Forward

These are Standards, with selected specification sections added for clarity.
This document is meant to give a brief comprehensive description of the campus systems and call out additional specific campus requirements that exceed standard commercial construction specifications and code requirements. These standards are in addition to industry engineering standards and code requirements. This document will point out code requirements that, historically, have been overlooked causing substantial additional project costs and/or compromise to project merit.
UMass Utilities Department has found these specifics to be very beneficial and cost effective by substantially increasing reliability and minimizing the effects of power outages to our campus community.

Any deviation from this standard or any part thereof must include a written comparative economic review by the project electrical designer.
UMass Amherst Utility Department will review and make recommendations to the Director of the Physical Plant. The project will not proceed without written approval by the UMass Amherst Physical Plant Director.
University of Massachusetts Amherst
Electrical Distribution & Outdoor Lighting V5.0

Table of Contents

<table>
<thead>
<tr>
<th>Page</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>UMass Medium Voltage Distribution System</td>
</tr>
<tr>
<td>2</td>
<td>Electrical Design Criteria</td>
</tr>
<tr>
<td>5</td>
<td>Electrical Design Submittals</td>
</tr>
<tr>
<td>8</td>
<td>Medium Voltage Switchgear</td>
</tr>
<tr>
<td>11</td>
<td>Medium Voltage Subsurface Infrastructure</td>
</tr>
<tr>
<td>17</td>
<td>Medium Voltage Cables</td>
</tr>
<tr>
<td>28</td>
<td>Medium Voltage Transformers</td>
</tr>
<tr>
<td>36</td>
<td>Building Service Metering</td>
</tr>
<tr>
<td>38</td>
<td>Exterior Lighting</td>
</tr>
<tr>
<td>48</td>
<td>Typical Subsurface Distribution</td>
</tr>
<tr>
<td>49</td>
<td>Typical 5kV Building Service</td>
</tr>
<tr>
<td>50</td>
<td>Typical 15kV Building Service</td>
</tr>
<tr>
<td>51</td>
<td>Typical Outdoor Lighting</td>
</tr>
<tr>
<td>52</td>
<td>King Luminaire black Walkway Light fixture drawing.</td>
</tr>
<tr>
<td>53</td>
<td>16 Foot black composite drawing.</td>
</tr>
<tr>
<td>54</td>
<td>Roadway LED black cobra head light fixture cut sheets.</td>
</tr>
<tr>
<td>57</td>
<td>29 Foot black StressCrete Pole Cut sheet</td>
</tr>
<tr>
<td>58</td>
<td>4 Foot Light arm drawing.</td>
</tr>
<tr>
<td>59</td>
<td>Double arm cut sheet</td>
</tr>
<tr>
<td>60</td>
<td>MV Cable Test Example</td>
</tr>
<tr>
<td>61</td>
<td>Cast Iron Man hole cover drawing.</td>
</tr>
<tr>
<td>62</td>
<td>Manhole detail drawings.</td>
</tr>
<tr>
<td>65</td>
<td>Version 4.0 and 5.0 revision notes</td>
</tr>
</tbody>
</table>
UMass Amherst Medium Voltage Distribution Systems

Overview

The Amherst Campus has two electrical distribution systems: a 13.8 kV grounded wye Primary Selective system and a 2.4 kV ungrounded delta open loop system.

The campus takes service at 115KV from two Convex transmission lines via the Tillson substation. Four 13.8KV circuits service the campus from the Tillson Substation. Two 13.8KV circuits to the Westside substation, and two 13.8KV circuits to the Eastside Substation. At the Westside substation, there are three 13.8kv generators, a 10MW combustion turbine, a 2MW back pressure steam turbine, and a 4MW back pressure steam turbine.

From the Westside Bus the primary selective system is distributed throughout campus and is stepped down at each building to service voltage utilizing 13.8 kV delta to 480/277 and/or 208/120 grounded wye. The Eastside Sub-station distributes additional primary selective circuitry to buildings located on the East side of campus.

