SECTION 33 71 19
UNDERGROUND POWER DUCT AND SUB-STRUCTURES

PART 1 GENERAL

1.1 RELATED WORK
   A. Section 31 23 33: Trenching, Backfilling, and Compacting
   B. Section 32 01 00: Site Restoration and Rehabilitation
   C. Section 33 71 49.23: Primary Voltage Cable

1.2 REFERENCES
   A. American Association of State Highway and Transportation Officials (AASHTO): Standard Specifications
   B. State of California, Dept. of Transportation (CalTrans), Standard Specifications, current revision.
   C. California Electrical Code (CEC). This is the National Electric Code (NEC) with California Amendments, use the current adopted edition.
   D. National Electrical Manufacturers Association (NEMA)
   E. California Building Code (CBC)

1.3 SUBMITTALS
   General: Provide to Utility System Manager for approval according to the General Conditions. Include conduit, manholes, vaults, frames, rings, and covers with dimensions and part numbers.

1.4 DELIVERY, STORAGE, AND HANDLING
   A. Deliver all conduit to the job site in the original bundles.
   B. Properly store and protect materials from damage.
PART 2 PRODUCTS

2.1 CONDUIT AND FITTINGS

A. Plastic Conduit: Schedule 40 PVC of the size shown on the drawings and UL listed for use as electrical conduit: NEMA TC2 and TC3 (fittings). Fittings shall be from the same manufacturer as conduit. Schedule 20 and Type DB conduit is not acceptable. Carlon or approved equal. Size conduit as shown or noted on the drawings.

B. Rigid Metal Conduit: UL 6, hot-dip galvanized, threaded couplings and fittings with insulated end bushings. Wrap buried conduit with twenty- (20) mil pipe wrap with fifty percent (50%) overlap. Fittings and outlet boxes for use with steel conduit, rigid or flexible, shall be cast metal with gasketed closures (UL514). Running thread will not be accepted.

C. Conduit Spacers: Carlon or approved equal, conduit spacers shall be used to maintain proper separation.

2.2 GROUNDING:

Ground rods shall be copper-clad steel with diameter adequate to permit driving to full length of the rod, but not less than ¾-inch by 10-feet.

Provide ground rods in all high volt vaults and / or manholes.

2.3 CONCRETE:

Cast-in-place concrete other than conduit encasement shall be Cal Trans Class A with 1-inch maximum aggregate and shall have a minimum 28-day compressive strength of 2500 psi. Concrete for conduit encasement shall be Cal Trans Class C with 1-inch maximum aggregate and shall be red concrete containing four (4) pounds red dye per cubic yard.

2.4 DUCT PLUGS:

Removable, reusable, corrosion proof, water/air/gastight, provide pull rope attachment. Tyco, type JMS, or approved equal.

2.5 PULL ROPE:

Pull rope shall be placed in each conduit with at least 24-inches excess length on each end. The rope shall be a minimum of 3/16-inch diameter, 150-pound min. test, yellow nylon or polypropylene pull line, Polypro or equal.

2.6 MANHOLES

Manholes are large underground structures, at least 3-foot x 5-foot, the actual size will depend on the application, that require personnel and equipment entrance). See FDG Drawings, ES-15, 16, 17 and 21.
A. Use pre-cast; designed for AASHTO H20 traffic loading including necks and cast iron frames and covers.

B. Precast manholes may be constructed as a box with a slab top, or as two halves.

C. Provide full sized openings as required by the UBC with neck, frame and cover. The inside neck diameter shall be a minimum of 39-inch except for the cast iron frame as noted below. A 42-inch opening with a 42-inch x 39-inch pre-cast cone or transition section may be used. The edge of manhole openings shall be located 18-inch from the inside wall of the narrow side of the manhole on the longitudinal centerline, unless otherwise shown or noted on the drawings.

C. Manhole Frame and Cover: Neenah R-1792-JL, or approved equal, with an absolute minimum clear opening of 38-1/2 inch. See FDG Drawings ES-21 for H.V. Pattern. Castings shall be of uniform quality, free from blowholes, shrinkage, distortion or other defects. Shotblast the castings smooth and well cleaned. Frames and covers shall have continuously machined bearing surfaces to prevent rocking and rattling.

E. Manholes shall be supplied with cast-in-place terminators for all conduits at the locations shown or noted on the drawings, unless otherwise noted. Where locations conflict with manhole section joints, alternate locations to avoid joints shall be submitted with shop drawings for approval.

