PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The general conditions, Division 26, and Basic Electrical Materials and Methods (Section 260500) are part of this section and the contract for this work and apply to this section as fully as if repeated herein.

B. Reference to other sections: The applicable requirements from other Division 26 sections required for a complete and operational system shall form a part of the electrical work and each section shall be thoroughly reviewed by the Contractor for application to all other sections.

C. Related Requirements:
1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
2. Section 280528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

1.2 SUMMARY

A. Section Includes:
1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Surface raceways.

1.3 QUALITY ASSURANCE AND STANDARDS

A. All work, material or equipment shall comply with the codes, ordinances and regulations of the local government having jurisdiction, including the regulations of serving utilities and any participating government agencies having jurisdiction.

B. Equipment shown to scale is approximate only and based upon a general class of equipment specified. The Contractor shall verify all dimensions and clearances prior to commencement of work.

C. The Contractor shall verify all points of connection with the manufacturer’s requirements, instructions, or recommendations prior to installation. The actual dimensions, weights, clearance requirements and installation requirements shall be verified and coordinated by the contractor.

1.4 SUBMITTALS

A. Action Submittals
1. Product Data: For surface raceways, wireways and fittings.
2. LEED Submittals:
   a. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
3. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

B. Informational Submittals
   1. Seismic Qualification Certificates: For conduit racks and their mounting provisions, including those for internal components, from manufacturer.
      a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      b. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.1 RIGID GALVANIZED STEEL (RGS) CONDUIT

A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in CEC, by a qualified testing agency, and marked for intended location and application.

B. Continuous hot-dipped galvanized manufactured per UL and ANSI requirement.

C. Rigid aluminum conduit is not acceptable, except where required by MRI manufacturer.

D. Conduit bodies for use with steel conduit, rigid or flexible, shall be manufactured per UL requirements and shall be cast metal with gasketed closures.

E. Fittings for RGS conduit shall be malleable iron or forged steel with cadmium or zinc coating.

F. Rigid Steel Conduit: Use threaded or threadless fittings if needed rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.

G. Union couplings for joining rigid conduit at intermediate runs shall be of the same material as the conduit. Couplings shall be threaded concrete-tight to permit completing conduit runs when neither conduit can be turned and to permit breaking the conduit run at the union.

H. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

I. Joint Compound for GRC: Approved, as defined in CEC, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

J. Minimum raceway size shall not be less than ¾”.

2.2 ELECTRICAL METALLIC TUBING (EMT)

A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in CEC, by a qualified testing agency, and marked for intended location and application.

B. Conduit shall be cold rolled zinc coated steel and manufactured per UL and ANSI requirements.

C. Fittings for EMT shall be watertight steel or malleable gripping ring compression type at outdoor locations.

D. Pressure cast material for nuts of compression ring type fittings are not acceptable. Set-screw connections are acceptable when installed indoors only.

E. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

F. Minimum raceway size shall be ¾".

2.3 FLEXIBLE METALLIC CONDUIT

A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in CEC, by a qualified testing agency, and marked for intended location and application.

B. Flexible conduit shall bear the UL label and be zinc coated steel.

C. Fittings for flexible metallic conduit shall be steel or malleable iron. Fittings shall clamp to conduit securely.

D. Screw in type, sheet metal or set-screw type fittings are not acceptable.

E. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

F. Minimum raceway size shall not be less than ¾" or sized to match factory connections.

2.4 LIQUID TIGHT FLEXIBLE CONDUIT

A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in CEC, by a qualified testing agency, and marked for intended location and application.

B. Conduit shall be manufactured in accordance with UL and ANSI requirements. Conduit shall be approved for grounding and compatible with approved fittings. Flexible steel conduit shall be hot dipped galvanized with extruded PVC covering manufactured per UL requirements.

C. Fittings shall be liquid tight type with body and gland nut of steel or malleable iron with provisions for grounding flexible conduit to fittings.

D. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

E. Minimum raceway size shall be ¾" or sized to match factory connection points.

2.5 PVC-COATED STEEL CONDUIT: PVC-COATED RIGID STEEL CONDUIT.

A. Comply with NEMA RN 1.

B. Coating Thickness: 0.040 inch, minimum.

C. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

D. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

E. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

F. Minimum raceway size shall be ¾".

2.6 POLYVINYL CHLORIDE (PVC) CONDUIT

A. PVC shall be constructed of a virgin homopolymer PVC compound and be manufactured according to NEMA and UL specifications. PVC conduit shall be Schedule 40 or 80.

B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in CEC, by a qualified testing agency, and marked for intended location and application.

C. Ducts for Electrical Cables More than 600 V: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank unless otherwise indicated.

D. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank unless otherwise indicated.

E. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank unless otherwise indicated.

F. Ducts Crossing Driveways and Roadways: RNC, NEMA Type EPC-40-PVC, encased in concrete.

G. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

H. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

I. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and size of ducts with which used, and selected to provide minimum duct spacing indicated while supporting ducts during concreting or backfilling.

J. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

K. Minimum raceway size shall be ¾".

2.7 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
1. Cooper B-Line, Inc.; a division of Cooper Industries.
2. Hoffman; a brand of Pentair Equipment Protection.
3. Square D.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to CEC.
1. Metal wireways installed outdoors shall be listed and labeled as defined in CEC, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Screw-cover type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.8 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in CEC, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Prime coated, ready for field painting.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
a. Hubbell Incorporated; Wiring Device-Kellems; Hubbell Surface Metal raceway.
b. Panduit Corp.
c. Wiremold / Legrand.

C. Tele-Power Poles:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
a. Panduit Corp.

b. Wiremold / Legrand.