The campus 2.4 kV open loop system is derived from the campus 13.8 kV system. This system has three sub-stations; one sub-station is fed directly from the Westside Service, one is fed from, and located at, the Eastside sub-station and the third, also fed from Eastside, is located more central on campus. From these sub-stations the open loop system is distributed throughout campus and is stepped down at each building to service voltage utilizing 2.4 kV delta to 480/277 and/or 208/120 grounded wye building service voltage.

System Type and Approval

The 13.8 kV electrical distribution systems have either manual or automatic switches located at each building served.

The 2.4 kV open loop system switches are all manual with one exception; the switch located at the University Health Services building. Building service configuration is assessed at time of design to best serve the individual building and the campus overall operation.

Final acceptance regarding system voltage, configuration and point of connection to the UMass Amherst Electrical Distribution system will only be with the approval of the Director of the Physical Plant.
**Electrical Design Criteria**

The following criteria shall apply to all new construction, retrofit and/or replacement of Electrical Utility Systems design and construction for the University of Massachusetts/Amherst Campus. Electrical Utility Systems shall include all medium voltage (greater than 600 volts) equipment and material from the local utility service point to and including the low voltage (less than 600 volt) building service equipment.

**General**

1. **Voltage:**
   
   i. **Medium Voltage Distribution Systems** shall be three phase, three wire, Grounded Wye 13.8 kV or three phase, three wire, Ungrounded Delta 2.4 kV. 
      
      NOTE: NO single phase loads will be acceptable on the Medium Voltage Distribution Systems.

   ii. **Low Voltage Services** shall be three phase, four Wire, Grounded Wye 480/277 and/or 208/120.

   iii. **Low Nominal MOTOR Utilization Voltage** shall be two wire, three wire or four wire, 460 and/or 230 volts respectively.

2. **Power Sources and Distribution:**

   i. **Medium Voltage Distribution Systems** shall not be burdened in excess of 45% of their continuous rated current carrying capacity. Any proposed additional load or alteration to existing Medium Voltage Distribution equipment, or circuitry, shall be consistent with in place circuit arrangements and shall be submitted to, and approved by the Physical Plant Utility Dept. prior to any estimate, design and/or construction or alteration.

   ii. **Medium Voltage Distribution System Ducts** shall be concrete encased with a minimum conduit size of 5” between MHS and from final MH to building service. All ducts shall include 100% spare number of conduits.
iii. Existing Low Voltage Service equipment and/or circuitry shall not be burdened in excess of 80% of its original designed capacity.

3. Fault Current Calculations:
   
i. Medium Voltage Distribution shall be designed for a minimum 350 MVA 3 phase sym and 14 kA Rms sym.

   ii. Low Voltage Service equipment calculations shall be calculated using the following method due to the ever-growing conditions at the university.

       1. Using unlimited primary contribution:

           a. \[ \text{AIC} = \frac{100}{\text{Service Transformer Impedance}} \times \text{Service transformer secondary full load current.} \]

4. Flexibility:

   i. Design systems to maximize flexibility and to accommodate future growth. This includes attention to system capacity, equipment access and ability to accept additional components and planned space to accommodate the additional footprint.

   ii. Design all systems in raceways; with maximum 50% fill to allow for future renovations/modifications.

   iii. Design all underground raceway systems with a minimum of 100% spare raceways for future growth.

5. Maintainability:

   i. All designs shall include front & rear accessibility with minimum code compliant working clearance and egress about electrical equipment. THE ELECTRICAL DESIGNER MUST WORK CLOSELY WITH THE ARCHITECT DURING EARLY PROJECT STAGES TO ENSURE. HISTORICALLY THIS HAS PRESENTED PROBLEMS.
ii. All designs shall include on drawings routes for major equipment replacement i.e transformers and switchgear.

6. Exterior Lighting:

i. All exterior lighting must be consistent with UMA CLIP, UMA Campus Design Standards and this document.

7. Electric System Metering/Monitoring:

i. All Electrical Distribution and Building Service Equipment mains shall be monitored with SQD PowerLogic. Each installation shall include an interface to the university LAN system/UMass PowerLogic System.

ii. It is recommended that the metering equipment and service equipment be specified separately to maintain competitive bidding on service equipment.

