

# Outdoor Power Transmission & Distribution **33.71.00**

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## **Description:**

The purpose of the section is to highlight the current applicable UMCP Design Standards and requirements for Outdoor Power Transmission and Distribution, including but not limited to the following:

- High Voltage cable
- High Voltage Splices and Terminations
- High Voltage Loop Switches
- High Voltage Transformers
- Underground Ductbank
- Electrical Manholes
- of building service/maintenance support within buildings on the UMCP campus.

## **Related Sections:**

- TBD

## **Effective Date:**

July 10, 2009

## **Applicable Standards:**

- All materials and installation methods shall comply with current NFPA Regulations.
- All work in or around high voltage systems shall comply with current OSHA Safety Regulations.
- NEC
- UL Underwriters Laboratories

## **General Requirements**

### **1. Operations and Maintenance**

The high voltage (13,800 volts) distribution system on campus is operated and maintained by MEDCO through their contractor Trigen Cynergy Solutions (TCS). Any modifications, removal or new installations involving the following components shall be forwarded to MEDCO and TCS for review and approval (in addition to the normal university review process);

- High voltage cables or ductbank
- High voltage loop switches
- High voltage transformer
- Low voltage cables or ductbank from service transformer to service disconnect
- Main service entrance switchgear

### **2. Qualifications**

- All work on the high voltage system shall be completed by technicians certified to work on high voltage systems. This includes all workers entering high voltage manholes or working in loop switches or transformers.
- All testing of high voltage loop switches, transformers and cables shall be performed by independent testing companies, certified by nationally recognized testing agency to perform such work.

### **3. Products**

- **Basic Materials**
  - All products shall be UL (Underwriters Laboratories) listed.
  - Warning Signs: Provide warning signs for electrical equipment per OSHA and NFPA.
- **High Voltage Cable**
  - The High Voltage feeder cable shall be 3-1/c; each rated 15KV, 133% level, 220 mils insulation, EPR (ethylene-propylene rubber) cable.

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- The cable shall have a full tape shield, and be rated for 105 degrees C continuous operating temperature (MV-105), and 100 hours per year of “emergency” overload at 130 degrees C for five years of cable life. The Outside Diameter (O.D.) of the 500 kcmil cable and jacket shall be less than 1.5 inches.
- The cable shall be rated for 500 amps in accordance with NEC for three single conductors in one underground raceway, three feet deep with a conductor temperature of 105 degrees C, 100% Load Factor, an ambient earth temperature of 20 degrees C, and thermal resistance (RHO) of 90.
- The cable shall be either 500 kcmil or 750 kcmil cable if installed as part of the campus “Loop” Feeder system. The cable may be 4/0 AWG between the Loop Switch and the transformer.
- Manufacturer: Okonite, Prysmian, Rome, or approved equal.
- The ground conductor shall be 2/0 AWG stranded soft drawn bare copper conductor.

## 4. High Voltage Splice And Termination Materials

### • Splice Kits

- The splice kits shall match the make and type of high voltage cable provided.
- They shall be “cold shrink” splice kits and be rated for operation at 105 degrees C. If “cold shrink” splice kits are not manufactured for the particular cable application, then “resin filled” kits shall be provided.
- The kits shall include all components, including lugs and connectors, etc., needed to prepare the cables and completely install a splice.
- The kits shall provide water, weather, and mechanical protection, and be suitable for underground and cable tray applications.
- All splices shall be grounded type (outdoor type).
- Splice kits shall be manufactured by Prysmian, “3M” or approved equal.

### • Termination Kits

- The termination kits shall match the make and type of high voltage cable provided. They shall be “cold shrink” termination kits. The kits shall include all components, including lugs and connectors, etc., needed to prepare the cables and completely install a termination. The kits shall provide water, weather, and mechanical protection.
- Termination kits shall be manufactured by “3M”, Prysmian or approved equal.

## 5. High Voltage Loop Switches

- The High Voltage Loop Switches shall be S&C Electric Company “PMU-19” style low profile, pad-mounted switchgear. No substitutions will be permitted.
- The S&C switch shall be a four compartment, three phase switch rated 14.4 KV Nominal, 17.0 KV max, and 95 KV BIL. The switch shall be rated 600 amps RMS Continuous, as well as 600 amps RMS for Load interruption (Dropping and Load Splitting) (Parallel or Loop Switching)
- The switch shall have the following Duty-Cycle Fault-Closing, Two Time ratings;
  - Asymmetrical—40,000 Amps RMS
  - Symmetrical—25,000 Amps RMS
  - Peak—62,500 Amps RMS
- The switch shall have a Momentary rating of 40,000 Amps RMS, and a One-Second rating of 25,000 Amps RMS.
- The switch shall utilize SM-5S fuses and fuse holders. Three spare fuses shall be provided with switch. The fuse ratings shall match the transformer Primary protection rating.
- Compartments #2 and #3 shall disconnect the incoming cables from the internal bus. Compartment #4 shall disconnect the internal bus from load side fuses. Compartment #1 shall contain fuses and connect to load side cables.
- The switch shall have physical dimensions of 72” wide x 74” deep by 63” high. The switch shall be dark green.

