PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Medium voltage cable. Single conductor 15 kV, 133% insulation ethylene propylene rubber (EPR) insulated, metallic tape shield, PVC jacketed, with copper conductors for use in underground distribution systems.

B. Terminations and splices.

1.02 QUALITY ASSURANCE

A. DC proof testing, labeling, and phasing after cable is installed, spliced and terminated, and before energizing in accordance with Section 26 05 53.

B. Reference standards:
   1. ASTM: B3 Soft or Annealed Copper Wire.
   2. ASTM: B8 Concentric Lay-Stranded Copper Conductor, Hard, Medium-Hard or Soft.
   3. NEMA: WC8 Ethylene-Propylene, Rubber-Insulated Wire and Cable for Transmission and Distribution of Electrical Energy.
   4. NEMA: WC26 Wire and Cable Packaging.

C. Cable splicers:
   1. Only experienced personnel shall be allowed to handle the installation, splicing, and terminations of high voltage cable.
   2. Experience records of cable splicers/handlers shall include educational or special instruction courses attended for splicing and any certifications issued by cable manufacturers. Splicing experience shall include a minimum of 5 years of experience as a journeyman cable splicer, with dates and jobs listed. No one shall
be permitted to splice or terminate medium voltage cable prior to Owner having reviewed the qualifications of the cable splicer. Contractor shall provide Owner, in writing, compliance with these Specifications. All electricians including cable splicers shall have general electrician certification required by the California Division of Apprenticeship Standards.

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Tests and identification: Section 26 05 53.
B. Medium Voltage-Voltage SF6 Switch: Section 26 05 45.
C. Electrical Duct Bank: Section 26 05 41.
D. Pad Mounted Transformers: Section 26 12 19.
E. Medium Voltage Switchgear: Section 26 13 23.

1.04 SUBMITTALS

A. Procedure: In accord with Division 1 requirements.
B. Warranties: In accordance with Division 1 requirements.
C. Contractor shall furnish cable manufacturer’s catalog cut sheets and written statements from the manufacturer for the specific cable to be furnished that shall include the following information:
   1. Conductor size and stranding.
   2. Type and thickness of the semi-conducting shield.
   3. Type and thickness of insulation.
   4. Type and thickness of insulation shield.
   5. Type and thickness of jacket.
   6. Diameter of the insulated, shielded cable and variations from the average O.D. due to production.
   7. Diameter of the single cable including the jacket.
   8. Diameter over the insulation for single cable.
   9. Recommended minimum bending radius, single conductor.
  10. Manufacturer’s recommendation for:
      a. Maximum pulling tension with conductor pulling eye and cable grip.
      b. Maximum sidewall pressure.
11. Cable manufacturer’s name and location of plant at which cable will be produced.

12. Manufacturer’s warranty for cable offered.

1.05 SERVICE CONDITIONS

A. The design and construction of the completed cables shall be such that they will operate satisfactorily at conductor temperatures not exceeding the following, at the hottest portion of the circuit at any time:

<table>
<thead>
<tr>
<th>Type of Operation</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>105°C</td>
</tr>
<tr>
<td>Emergency Overload</td>
<td>140°C</td>
</tr>
<tr>
<td>Short Circuit</td>
<td>250°C (482°F)</td>
</tr>
</tbody>
</table>

B. The normal or continuous rating is based on 100% load factor, 40°C ambient temperature, and soil thermal resistivity of 105°C-cm/watt. The cable shall be capable of meeting the cumulative overload duration of 1500 hours during the lifetime of the cable. The short circuit rating is based on the highest temperature attained by any part of the cable during a short circuit having a duration of 2 seconds, or less.

C. The cable furnished under these Specifications shall be suitable for installation in underground ducts, conduits, and conduit risers (plastic, steel, or concrete), and for direct burial.

D. The cable shall be suitable for operating both in wet and dry locations and in installations with alternate wet and dry conditions. Under wet conditions, alkaline liquid may be present.

E. The cable may be located in areas where atmospheric ozone concentrations up to a maximum of one ppm may be present for extended periods through the year.