8. Deviation from UMass Electrical Standard:

i. Any request to deviate from this standard must include a comparative review. The designer shall submit the review including detailed equipment specifications and shall include capital, maintenance and operational costs for any proposal inconsistent with these standards to the UMass Utility Department for review. The project will not proceed until receipt of approval from the Director of the Physical Plant.

9. Construction Utility Submittals:

i. Utility Construction Submittals must be approved by the UMass Amherst Utility Department.

10. All new buildings shall conform provide Physical Plant Utilities Department a SKM load modeling software configuration to be added to the existing campus SKM load model.

11. All new buildings shall have a circuit breaker co-ordination study implemented in the building and the final document shall be handed over to the Physical Plant Utilities Department.
Electrical Design Submittals

The design team must submit in digital searchable format and must allow a minimum of 3-weeks or 15 working days form time of receipt for Submittal Review Comments from the UMA Utility Department.

Conception Design Submittal

During the conception design stage for all new buildings and/or major building renovations a GENERAL PROJECT SCOPE shall be submitted to the Physical Plant Utility Department. This information will give the utility department an upfront overview of the proposed project scope. With this information the Utility Department will communicate to the design team the capabilities of the campus distribution systems and information regarding best point of connection for the project.

1) The GENERAL PROJECT SCOPE SUBMITTAL shall include but shall not be limited to:

   i. Project Type (New Construction, Addition or renovation)

   ii. Intended Use (Academic, Research, Animal Care, Student Housing, Family Housing, Medical Facility, Office or Other).

   iii. Project square footage.

   iv. Project location/ footprint and number of floors.

   v. Type of heat and cooling.

   vi. Other large electrical loads and/or special provisions to reduce electrical load.

   vii. Project schedule.
50% Design Submittal

No later than time of 50% design submittal for all new buildings and/or major building renovations a SURVEY OF EXISTING CONDITIONS and PROPOSAL FOR ELECTRICAL SERVICE shall be submitted to the Physical Plant Utility Department. All available information from UMass Facilities Department and Physical Plant will be supplied to the project. Any information not available or requiring updates for totality is the responsibility of the project.

50% Design Submittal shall include all UMass Amherst Electrical Utility Department Standards and shall include all major electrical equipment specifications, equipment dimensions, and equipment layout plan view and elevation drawings.

This information will give the utility department detailed specific information regarding the project, its requirements and means of realization. The Utility Department will review this information and verify UMass Amherst Electrical Utility Department Standards are all inclusive and design has considered existing and future needs of the project/footprint to best serve the university.

1) The SURVEY OF EXISTING CONDITIONS submittal shall include but shall not be limited to:

   i. Updated GENERAL PROJECT SCOPE.

   ii. Contract site limits.

   iii. Detailed site survey drawings of all existing site utilities and proposed new utilities. Survey shall include but shall not be limited to:

       1. Electrical Switches, Man-Holes, Hand-Holes, Duct-banks, Conduit & conductor sizes and conditions (in use and available for use).

       2. All other site utilities including condition and detailed plan and elevations at crossings of all electrical ducts.

   iv. Existing Load Characteristics including (voltage, current, real power and power factor or apparent power, and harmonics) shall be known. When existing data is not available or nonexistent, surveys shall be performed by the project. Recording equipment shall be installed for a period of not less
than one week on each circuit, feeder, transformer and service and/or distribution system affected.

v. Updated Project schedule.

vi. Any and all additional future planned site projects/expansions.

2) The PROPOSAL FOR ELECTRICAL SERVICE submittal shall include but shall not be limited to:

i. Type of construction: New, Renovation or addition.

ii. Use: Animal Care, Research, Medical, Academic, Student Housing, Family Housing, Office or Other support etc.

iii. Type of Service: New, Change, Temporary, Removal or Relocation.

iv. Load Breakdown including:

1. Construction square footage.

2. Mechanical HVAC package including tonnage and electrical requirements thereof.

3. Elevator and electrical requirements thereof.

4. Required emergency power type including source and fuel type if required.

5. Standby power type including source and fuel type.

6. Other known specific electrical equipment.

7. Total required service size.
Medium Voltage Switchgear

Overview

The University has experienced reliability from S&C switchgear and therefore has adopted their switchgear specification as a minimum standard. All switchgear shall be Load Break, air insulated, visual break and shall meet or exceed S&C specification referenced below.