F. Provide manholes with the following:
   1. Standard pulling irons.
   2. 14-inch diameter sump.
   3. Non-metallic cable racking system per approved design drawings. Use Underground Devices, Inc. CR36 stanchions and RA08 arms or approved equal.
   4. 1-inch diam. ground rod holes in each corner.

G. Manholes shall be at least 7-foot high, inside dimension.

H. Minimum inside plan dimensions of manholes shall be 3-foot x 5-foot. Manufacturers may utilize their next-larger standard sizes provided they are larger than the minimums listed, subject to project space limitations and as shown on Design Drawings.

I. Precast manholes shall be as manufactured by Utility Vault Co., Brooks Products, Forni, Associated Concrete Products, or approved equal.

2.7 SUBSURFACE VAULTS:

Vaults are underground structures that are intended to house equipment that can be operated from the surface through the opening in the top.
A. Use precast concrete with a 12-inch high riser and AASHTO H20 full traffic cover as shown in FDG Drawings ES-16 and 17. Covers rated “Pedestrian” or “Parkway” or otherwise less than H20 are not acceptable. Provide cast ring and round cover only in traffic lanes on streets and access roads; otherwise, provide hinged cover.

B. Provide one 12-inch vault extension at the top of the vault. Provide nameplate: "SU POWER".

C. Provide nameplate showing “MH-XXX” (see Design Drawing for MH number)

D. Provide vaults with the following:
   1. Standard pulling irons.
   2. 14-inch diameter by 12-inches deep sump.
   3. Non-metallic cable racking system per approved design drawings. Use Underground Devices, Inc. CR36 stanchions and RA08 arms or approved equal.
   4. 1-inch diam. ground rod holes in each corner.
   5. Supply vaults with cast-in-place terminators for all conduits at the locations shown on the project drawings.
   6. Removeable ladder.

2.8 TRANSFORMER PADS:

Provide transformer pads according to Utilities Department Standard Drawing ES-01. Transformer pads may be precast where shown or noted on the drawings, or when otherwise approved. Precast pads shall be provided with lifting inserts. Utility Vault, or approved equal.

PART 3 EXECUTION

3.1 UNDERGROUND DUCT INSTALLATION

A. General:

   1. Duct system layouts as shown on the drawings are diagrammatic and should be followed as closely as possible. Number of conduits shall be according to the design drawing and in accordance with FDC Drawing ES-11. Determine exact routing by the field conditions encountered. Excavate the trench sufficiently ahead so that such changes may be made smoothly and avoid additional bends or offsets. Radii required to clear any subsurface lines, structures or obstructions shall be as great as possible but in no case shall be less than 20 feet without prior written approval from
the Project Manager. All deviations from the drawings must be approved in advance in writing by the Project Manager.

High Volt ducts shall be installed with 12 inches clearance in all directions from new or existing water lines and 5-foot clearance in all directions from steam or hot-water lines.

2. The term "conduit" refers to the individual tube designed to carry power cable. The term "duct" refers to the complete cable-carrying installation comprised of one or more conduits.

3. The top of the duct shall be not less than thirty-six (36) inches below grade, and shall have a minimum slope of three (3) inches in each one-hundred (100) feet away from buildings and toward manholes and other necessary drainage points where possible, and shall run in straight lines except where a change in direction is necessary, unless otherwise shown or noted on the drawings.

4. Except at conduit risers, changes in direction of duct runs exceeding a total of ten (10) degrees, either vertical or horizontal, shall be accomplished by long sweep bends. Make sweep bends by one or more curves or straight sections or combinations thereof, except where a single curve with minimum radius is shown. Pipe deflection and curvature shall not exceed the maximum values recommended by the manufacturer. Use manufactured bends with a minimum radius of sixty (60) inches, except for risers from shallow trenches, unless otherwise noted or shown. There shall be no shoulder or unevenness at joints along the duct interior.

5. There shall be no more than three (3) 90-degree bends between vaults or pull boxes. Exception may be made if detailed pulling tension calculations are made to show that cable maximum are not exceeded.

6. Terminate conduits entering new structures in factory installed terminators. Terminate conduits entering existing structures through cored holes and provide end-bells neatly grouted in place. Install terminators and end-bells flush with the interior walls of structures unless otherwise shown or noted. Stagger the joints of the conduit rows and layers to provide a duct line having maximum strength.

7. Immediately following backfill and required compaction, draw a testing mandrel not less than twelve (12) inches long and with a diameter 1/4 inch less than the interior size of the conduit through each conduit. Then draw a brush equipped with stiff wire bristles and sized to match the diameter of the conduit until the conduit is clear of all particles of earth, sand, and gravel.

