junction box cover plates not exposed to public view of flat stainless steel.

F. In addition to furnishing accessory parts to form a complete assembly, furnish core drills, hole saws, afterset inserts, and insert extensions as required for normal installation.

G. Junction boxes and cover plates shall be watertight.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install electrical raceway materials, equipment, and accessories in locations as indicated, rigid and secure, plumb and level, and in alignment with related and adjoining work to provide a complete and operable system. Do not weld electrical materials for attachment or support, except as otherwise specified in Section 26 05 26 - Grounding and Bonding for Electrical Systems, for electrical continuity bonding and grounding.

B. Provide anchor bolts and anchorage items as required, and field check to ensure proper alignment and location. Provide templates, layout drawings, and supervision at the jobsite to ensure correct placing of anchorage items in concrete. Check embedded items for correctness of location and detail before concrete is placed.

C. Install supporting members, fastenings, framing, hangers, bracing, brackets, straps, bolts, and angles as required to set and connect the work rigidly. Conform to California Building Code requirements for Seismic Zone 4 location.

D. Control erection tolerance requirements so as to not impair the strength, safety, serviceability, or appearance of the installations. Determine exact locations of conduit. Route conduit parallel to building lines unless otherwise indicated.

E. The trade size, type, and general routing and location of conduits, raceways, and boxes shall be as indicated or specified.

F. Install exposed conduit so as to avoid conflicts with other work. Install horizontal raceways close to the ceiling or ceiling beams, and above water or other piping.

G. Use of powder-actuated or explosive fasteners is prohibited.

3.02 CONDUIT AND FITTINGS

A. Electrical Conduit - Installation Requirements:

1. Install conduit in accordance with California Electrical Code, NFPA 130, and as indicated. Prevent concrete and other materials from entering and obstructing the conduit, outlets, and pull and junction boxes.

2. Conduits smaller than ¾-inch shall not be used.

3. Non-Metallic Conduit (NMC) shall be 1-inch or greater for underground and embedded locations. For concrete slabs less than 5-inch thick or elevated prestressed concrete decks, 3/4-inch NMC may be used. Bending radius shall not exceed manufacturer's specification.

4. Conduit fill of ENT shall not exceed 30%. Junction boxes or pull boxes for ENT shall be spaced no more than 100-feet apart.

5. All flexible conduits, exposed, embedded or concealed shall be fastened every 3-feet and 24-inches from a box outlet.

6. Unless otherwise indicated, make conduit bends in accordance with California Electrical Code, with not more than three quarter bends, 270 degrees total, per run of conduit. Where more bends are required in a particular run, install pull boxes as required to facilitate pulling conductors even if not indicated.

7. Terminate metallic conduit installed for future extension with flush threaded couplings set to finished floor level or wall, unless otherwise indicated. Provide plug for open end. Extensions to existing Work shall match existing size.

8. Provide and install metallic numbering tags on both ends of all conduits. Tags shall be marked with a stamped conduit identification number.

9. Properly support and anchor conduit to be embedded to maintain correct location and spacing and to prevent flotation during concreting operations. If necessary, provide suitable metal supports.

10. Install conduit so that moisture collecting in the conduit will be drained to the nearest outlet or pull box. Drill weep-holes at the lowest points in each exposed conduit run. Install a "T" conduit with drain fitting at the lowest point.

11. Whenever exposed or buried conduit passes through an expansion or contraction joint in the structure, install the conduit at right angles to the joint, and provide an approved conduit expansion fitting at the joint. Paint the conduit with an approved bituminous compound for one foot on each side of the expansion couplings.

12. Provide expansion fittings in conduit runs to compensate for thermal expansion.

13. Rod and swab embedded conduit after installation to remove foreign matter. If obstructions are encountered which cannot be removed, or if conditions exist which may result in damage to wires and cables pulled through the conduit, install new conduit at no additional cost to the District.

14. After the conduit has been rodded and swabbed, install covers on boxes and protect conduit ends to prevent foreign material from entering the conduit.

15. Where conduit is exposed to different temperatures, seal the conduit to prevent condensation and passage of air from one area to the other.

16. Metallic conduits shall be electrically and mechanically continuous and connected to ground by bonding to the grounding system.

17. Apply conductive compound to the threads of threaded rigid conduit joints. Do not use compounds containing lead. Terminate the conduit in appropriate boxes at motors, switches, outlets, and junction points.