Switchgear Locks

1) Locking – All gear compartments shall be pad-lockable to prevent unauthorized access to all cabinets and controls.

2) Kirk Key interlocks shall be supplied with a spare defeater key turned over to the UMass Amherst Electrical Utility Manager. Kirk Key interlocks shall be installed to prevent:
   a. Paralleling sources &
   b. Opening doors with potential

Automatic Switchgear Operation

1) All switchgear shall be Load Break, air insulated, visual break with viewing window and shall meet or exceed S&C specification below. Paralleling in the input side is needed to perform close transition switching.

   a. Automatic operation shall be primary selective with preferred source (Normally closed) and alternate source (Normally open). The following options shall be programmable, by user, from front panel or selector switch without any additional hardware or software.
      i. Preferred and alternate source select.
      ii. Hold on transfer.
      iii. Transfer time delay.
v. Source seeking (Automatic open transition back to preferred after transfer to alternate and alternate becomes unavailable and preferred is available).

2) All automatic switchgear shall include provisions to decouple actuators for testing and maintenance of automatic operations without operating switch blades.

Outdoor Switchgear


Indoor Switchgear

1) S&C Custom Metal-Enclosed Switchgear

Available in ratings of 4.16 kV, 13.8 kV, 25 kV, and 34.5 kV, S&C Custom Metal-Enclosed Switchgear is ideal for applications having unique requirements beyond the scope of S&C’s pre-engineered switchgear, including:

- Complex automatic source-transfer schemes, with three or more incoming power sources; multiple split-bus sections; or ring-bus arrangements.
- Applications with hot-sequence metering.
- Applications with special installation requirements, such as transformer primary unit substations, and those requiring special-purpose components such as grounding switches, control power transformers, metering panels, or capacitors for power-factor correction.
• Applications requiring unusual switchgear layouts, such as “U-shaped” configurations.

Custom Metal-Enclosed Switchgear features:

• Rugged 11-gauge steel enclosures.
• 600- and 1200-ampere load switches with duty-cycle fault-closing ratings.
• One-cycle minimum total clearing of fault currents with S&C SM and SML Power Fuses.
• Choice of unique response curves with S&C Fault Fiter® Electronic Power Fuses.
• Sophisticated, pre-engineered automatic source-transfer controls.
• Three-phase load protection. S&C open-phase detection relays and overcurrent relays isolate three-phase loads from single-phasing and other open-phase conditions.
• Single-phase load protection. Fuses, unlike circuit breakers, selectively isolate only faulted phases of feeders serving single-phase loads.
• Low purchase cost compared to metal-clad gear.
• Light weight. Easier to handle than metal-clad gear.

Outdoor Switchgear Base

Due to corrosive properties, construction and maintenance costs the university uses fiberglass bases for all pad-mount switchgear and transformers.

1) Each base must be sized to accommodate weight and dimensions of each switch or transformer. Base depth must be 30” below grade and 12” above grade.

2) Available Manufacturers: Subject to compliance with requirements, manufacturers offering transformers pads that may be incorporated into the Work include, but are not limited to, the following:

1. Nordic Fiberglass Inc.
2. Highline Products
3. Concast Fibercrete
Medium Voltage Subsurface Infrastructure

Overview

The section includes underground manholes and duct-banks and associated components thereof.

Manholes

Manholes and all associated enclosure materials shall be designed and constructed for HEAVY TRAFFIC and shall include the following: See drawings pages 61-64, for more details.

Manholes may be precast or field constructed.