F. The minimum temperature at the time of installation may be considered as being above freezing.
PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Terminations and splices:
   1. Quick-Term molded rubber termination kit to make the 8kV stress-cone-type termination; Kit No. 7625-T-110 or 7622-T-110 7655-S-4 from Minnesota Mining Manufacturing Co. (3M) or Owner-approved equivalent from Raychem.
   2. Arc-proofing tape: Scotch #7700 or Tomic #43A.
   3. Pressure-sensitive glass cloth tape, minimum 1/2 in. wide: Scotch #27 or Tomic #77T.
   4. 200A/600A, 15 kV loadbreak elbows and inserts: Elastimold.
   5. Preformed rubber boot with nylon type bolts from Myers Products or General Electric.
   6. 15kV and 5 kV silicone rubber splice kits: QS-III cold shrink splice kit No. 5418-1000 from 3M or Owner-approved from Raychem.
   7. Hand Taped Splice Kits and materials supplied by 3M.

B. High voltage cable:
   1. The medium voltage power cable shall have a performance record demonstrating a minimum of thirty-five (35) years successful operating in utility and industrial power cable applications.
   2. Acceptable Manufacturers:
      a. Okonite.
      b. Southwire

2.02 MATERIAL AND FABRICATION

A. High voltage cable:
   1. Conductors:
      a. The individual compact copper strands shall be uncoated or shall have electrical and mechanical properties that conform to ASTM B-496 for soft annealed copper wire, before stranding.
   2. Conductor (strand) shield:
a. Extruded layer of semi-conducting thermosetting compound with a volume resistivity not in excess of 100 ohm meters at 105°C shall be applied over the conductor. The compound shall have a minimum elongation after an air oven test at 121°C for 168 hours of 100% and a brittleness temperature not warmer than -30°C.

b. The shield shall be clean stripping from the conductor, and inseparably bonded to the overlying insulation.

c. The thickness of the conductor shield shall be as follows:

<table>
<thead>
<tr>
<th>Conductor Size</th>
<th>Conductor Shield Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum Point (mils)</td>
</tr>
<tr>
<td>4/0</td>
<td>12</td>
</tr>
<tr>
<td>500</td>
<td>16</td>
</tr>
<tr>
<td>1000</td>
<td>20</td>
</tr>
</tbody>
</table>

3. Insulation:

a. The insulation shall be EPR, a flexible thermosetting dielectric based on an ethylene propylene elastomer. The ethylene content of the elastomer shall not exceed 72% by weight of ethylene, to limit the degree of susceptibility to treeing experienced by highly crystalline materials. The insulation shall be compounded by the cable manufacturer in its own facility using a closed system to ensure maximum cleanliness.

b. The minimum average insulation thickness shall be suitable for 133 percent insulation level. The eccentricity of the cable shall be as follows:

\[
\frac{T_{\text{max}} - T_{\text{min}}}{T_{\text{max}}} < 0.12
\]

c. The insulation shall have heat, moisture, ozone, and corona resistant properties.

d. The insulation shall be homogeneous, solid, free from porosities, voids, and contaminants in number or size greater than allowed in AEIC CS-8.

e. The EPR insulation shall be extruded with the conductor and insulation shields to prevent intersurface contamination. The extrusion operation shall be
performed in a manner to permit measurement and accurate control of wall thickness of each layer of compound as the cable is manufactured.

4. Insulation shield:
   a. The insulation shield shall be an extruded semi-conducting compound with a volume resistivity not in excess of 500 ohm-meters at 90°C when tested in accord with AEIC CS-8.
   b. The thickness of the extruded shield, and the indent on the insulation, shall be as follows:

<table>
<thead>
<tr>
<th>Calculated Minimum Diameter over Insulation (in.)</th>
<th>Insulation Shield Thickness (mils)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum Point</td>
</tr>
<tr>
<td>0 - 1.000</td>
<td>30</td>
</tr>
<tr>
<td>1.001 - 1.500</td>
<td>40</td>
</tr>
<tr>
<td>1.501 - 2.000</td>
<td>55</td>
</tr>
<tr>
<td>2.001 and larger</td>
<td>55</td>
</tr>
</tbody>
</table>

   c. The extruded shield shall be clean stripping and have a peel strength from the insulation between 6 and 18 lb. per 0.5 in. width when tested in accord with AEIC CS-8. This compound shall have a minimum elongation after an air oven test at 121°C. For 168 hours of 100% and a brittleness temperature not warmer than -30°C.