8. Provide pull tape with footage markers in all high volt ducts upon completion of mandrel test.

9. All conduits terminating in manholes, service boxes, or pullboxes shall be plugged after successful testing, installation of pull-line and completion of conduit installation. Conduits entering any building shall be plugged with approved watertight compression type plugs.
10. Install PVC conduit as recommended by the manufacturer using approved couplings, fittings, and cement. All PVC conduit shall have solvent-weld joints and all joints shall be watertight.

11. During construction, conduits of partially completed ducts shall be protected from entrance of debris such as mud, sand and dirt by means of suitable temporary plugs.

12. Risers to grade from PVC conduits may be PVC with endbells where they terminate inside equipment enclosures such as transformers and switchboards. Risers that are exposed to damage shall be rigid steel, wrapped, wrapped from 24" below grade to 2" above grade. Terminate rigid steel risers with grounding bushings with insulated inserts.

13. Trees may not be planted over top of underground ducts. Other structures may not be built over tops of ducts without specific approval by Stanford.

14. Duct systems that cannot meet required depth or clearance requirements with other underground utilities must be specifically approved by Stanford, and may require additional engineered barriers for protection.

B. Underground Duct without Concrete Encasement: Unless the drawings show otherwise, ducts for circuits below 600 volts shall not be encased in concrete. Where ducts are not encased in concrete:

1. Conduits shall be PVC schedule 40, or rigid galvanized steel, wrapped or PVC coated.

2. Install conduits using the sand shading method. Place each row of conduits, properly spaced horizontally, on a level bed of sand, covered with a uniform layer of sand to the depth required for separation, and the next row of conduits installed, and so on until the last row of conduits have been placed and covered with sand. Maintain no less than three (3) inches clearance from any conduit to each side of the trench. The bottom of trenches shall be cleared of rocks and loose dirt and a bedding of three (3) inches of sand placed. Initial backfill material as described in FDG 02321 shall be placed to a minimum depth of six (6) inches over the highest conduit.

3. Install marking tape three (3) inches wide over nonmetallic conduit on top of the upper sand layer. Tape shall be red, continuously imprinted "CAUTION - ELECTRIC LINE BURIED BELOW" or similar approved legend.

C. Underground Duct with Concrete Encasement: Except where specifically shown otherwise, underground ducts for circuits above 600 volts shall be constructed of individual conduits encased in red concrete as follows:

1. Use PVC Schedule 40 conduit 4-inch or 5-inch trade size and as shown on the Drawings.

2. The concrete encasement shall be rectangular in cross-section and shall provide at least three (3) inches of concrete between conduit and earth on all sides and bottom.
Conduits shall be separated by a minimum concrete thickness of two (2) inches, except light and power conduits shall be separated from SCADA, control, signal, and telephone conduits by a minimum concrete thickness of four (4) inches.

3. If there is more than one row of conduits, install duct spacers on five (5) foot centers. Secure conduits shall be secured prior to placing of concrete to prevent floating.

3.2 MANHOLES

A. Manholes shall be placed on a bed of six (6) inches of gravel over undisturbed or tamped earth. Backfill around manholes to outside top of top slab shall be an approved flowable compactable fill mix delivered by ready-mix truck (Do not use concrete above possible future bottom duct runs).

B. The depth from finish grade to the outside top of the manhole (overall neck depth) shall be a minimum of 24-inches.

C. Install two ground rods, one in each opposite corner. Ground rods shall project 6-inches above manhole floor unless otherwise shown or noted.

3.3 VAULTS

A. Place vaults on a bed of six (6) inches of gravel over undisturbed or tamped earth.

B. Terminate conduits entering new vaults in factory-installed terminators. Terminate conduits entering existing vaults through cored holes and provide end-bells. Set terminators and end-bells flush with inside wall and shall be neatly grouted in place.

C. Install two ground rods, one in each opposite corner. Ground rods shall project 6-inches above the vault floor unless otherwise shown or noted.

D. Adjust the covers to match adjacent finish grades.

3.4 TRANSFORMER PAD

A. Set poured-in-place and precast transformer pads on six (6) inches of compacted Class 2 aggregate base.

B. Insure that primary and secondary conduits and ground rods feeding up through the pad openings are in the correct locations for the desired orientation of the transformer. Note that primary and secondary transformer sections are not symmetrical with centerline of pad or the opening in the pad (see FDG Drawing ES-01).

C. Ground rods shall extend six (6) inches above transformer pad surfaces, unless otherwise dimensioned on the drawings.

END OF SECTION