1. Field constructed Manholes. Furnish manholes with exterior dimensions at 11’ wide, 13’ length, and 9’ height. Use 5000psi concrete and materials as listed under precast manholes.
2. Precast Manholes: As manufactured by the Fort Miller Co., Arrow Concrete Co., or Lakelands Pre-cast, Inc., having:
   - 5000psi concrete minimum.
   - Epoxy coated reinforcing meeting American Association State Highway Officials requirements for H-20 loading. Drawings shall bear the seal of a professional engineer licensed to practice in the State of Massachusetts.
   - Walls minimum 8 inches thick reinforced concrete.
   - Top slab minimum 8 inches thick reinforced concrete.
   - Bottom slab minimum 12 inches thick reinforced concrete.
   - Sealed joints.
3. Equip manholes with a puling hook opposite to each conduit entrance. Construct a hook of 0.875” galvanized stock with 3” diameter eye and 8 inches for anchoring in manhole wall.
4. Provide a sump drain and sloped floor in manhole per drawing.
5. Brick shall comply with the specifications for Sewer Brick, Grade MS, ASTM C32.
6. Mortar: One part of Portland cement to two parts sand, mixed with water for proper consistency.
7. Waterproofing for Bricked-up throat: Single component, rubber reinforced asphalt elastomeric coating, ASTM D-4586 Type 1 and ASTM D-4479 Type I.
Watertight Manhole Frames and Covers

1. Design of each shall be the same throughout the project unless otherwise specified or indicated on the drawings.
2. Lid and frame – Shall be Heavy duty Large Manhole Frames with Base Flange and Solid 44” Lid with 6” offset removable 22” Center Lid, each/both lids shall have 2 each 1” diameter holes 5” from edge of lids, 2 each Type C Drop Handles and with “ELECTRIC” and MH- (**) Lettering on large Lid. (**) will be designated by the UMass Utility Department as manufactured by NEENAH Foundry Company # R-1741-E. 1-800-558-5075 (See Cut Sheet Page 61)

Cable Support System

1. Cable support systems must be heavy duty, non-metallic. Cable support arms shall be 20” minimum 12” in length. Supports shall be installed to support 500 kCM 15kV cables.

Grounding and Bonding

1. Rod Electrodes: Copper clad (min. .010 jacket) ground rods minimum 0.75” diameter by 10 foot long.
2. Exothermic Type Weld: Erico Products Inc.'s Cadweld Process or approved equal.
3. Grounding Electrode Conductors and Bonding conductors: Bare Copper conductors.
4. Hardware: Silocon-bronze bolts, nuts, flat and lock washers, etc. as manufactured by Burndy Corp., or OZ/Gendey Co.
5. Ufer ground run through bottom of concrete duct bank, bonded inside of man hole.

Execution Preparation:

1. Dewater and remove debris from existing manholes used for the work.
2. Provide heavy blankets, plywood or other devices to protect cables and equipment from physical damage.

Installation:

- Depth: Install manholes at depth required to bring top of manhole covers 2 inches above finished grade in lawns, and flush with paved surfaces of walks, roads, or parking spaces.
- Bricked-up throat: Mortar brick into place. Set manhole frame with mortar. Waterproof exterior of throat with minimum of 3/32 inch of bituminous plastic cement coating.
- Cable Supports: Install racks, support arms and insulators of size and number to provide one insulator (or equivalent space of nonmetallic support arms) on each cable support assembly for each conduit entering manhole.
a) **New Manholes.** Equip manholes with a number of cable support assemblies indicated below
  - Where conduits penetrate 2 adjacent sides of a manhole, provide a minimum of 10 cable support assemblies.
  - Where conduits penetrate 2 opposite sides of a manhole, provide a minimum of 10 cable support assemblies.
  - Where conduits penetrate 3 sides of a manhole, provide a minimum of 12 cable support assemblies.
  - Where conduits penetrate 4 sides of a manhole, provide a minimum of 12 cable support assemblies.

b) **New Pull boxes:** Equip pull boxes with number of cable support assemblies indicated below.
  - Where conduits penetrate 2 adjacent sides of a pull box, provide a minimum of 2 cable support assemblies.
  - Where conduits penetrate 2 opposite sides of a pull box, provide a minimum of 1 cable support assemblies.
  - Where conduits penetrate 3 sides of a pull box, provide a minimum of 3 cable support assemblies.
  - Where conduits penetrate 4 sides of a pull box, provide a minimum of 4 cable support assemblies.

**Signal Manhole or pull boxes:** In addition to cable support assemblies, provide across and spanning the support arms, troughs for support of each signal cable. Troughs shall consist of lengths of 4 inch diameter Schedule 40 plastic conduit split lengthwise into halves. Route cables around periphery of manhole. Set trough on the support arms, lay in cable and secure with cable ties.