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## 6. High Voltage Transformer

- Transformers shall be outdoor, pad-mounted, oil-filled units with primary fusing via the S&C switchgear.
- The transformer shall be three phase(unless UM approved otherwise), 65 degree C rise, 60 hertz, copper windings, rated 30 degree C average ambient.
- The transformer shall be rated 13,800 volts delta on the primary side, with 480/277 volts (or 208/120 volts) on the secondary side. It shall be rated 95 KV BIL, and have 2-2.5% FCAN and 2-2.5% FCBN taps. Total voltage compensation shall be 5%.
- Impedance values—2.3% min and 5.75% max up through 500kva. 750 kva and larger shall have a design impedance of 5.75%.
- Transformers shall be equipped with externally replaceable, 8.3/14.4kV rated loadbreak bushing wells and inserts suitable for use with loadbreak elbow connectors. Bushings shall be arranged for loop feed in accordance with ANSI C5.12.26 Fig 6A.
- Transformers shall be equipped with metal oxide, distribution class under oil lightning arresters. Arresters shall be rated 10kV.
- Transformer shall be equipped with ground attachment points, one in the primary compartment, and one in the secondary compartment. The secondary ground point shall be a bar capable of supporting up to 12 ground cables. Grounding attachments shall be made using a “taplug” connector with ½” – 13UNC threads.
- Transformer shall be filled with ANSI Type II mineral oil and shall have less than 1 PPM of PCB content at the time of manufacture.
- Transformers shall be equipped with 6-hole spade type connectors. Transformers over 1500 kva shall be equipped with 10 hole spades. Spades shall be capable of accepting copper conductors up to 750 kcmil in size.
- Transformers shall be equipped with a pressure relief device that utilizes a pull-ring to operate the device.
- The transformer shall have the following accessories:
  - 5 position tap changer
  - Dial type thermometer (measuring current and max temperature achieved)
  - Liquid level gauge
  - Pressure vacuum gauge
  - Gas sample valve
  - 1” drain valve and sampler
  - Pressure relief valve
  - Ground bar in the secondary compartment
  - Standard industrial enamel paint (dark green)

## 7. Utility Access Holes

- Utility access holes shall be pre-cast reinforced concrete with minimum inside dimension as indicated for each utility access hole (minimum size 6’ wide x 8’ long x 6’ high) and a centered entrance opening of 36 inches diameter (minimum).
- The utility access hole, cover, and collar shall be capable of supporting truck loads on the cover and all other loads imposed by dry or wet earth. Provide engineering computation "sealed" by a registered professional engineer as part of the shop drawing submittals for each size of utility access hole to substantiate that the utility access hole design accommodates the criteria set forth in the Design Loads below
  - Design Loads:
    - Dead Load:
      - Concrete at 150 PCF
      - Earth Cover at 120 PCF

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- Lateral Earth Pressure on Walls:
  - Equivalent Fluid pressure above the water table at 32 PSF per foot of depth.
  - Equivalent Fluid pressure below the water table at 81.4 PSF per foot of depth.
  - Surcharge on walls equal two feet of dry earth.
- Time Load:
  - H2O-AASHO truck loading rear wheel load of 16,000 lbs. + 30% impact (20,800 lbs. total)
- Utility access holes shall be as manufactured by: Penn Cast, Easi Set, A.C. Miller Products Inc., Smith-Midland or approved equivalent.
- The utility access hole cover shall be cast iron to accommodate a clear opening into the utility access hole of 36 inches diameter (minimum).
- Covers for "Electric" utility access holes shall have the word "Electric" cast as part of the cover.
- The rim supporting the cover shall be cast iron.
- Cover and rim shall be structurally adequate to accommodate a 20 ton truck loading (H2O-ASSH) as required for each utility access hole.
- Covers shall be solid except for openings to enable placing and removing the cover, and shall be designed to meet standard U.S. Government designs for underground electric or telephone construction.
- A Ground rod shall be installed, and shall be copper clad steel at least 10 feet long and 3/4 inches diameter (minimum).
- Cable support racks shall be installed on all four interior walls of the utility access hole and shall be non-metallic, adjustable arm, cable racks. Each stanchion (upright) shall be at least 36" long. Install six stanchions in the utility access holes—two on each of the long walls, and one on each of the short walls. Utilize stainless steel bolts and washers to attach the stanchions. Install a total of twelve 14" support arms on the stanchions. Each arm shall be rated to support 350 lbs. The racks shall be Underground Devices, Inc. or approved equal.
- Each utility access hole shall have a hot dip galvanized steel ladder that reaches from the rim supporting the cover to the floor of the utility access hole. Attachments to secure the removable ladder to the steel rim shall be stainless steel.
- Each utility access hole shall have "hot dip galvanized steel pulling eyes" for each wall. Each "pulling eye" shall be located near the floor and shall be centered in the respective wall.
- Provide end bells for all duct penetrations.