2. Material: Galvanized steel with ivory baked-enamel finish.
3. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

PART 3 - EXECUTION

3.1 RIGID GALVANIZED STEEL (RGS) CONDUIT

A. RGS shall be used where exposed to weather or where subject to physical damage in exposed areas below 8'0" above finished floor.

B. RGS shall be used in CEC classified hazardous locations with seal connections per CEC requirements.

3.2 ELECTRICAL METALLIC TUBING (EMT)

A. EMT shall be run indoors concealed in drywall type construction, above suspended ceilings, and exposed indoors not less than 8'0" above finished floor in unfinished areas where subject to physical damage.

B. EMT shall not be installed underground, outdoors, or embedded in concrete.

3.3 FLEXIBLE METALLIC CONDUIT

A. Flexible conduit shall be used for indoor lighting connections in suspended ceiling areas and shall not exceed 6'0" in length.

B. Flexible conduit shall be used for final connection to control equipment and not to exceed 2'0" in length.

C. The conduit grounding system shall be continuous as recommended by the manufacturer and UL approved.

3.4 LIQUID TIGHT FLEXIBLE CONDUIT

A. Liquid tight flexible conduit shall be used for final connection to machines, motors, transformers and equipment that requires vibration isolation.

B. Liquid tight flexible conduit shall be used for final connection to equipment in wet or damp locations or where exposed to grease, water, dust, dirt, vapors, or chemicals.

C. The conduit grounding system shall be continuous as recommended by the manufacturer and UL requirements.

3.5 POLYVINYL CHLORIDE (PVC) CONDUIT

A. All sweeps, bends, and risers shall be concrete encased Schedule 40.

B. All underground high voltage conduit, telephone conduit, service entrance conduit and feeders 100A and over shall have 3" of red mixed concrete cover and a metallic locating tape installed 6” above the top of the conduit.

C. All PVC conduit feeders shall contain a copper green grounding conductor sized per CEC requirements and continuity shall be maintained throughout conduit runs and pullboxes.

3.6 CONDUIT INSTALLATION

A. All conduit installation methods shall comply with the 2013 edition of the California Electrical Code and the authority having jurisdiction.

B. All conduit installations shall comply with the manufacturer's installation requirements.

C. Install nonferrous conduit or tubing for circuits operating above 60 Hz or areas designated by MRI manufacturer. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

E. Install surface raceways only where indicated on Drawings.

F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

G. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with CEC limitations for types of raceways allowed in specific occupancies and number of floors.

H. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

I. Complete raceway installation before starting conductor installation.

J. Comply with requirements in Section 260529 "Supports and Hangers for Electrical Systems" for hangers and supports.

K. Arrange stub-ups so curved portions of bends are not visible above finished slab.

L. Install no more than the equivalent of four 90-degree bends in any conduit run. Support within 12 inches of changes in direction.

M. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

N. Support conduit per the California Electrical Code.

O. Raceways Embedded in Slabs:
1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-footintervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

P. Stub-ups to Above Recessed Ceilings:
1. Use EMT or RGS for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

Q. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

R. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

S. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

T. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

U. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

V. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

W. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

X. All spare conduit shall be cleaned, mandrelled, and provided with a pullwire. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

Y. Surface Raceways:
1. Install surface raceway with a minimum 2-inch radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

Z. Install raceway sealing fittings at accessible locations according to CEC and fill them with 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 according to CEC.

AA. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by CEC.

BB. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

CC. Expansion-Joint Fittings:
1. Install in each run of aboveground RGS and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
   c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
   d. Attics: 135 deg F temperature change.
3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints using flexible conduit with slack.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

DD. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

EE. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

FF. Protect coatings, finishes, and cabinets from damage and deterioration.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.7 INSTALLATION OF UNDERGROUND CONDUIT

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined

in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

C. Clear and grub vegetation to be removed, and protect vegetation to remain according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

D. Install ducts according to NEMA TCB 2.

E. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes, to drain in both directions.

F. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured bends ~~with a minimum radius of 24 inches,~~ both horizontally and vertically, at other locations unless otherwise indicated.

G. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. ~~Stagger couplings so those of adjacent ducts do not lie in same plane.~~

H. Installation Adjacent to High-Temperature Steam Lines: Where duct banks are installed parallel to underground steam lines, perform calculations showing the duct bank will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct bank crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.

I. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells.
   1. Grout end bells into structure walls from both sides to provide watertight entrances.

J. Building Wall Penetrations: Install conduit penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

K. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

L. Pulling Cord: Install 100-lbf- test nylon cord in empty ducts.

M. Concrete-Encased Ducts: Support ducts on duct separators.
   1. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches in nominal diameter.
   2. Depth: Install top of duct bank per CEC and AHJ.

3. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
4. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than four five spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting.
5. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
6. Elbows: Use manufactured duct elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run unless otherwise indicated. Extend concrete encasement throughout length of elbow.
7. ~~Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.~~
8. ~~8.~~7. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
9. ~~9.~~8. Concrete Cover: Install a minimum of 3 inches of concrete cover at top and bottom, and a minimum of 2 inches on each side of duct bank.
10. ~~10.~~9. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
    a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. ~~Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.~~
    b. ~~If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.~~
11. ~~11.~~10. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

N. Direct-Buried Conduit:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
4. Space separators close enough to prevent sagging and deforming of ducts, with not less than four spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
5. Depth: Install top of duct bank per CEC and AHJ.

6. Set elevation of bottom of duct bank below frost line.
7. Install ducts with a minimum of 2 inches between ducts for like services and 6 inches between power and signal ducts.
8. Elbows: Install manufactured duct elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

O. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

END OF SECTION