**Grounding an Bonding:**
1. **New Manholes containing feeder circuits over 600 volts.**
   a) Install rod electrodes in each manhole near a corner. Install rod electrodes through floor into earth below manhole with 4 inches protruding for ground connection.
   b) Bond manhole cover frame, steel cable support assemblies and splices (lead sheath of splice or cable shields for non-lead type cables) to ground plates with No #4/0 bare copper ground conductor.
   c) Make connection to rod electrode with exothermic type weld or compression connectors.
**Waterproofing additive:**

1. When purchasing or constructing manholes, please use Krystol Internal membrane additive to the concrete.

1) Drainage – Manholes shall include a sump with removable vented drain cover drained to the campus storm-drain system.

2) Location – Manholes shall be located to avoid exposure from steam line heat loss and to ensure duct runs between MHs, Vaults and buildings are straight runs. Manholes shall be placed a maximum of every 500 ft.

3) Lid and frame – Shall be Heavy duty Large Manhole Frames with Base Flange and Solid 44” Lid with 6” offset removable 22” Center Lid, each/both lids shall have 2 each 1” diameter holes 5” from edge of lids, 2 each Type C Drop Handles and with “ELECTRIC” and MH-(**) Lettering on large Lid. (**) will be designated by the UMass Utility Department) as manufactured by NEENAH Foundry Company # R-1741-E. 1-800-558-5075 (See Cut Sheet Page 57)

4) Ladder – Manhole ladders shall be fiberglass designed, assembled and installed to OSHA standards. Manufactured by Empire Fiberglass Products Inc. 1-800 547-8825

5) Grounding – MH grounding shall include:
   a. Two Harger “J” Pattern (GBI14412J) Ground Plates located at diagonal corners.
   b. Two ¾” x 10’ ground rod driven and bonded at each plate.
   c. 4/0 copper ground loop on all four walls of MH supported every 18” Hargar CCC3 wire clips with stainless steel anchors. 1/0 tails shall be brought from plates for bonding splice shields and shall be supported every 18” by Hargar CCC2 wire clips with stainless steel anchors.

6) Spare Conduits – All spare conduits shall have NEPTCO WL1800 Woven 3/8” (Aramid) MULETAPE installed and shall be sealed for a water tight seal. (3,000 ft min order)

7) Cable Racks – Cable racks shall be Heavy Duty Non Metallic. Cable support arms shall be 20” minimum 12” in length. Supports shall be installed to support 500 kCM 15kV cables.
8) Duct Bank Terminators - Duct Bank Terminators shall be installed in all MHs and vaults (Building entrances). Duct Bank Terminators shall be designed for the specific application and shall be installed a minimum of 30” BFG and at diagonal corners of MHs. Additional Duct Bank Terminators for future expansion shall be installed at two other diagonals, offset at a minimum of 40” BFG for future expansion. All unused or spare openings shall be capped for a water tight seal. Duct Bank Terminators shall be as manufactured by Formex Manufacturing Inc 1-800-310-3867.

9) Pulling Irons – 12” hot dipped 7/8” pulling irons with cross bar and retaining plate shall be set into the manholes opposite of all duct entrances.

10) Hardware – All hardware shall be stainless steel.

**Duct-banks**

All Duct banks and associated materials regardless of physical locations shall be designed and constructed for HEAVY TRAFFIC with red broadcast die on top of duct banks and shall include the following:

1) Raceways – One spare raceway shall be installed for every one raceway used. All raceways shall be 5” schedule 40 FRE (Fiberglass Reinforced Epoxy) Power Conduits. Spare conduits shall be sealed for a water tight seal with Muletape measuring tape installed.

2) Routing – Duct banks shall be routed straight between MHs.