## **8. Low Voltage Cables**

- All low voltage cables for feeders, branch circuits, and control circuits shall be copper conductor, THHN/THWN, 600 volt insulation, rated at 90 degrees C.
- Use of wire smaller than #12 AWG for feeder and branch circuits, and #14 AWG for control circuits shall not be acceptable.
- Feeder and branch circuit conductors larger than #10 AWG and all control circuit conductors shall be stranded.

## **9. Main Service Entrance Switchgear**

- Service Entrance disconnecting means for services of 400 amps or more shall be a single main breaker--fused disconnects are not acceptable.

## **10. Design**

- The high voltage (13,800 volts) distribution system on campus is operated and maintained by MEDCO through their contractor Trigen Cinergy Solutions (TCS), and will require their approval. Any modifications, removal or new installations involving the following components shall be forwarded to MEDCO and TCS for review and approval;
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  - High voltage Loop Switches
  - High voltage transformer

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- Low voltage cables or ductbank from service transformer to main building switchgear
- Main building service switchgear
- The design concept shall first be coordinated through the UMCP/FM, to ensure the concept agrees with the campus high voltage distribution philosophy.
- The design including the connection to the existing high voltage distribution system, through the loop switch and transformer to the first disconnecting device in the main electrical switchgear in the building shall be submitted to MEDCO for review and approval at each stage of the design.

## **11. High Voltage Cables**

- All feeders in manholes shall be labeled. The labels shall be permanent and be readable with auxiliary lighting in the manhole. The labels shall indicate origination and destination locations, as well as the feeder number.
- Install fireproof taping on all phase cables in manholes.

## **12. High Voltage Ductbanks**

- High voltage ductbanks constructed for high voltage loop feeders shall be concrete-encased, 5" diameter (minimum) PVC tubes, with a minimum of four tubes.
- Ductbanks for feeders between the loop switch and the transformer may utilize concrete-encased, 4" diameter PVC tubes.
- Ductbanks shall utilize "long sweep" elbows.
- Ductbanks terminating in buildings or manholes shall have "bell ends", where the tubes penetrate the wall, or bushings if terminating in equipment.
- Ductbanks shall have a minimum of 30" cover from the top of the ductbank to the top of grade.
- Ductbanks shall include a minimum of 100% spare tubes.
- Ductbanks should be graded gently sloping down toward each manhole (3" per 100' minimum).
- If multiple loop switches are installed on a common pad, the high voltage loop ductbanks shall not go from switch to switch, but shall go back to the manhole—one 4-tube ductbank for each switch on the pad.
- Utilize rigid PVC spacers to provide minimum duct spacing and concrete cover depths while supporting tubes during concrete pours.
- Install reinforcement in ductbanks passing through disturbed earth and when running perpendicular across roadways.
- Waterproof floor and wall penetrations of the duct tubes, prior to pouring concrete around the tubes
- Provide 6" of separation in combined ductbanks between high voltage tubes and communication or low voltage tubes.
- Provide a minimum of 18" separation when crossing steam or hot water lines. Ductbanks shall cross under steam and hot water lines, unless depth of ductbank exceeds 8'.
- Ductbanks shall not run parallel to steam lines, unless there is at least a 5' separation between ductbank and steam line.
- Empty tubes shall have pull strings installed, and tied off at both ends.

## **13. High Voltage Manholes**

- Manholes shall not be greater than 400' apart.
- Upon completion of the feeder installation, provide "fold-down" drawings of the interior of the manhole, with the duct tubes clearly labeled, and with cables annotated.
- Low voltage cables (less than 600 volts) shall not pass through high voltage manholes (more than 4160 volts).

## **14. Low Voltage Ductbanks**

- Low voltage ductbanks constructed for service entrance feeders or emergency power feeders shall be concrete-encased, 4" diameter (minimum) PVC tubes.
- Ductbanks shall utilize "long sweep" elbows.

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- Ductbanks terminating in buildings or manholes shall have “bell ends”, where the tubes penetrate the wall.
- Ductbanks shall have a minimum of 30” cover from the top of the ductbank to the top of grade.
- Ductbanks shall include a minimum of 50% spare tubes.

### **15. Testing**

- All high voltage components (loop switches and transformers, etc.) shall be tested after they are placed in their final position. The applicable tests include; Megger, Contact Resistance, and Hi-Pot test.
- All high voltage cables, terminations, and splices shall be tested prior to energizing.
- All test results shall be submitted to MEDCO (and TCS) prior to de-energizing the campus high voltage system in preparation for splicing in the new or modified system.