5. Jacket:
   a. An encapsulated linear low-density jacket shall be provided. This jacket shall be an insulating, black polyethylene compound (such as UCC-6425 or approved equal) meeting the requirements of ICEA S-97-682.
   b. The jacket shall be such that its linear shrinkage shall not exceed the linear shrinkage of the insulation.
   c. The jacket shall be of smooth and uniform composition, free of holes, cracks, blisters, and other imperfections. The jacket shall substantially fill the spaces between the concentric neutral wires and shall be free stripping from the insulation shield and concentric neutral.
   d. When tested in accord with ICEA, the jacket shall meet the following physical requirements:
1) Physical requirement (unaged):
   (a) Tensile, minimum (psi): 1400.
   (b) Elongation, minimum (%): 350.

2) Aging requirements after air oven for 48 hours at 100°C:
   (a) Tensile, minimum % of unaged: 75.
   (b) Elongation, minimum % of unaged: 75.

3) Heat distortion: Air oven, 1 hour at 90°C, % maximum: 25.

4) Absorption coefficient, minimum: 320.

6. Identification:
   a. Each insulated conductor shall incorporate a durable lifetime identification
      which shows manufacturer’s name and year of manufacture and the insulation
      thickness in mils, all at intervals not to exceed 2 ft. on the outer jacket.
   b. Contractor shall furnish to Owner a description of identification markers or
      tapes which will be used.
   c. Each cable reel tag shall indicate the beginning and ending sequential
      footage marked on the cable jacket or tape.

7. Production tests and test reports:
   a. Conductors shall meet the electrical resistance requirements of ICEA S-97-682,
      Section 2.5 and ASTM B-496.
   b. After the cable has been reeled in its completed form, all single conductor,
      paralleled, twisted and triplexed cables shall be tested in accord with ICEA S-
      97-682.
   c. Insulation resistance test shall be performed in accord with requirements of
      ICEA S-97-682, Part 6.28. Each cable shall have an insulation resistance not
      less than that corresponding to the insulation resistance constant of at least
      50,000 megohms-100 ft. at 15.6°C (60°F).
   d. Shield resistance shall be measured and recorded from end to end on the
      completed cable.
   e. Each reel of completed shielded power cable shall meet requirements of ICEA
      S-97-682, Part F.2, and be tested in accord with AEIC CS-8, Part G.
f. Contractor shall furnish to Owner, with each shipment of cable, a manufacturer's test report together with a statement to the effect that the cable meets all requirements in these Specifications.

g. The cable BIL impulse withstand value shall be in accord with AEIC requirements.

8. Marking on reels: All reels shall be plainly marked with a stamped metal label with manufacturer's name, description of the cable, including conductor size, voltage rating, length, type and thickness of insulation, gross weight, and destination.

B. Terminations and splices:

1. Splices in manholes: Provide only 15 kV 600 amp or 200 amp loadbreak elbows and connectors. No hand-taped splices are allowed unless specifically shown on plans.

2. 15 kV and 5 kV switchgear: Provide high compression, two-hole long barrel type lugs, 15 kV or 5 kV termination kit, and cover with preformed rubber boot with nylon type bolts.

3. SF6 Switch: Provide 15kV, 600amp elbows and inserts compatible with SF6 switch bushings.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Pull a brush with stiff bristles through each duct to make certain that no particles of earth, sand, or gravel have been left in the duct.

B. Pull a standard mandrel, not less than 12 inches long, with a diameter approximately 1/4 inch less than the inside diameter of the conduit, through each duct prior to installing cables.

C. Pull cables off reels into ducts as straight as possible with due care to avoid twists and kinks.

D. Use feed-in tubes of sufficient length to allow the entering end to be above the top of the manhole in feeding cable into the duct.

E. Do not allow scraping of the cable jacket against manhole edges.

F. Do not exceed the minimum allowable bending radius of twelve times the overall diameter of the cable.
G. Attach the cable to the pulling line through a swivel by means of a factory-installed pulling eye or a suitable cable basket weave grip.