3) Isolation/ Insulation – Duct banks shall not be installed within 5’ of water, sewer or drain lines. Duct banks shall not be installed within 10’ of steam and/or condensate return lines. When distance from steam and/or condensate returns is not achievable maximum allowable distance will be maintained and 2 layers of 2” thick, for a total of 4 inches, of rigid insulation, without seems overlapping, shall be installed between utility ducts extending out a minimum of 5’ from edge of ducts to minimize heat transfer. “Blue Board” is a Dow Styrofoam product with an “R10.8” rating. TG24 (tongue & groove), 2” thick x 24 “wide x 8’ long, # 121071 and may be purchased at Amherst Farm Supply.
4) **Record drawings** – All ducts shall be surveyed and documented prior to backfill.

5) **Duct banks** shall include a “Ufer Ground”, this is a bare conductor copper wire run in the bottom of the concrete duct bank. The wire is bonded in each manhole. It is typically a AWG 2 minimum.

6) **See pages 61-64**, for more detail on manhole standards.
Medium Voltage Cables

Specification

MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes cables and related splices, terminations, and accessories for medium-voltage (2.001kV – 35kV) electrical distribution systems.

1.2 SUBMITTALS

A. Product Data: Include cable, splices and terminations for cables and cable accessories.

B. Samples: 16-inch (400-mm) lengths of each type of cable specified. The 16 inch length is the minimum sample size. The submitted cable must have one cycle of all cable marking information; if more than 16 inches is needed to show all of the cable marking data then the minimum sample size shall be one cycle of the cable jacket marking.

C. Product Certificates & Warranties: Signed by manufacturers of cables and accessories certifying that the products furnished comply with requirements.

D. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements as described in Section 3.3 C.

F. Product Test Reports: Indicate compliance of cables and accessories with requirements based on comprehensive testing of current products.

G. Maintenance Data: For cables and accessories to include in the maintenance manuals specified in Division 1.
   1. Include periodic tests of cables in service.
2. Include operation of fault indicators, separable insulated connectors, and accessories.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced (minimum 5 years) and certified cable splicer to install, splice, and terminate medium-voltage cable.

B. Testing Agency Qualifications: In addition to requirements specified in Division 1 Section "Quality Control," an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907; and shall be a full-member company of the International Electrical Testing Association.

C. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.

D. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

   1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.


E. Comply with IEEE C2.

F. Comply with NFPA 70. (National Electric Code)

G. Comply with all applicable codes.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver medium-voltage cable on factory reels complying with NEMA WC 26.

B. Exposed ends of the cable must be sealed.

1.6 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following
conditions and then only after arranging to provide temporary utility services according to requirements indicated:

A. Notify the UMA Utilities Department at least 10 working days in advance of proposed utility interruptions.

B. Do not proceed with utility interruptions without the UMA Utilities Department’s written permission. Written permission will be via an approved Utility Shutdown Notice.

C. Prior to the utility shutdown a written procedure that complies with OSHA 1910.269 shall be submitted by the contractor and approved by the UMA Utility Department

PART 2 – PRODUCTS

2.1 MANUFACTURERES

A. Subject to compliance with requirements, provide products by one of the following Cable Manufactures:

   Kerite Co.
   Okonite Co.

B. Cable Splicing and Terminating Products and Accessories:

   Elastimold.

2.2 CABLES  Note: Cable specified has 10,000 ft minimum order.

2.2.1 15kV Cable:

A. Type: Single conductor, UL Listed MV105; for use on ungrounded systems in dry and wet locations, installed in conduit, underground ducts, or direct buried in the earth. Said cable shall be new and shall meet or exceed the requirements of the latest editions of UL 1072 and the MEC.

B. Conductor: The conductor shall be uncoated, Class B stranded compact round copper, _______ AWG, in accordance with ASTM B-496 standards.

C. Insulation: Ethylene propylene rubber complying with NEMA WC 8 (ICEA S-68-516). The insulation shall be 15kV, discharge resistant, ethylene-propylene rubber (EPR) based, 133% insulation level, rated for 105 Deg. C continuous normal operation and 140 Deg. C
emergency overload operation. In addition to meeting all tests specified in AEIC CS-6. Manufacturer shall submit x-y charts for latest version AEIC CS-6 corona withstand test.

D. The conductor and insulation screens shall be extruded semiconducting material compatible with the insulation. In lieu of a semiconducting screen, an insulating screen control layer may be utilized. The interface between the insulation and the screen shall be free of contaminants, protrusions, and sharp projections. The insulation screen layer shall be legibly identified.