18. When field cutting of conduit is required, thread and ream the conduit to remove rough edges. Where a conduit enters a box or other fitting, provide a bushing to protect the wire from abrasion. Provide insulation type bushings and double locknuts on ends of rigid conduits terminating at steel boxes, panelboards, cabinets, motor starting equipment, and similar enclosures.

19. Support individual conduits not larger than 1 inch in diameter by means of one-hole conduit straps with back spacers or individual conduit hangers.

20. Space conduits installed against concrete surfaces 1/4 inch away from the surface by clamp backs or other approved means.

21. Support individual conduits larger than 1 inch in diameter by individual hangers or forged steel two-hole conduit strap.

22. Hanger rods used in connection with spring-steel fasteners, clips and clamps shall be either 3/8-inch diameter galvanized steel rods or, if concealed above a suspended ceiling, galvanized perforated steel strapping. Do not use wire for support of conduit.

23. Support parallel conduits at the same elevation on multiple conduit hangers or channel inserts. Secure each conduit to the pipe hanger or channel insert member by a U-bolt,

one-hole strap or other specially designed and approved fastener suitable for use with the pipe hangers or channel inserts.

24. Space supports not over ten feet on centers for vertical conduits spanning open areas. Securely anchor conduit at each end, and run so as not to interfere with the installation and operation of equipment at the location.

25. Support conduits and raceways above suspended ceilings from either the floor construction above or from the main ceiling support members, by using the applicable methods specified herein.

26. Install liquid-tight flexible metal conduit at structural construction joints, at motor connections and where required so that liquids tend to run off the surface and not drain toward fittings. Provide sufficient slack to reduce the effects of vibration. Running threads are not acceptable. Where necessary for connecting to rigid conduits, use right and left hand couplings.

27. In areas of floating slabs, install horizontal runs of conduit beneath the floating slab. Conduit shall pass through the floating slab only where required to terminate in a vertical direction as indicated. Provide a sleeve with an all around 1/4-inch clearance between sleeve and vertical conduit riser. Fill the space around the conduit with rubber-base waterproofing compound.

28. Electrical metallic tubing (EMT) may be run exposed above 10 feet or concealed in walls and ceilings, where allowed. Do not install EMT in tunnels, subways, utility chase, under-platform utility chase, outdoor locations and exposed to weather. All emergency power and lighting circuits, communication circuits, fire alarms, service entrance, emergency system (vent fans/damper/pumps/generators), and essential loads of train control circuits shall not be installed in EMT. EMT may be used below 10-feet above finished floor for circuits exiting walls or ceilings but shall not have an exposed length exceeding 3-feet.

29. Tag unscheduled conduit in a manner acceptable to the District Representative for indoor installations only.

30. Conduits for emergency loads (such as emergency lighting and fire alarm system) shall be run separately from "normal" load conduits and protected from physical damage or fires, and shall be GRS.

31. Seal conduits with watertight duct sealing system, where waterproofing is required.

B. Nonmetallic Conduit:

1. Embed in slabs and walls where indicated.

2. Cap or plug the ends of embedded conduit to prevent concrete and other materials from obstructing the conduit.

3. Sandpaper joints in PVC conduit to remove burrs, clean and dry the joints, and brush with a solvent cement acceptable to the manufacturer before installing.

4. Support conduit to maintain the correct location and spacing during concreting operations and provide suitable plastic supports and spacers for conduit ductbanks.

5. Other installation requirements shall be the same as for metallic electrical conduit.

C. Pull Cords:

1. Provide nylon pull cords of tensile strength not less than 240 pounds in each conduit and duct. Leave pull cords in ducts and conduit.

2. Splices in pull cords will not be permitted.

3. Leave ample slack length at each end of pull cords.

D. Filling of Openings: Wherever slots, sleeves, or other openings are provided in floors and walls for the passage of raceways, conduits, and bus ducts, fill such openings as follows:

1. Provide fire-resistive filling material and installation for openings in conformance with Section 07 84 00 - Firestopping.

2. Where conduits passing through openings are exposed in finished rooms, use surface filling material that matches, and is flush with, the adjoining finished floor, ceiling, or wall.