H. Pre-lubricate for the entire conduit duct length with high performance non-carbon based pulling compound prior to the pull.

I. Lubricate cable jacket with high performance non-carbon based pulling compound compatible with the cable jacket material, immediately prior to its entering the duct.

J. Maximum allowable pulling tension if a pulling eye or a basket weave grip is used:

\[ T_m = 0.008 \times N \times CM \text{ (lb.)} \]

- Do not exceed a Tm of 1000 lb. with cable basket weave grip over PVC jacket.

K. To limit the sidewall pressure at bends, the pulling tension shall not exceed:

\[ T_B = 200 \times R \text{ (lb.)} \]

- R = radius at bend in ft.

L. Use the following formula for calculating tension on straight pull:

\[ T = 0.5 \times 1 \times w \times N \text{ (lb.)} \]

- 1 = length of cable run in ft.
- w = weight of cable lb./ft.
- N = number of conductors

M. Cut the cable at manhole or pullbox where the splice is to be made, leaving enough extra length to go around the manhole once, plus 5 ft.

N. Seal both ends making them watertight, holding the cut end pointing upward during application of the seal unless termination or splice is done immediately.

O. Terminate cables using a stress-relief kit at switchboard and separable connector pad mount SF6 switch.

1. Follow manufacturer’s instructions installing stress-relief cone kits.

2. Clean and dry area at the termination. Train cable into position avoiding sharp bends. Avoid contamination of the cable insulation from moisture. Do not remove sheath from cable until materials and tools are available so that once a termination is started, the operation may proceed without interruption.

3. Use long barrel, high compression, two-hole type lugs for connection of cable.
4. Install preformed rubber boot with nylon type bolts over termination.

P. SF6 switch cable terminators and cable splices in manholes shall be 200 amp load break or 600 amp elbow type. Install the elbow in accord with manufacturer's recommended method. Train the cables so that the elbow can be removed and parked on a standard parking stand, bushing, or grounding bushing. Provide load break bushing inserts as required.

1. Clean and dry the environment in the area of the splice, and train the cables into position, avoiding sharp bends. Avoid contamination of the joint insulation from moisture. The sheath should not be removed from the cable until all materials and tools are available and all the protective equipment in place, so that once started, the construction of the joint may proceed without interruption.

2. Obtain splicing kit designed specifically for the type of cable installed and shall be approved by the manufacturer of the cable.

3. Properly phase cable connections before splices are made. Each cable in each manhole shall be tagged to identify the feeder number and phase with stainless steel tags with 1/4 inch letters and numbers stamped into tag. Tags shall be provided 3’ feet from each conduit entrance and shall be visible after installation and fireproofing tape is applied. Phase letter and circuit number shall be verified in the presence of Owner’s representative with a Contractor-furnished split core transformer with phase angle meter.

4. All unused SF6 switch positions shall be terminated with insulating bushings.

Q. Manholes and vaults fireproofing: Individually fireproof and arc-proof all cables, including splices, in manholes and vaults from duct to duct mouth or terminator by the application of layers of fireproof material to the sheath of the jacket of the cable. Thoroughly clean all cable sheaths and jackets prior to the application of fireproofing and arc-proofing material. Wrap cable sheaths and sleeve fittings with 1/2 lapped, one lapped layer of arc-proofing tape. The fireproofing tape shall be held in place after application with a pressure-sensitive glass cloth tape. Spiral wrapping shall be used with maximum spacing of 12 inch between wraps.

3.02 SITE TESTING

A. Perform DC proof testing on all medium voltage cable as prescribed in Section 16030 after installation and before connecting to equipment. Perform tests in the presence of Owner and certify to Owner in writing before acceptance of the cable. Replace all
sections of cable failing to comply with test requirements at no additional cost to Owner.

1. Use proper safety precautions in conducting all high potential tests.

B. All circuits shall be tested for proper phasing upon energization and prior to supplying loads or interconnection to existing circuits. Phasing of new circuits shall match existing phasing for all circuits.

3.03 WARRANTIES

A. Cable furnished under these Specifications shall be guaranteed against defective materials and workmanship for a period not less than 40 years from date of initial energization of system and shall include labor and travel time for necessary repairs at job site.

END OF SECTION 26 05 13