E. Conduit Hangers:

1. Provide anchor bolts and anchorage items as required, and field check to ensure proper alignment and location. Provide templates, layout drawings, and supervision at the jobsite to ensure correct placing of anchorage items in concrete. Check embedded items for correctness of location and detail before concrete is placed.

2. Install supporting members, fastenings, framing, hangers, bracing, brackets, straps, bolts, and angles as required to set and connect the work rigidly. Conform to California Building Code requirements for Seismic Zone 4 location.

3. Support parallel conduits at the same elevation on multiple conduit hangers or channel inserts. Secure each conduit to the hanger or channel insert member by U-bolt, one-hole strap, or other specially designed and approved fastener suitable for use with the hangers or channel inserts.

4. Space supports not over 10 feet on center for vertical conduits spanning open areas. Securely anchor conduit at each end, and run so as not to interfere with the installation and operation of equipment at the location.

5. Support conduits and raceways above suspended ceilings from either the floor construction above or from the main ceiling support members, by using the applicable methods specified herein.

3.03 INSERTS

A. Channel Inserts: Install embedded channel inserts with the slotted face flush with the finished concrete surface.

B. Spot Inserts: Install with the insert face flush with the finished concrete surface, firmly embedded, with no evidence of movement.

C. Tests: Test selected inserts by suspension of 800 pounds of weight from the insert. If there is evidence of failure, replace the inserts in a satisfactory manner at no additional cost to the District, and retest.

3.04 SURFACE METAL RACEWAYS

A. Install surface metal raceways, where indicated, in accordance with California Electrical Code. Use fittings and accessories designed for the raceway.

B. Securely ground surface metal raceways to outlet boxes or to backplates and fixtures by means of bolts, screws, or other approved method and as specified in Section 26 05 26 - Grounding and Bonding for Electrical Systems.

3.05 OUTLET, JUNCTION, AND PULL BOXES

A. Mount outlet, junction, and pull boxes so as to prevent moisture from entering or accumulating within the boxes. Mount boxes opposite to the third rail wherever possible. Do not use conduits entering the box as supports for the box.

B. Outlet Boxes:

1. Unless otherwise indicated, flush mount outlet boxes with the front edges of the boxes or tile covers attached thereto flush with the finished wall or ceiling.
2. Mount boxes so that the long axis of the devices will be vertical, unless otherwise indicated.
3. Locate boxes and box knockouts in concrete so as not to interfere with the reinforcing steel.
4. Unless otherwise specified, provide boxes in tile walls and ceilings with tile covers. Do not install these covers until the finished tile line is determined for the particular location.
5. The mounting height indicated for a wall-mounted outlet box shall be construed to mean the height from the finished floor to the horizontal centerline of the cover plate.
6. Mount outlet boxes for switches and receptacles located on columns and pilasters so as not to interfere with installation of partitions.
7. Install boxes located near doors on the lock side, even where the symbols appear on the hinge side as indicated, unless other locations are approved by the Engineer.

C. Junction and Pull Boxes:

1. Install so that covers are readily accessible after completion of the installation.

2. Do not install boxes above suspended ceilings, except where the ceiling is of the removable type or where definite provisions are made for access to each box.

D. Boxes Set in Concrete:

1. Support boxes to prevent movement during placement of concrete.

2. Unused nailing holes or other holes in the side or bottom of the boxes shall be plugged or masked.

3. After installation, clean boxes placed in concrete and provide covers to prevent entry of dirt and debris.

3.06 CABLE TRAYS

A. Install cable trays as indicated and in accordance with California Electrical Code, Article 318, using approved fittings and adequately supporting the complete system.

B. Provide anti-sway brackets on horizontal tray assemblies at 10 foot intervals.

C. Connect each isolated cable tray system or the entire tray system to the building equipment grounding system with a bare copper conductor in accordance with California Electrical Code.

D. Base size determination of grounding cable on the largest power and control conductor in the cable tray:

1. Minimum size: 14 AWG.

2. Maximum size: 750 kcmil.

3.07 UNDERFLOOR DUCTS AND FITTINGS

A. Install duct systems in the station finish floor as indicated.

B. Join duct sections using sleeve-type couplings, and fasten to station structure with expansion bolts as indicated. Hold-down straps shall maintain a one inch space between the two ducts.

C. Seal duct installations watertight with an approved sealing compound before concrete pour.

END OF SECTION 20 50 13