E. Insulation, Shielding and Jacket: Shall be as follows:

1. The insulation shall be 15kV - minimum average thickness = 220 mils; minimum thickness at any point = 198 mils.

2. The shield shall be flat five (5) mil coated copper tape helically applied with twelve and one-half percent (12.5%) overlap.

3. The JACKET MATERIAL SHALL BE THERMAL PLASTIC RUBBER (TPR), APPROVED BY UMASS AMHERST PHYSICAL PLANT UTILITY DEPARTMENT RATED FOR 105 DEG. C CONTINUOUS OPERATION and shall be permanently and durably marked throughout its length with the conductor size, conductor metal, insulation and jacket type, voltage rating, year of manufacture, and manufacturer’s name.

2.2.2 5 kV Cable

A. Type: Single conductor, UL Listed MV105; for use on ungrounded systems in dry and wet locations, installed in conduit, underground ducts, or direct buried in the earth. Said cable shall be new and shall meet or exceed the requirements of the latest editions of UL 1072 and the MEC.

B. Conductor: The conductor shall be uncoated Class B stranded compact round copper, _______ AWG, in accordance with ASTM B-496 standards.

C. Insulation: Ethylene propylene rubber complying with NEMA WC 8 (ICEA S-68-516). The insulation shall be 5kV, discharge resistant, ethylene-propylene rubber (EPR) based, 133% insulation level, rated for 105 Deg. C continuous normal operation and 140 Deg. C emergency overload operation. In addition to meeting all tests
specified in AEIC CS-6. Manufacturer shall submit x-y charts for latest version AEIC CS-6 corona withstand test.

D. The conductor and insulation screens shall be extruded semiconducting material compatible with the insulation. In lieu of a semiconducting screen, an insulating screen control layer may be utilized. The interface between the insulation and the screen shall be free of contaminants, protrusions, and sharp projections. The insulation screen layer shall be legibly identified.

E. Insulation, Shielding and Jacket: Shall be as follows:

1. The insulation shall be 5kV - minimum average thickness = 115 mils; minimum thickness at any point = 103 mils.

2. The shield shall be flat five (5) mil coated copper tape helically applied with twelve and one-half percent (12.5%) overlap.

3. The JACKET MATERIAL SHALL BE THERMAL PLASTIC RUBBER (TPR), APPROVED BY UMASS AMHERST PHYSICAL PLANT UTILITY DEPARTMENT RATED FOR 105 DEG. C CONTINUOUS OPERATION and shall be permanently and durably marked throughout its length with the conductor size, conductor metal, insulation and jacket type, voltage rating, year of manufacture, and manufacturer’s name.

2.2.3 Grounding Conductor

A. An appropriately sized grounding conductor shall be installed with all circuits.

2.2.4 Source Quality Control

A. Test and inspect cables according to NEMA WC 7 (ICEA S-66-524) and NEMA WC 8 (ICEA S-68-516) before shipping.

2.2.5 Guaranty:

The manufacturer shall guarantee that the cable furnished is in accordance with the specifications of this document and shall agree to supply new cable if:

1. Any length of cable is found defective in material or workmanship during installation and initial testing.
2. Any length of cable fails and shows defects of material or workmanship during normal and proper use within forty (40) years of installation, provided that the manufacturer is given immediate written notice and reasonable opportunity to inspect such failure.

3. In the event of a failure due to defects in material or workmanship, credit will be extended for attendant labor cost for the replacement or repair of any defective cable during the first twenty (20) years of service. In the event replacement cable is necessary, labor costs will be reimbursed in accordance with the following schedule:

   a. First 20 years: An amount not to exceed two-hundred percent (200%) of the original cable value for the length involved, or $3,000.
   b. 21 to 40 years: Replacement of the length of cable involved, only.

2.3 SPLICE KITS

2.3.1 15kV Separable Insulated Connectors

A. 15kV splices shall be Elastimold 600 Series Deadbreak separable connectors (CABLE JOINTS). This is necessary to keep the splices compatible with existing modular kits already installed and in stock. If any substitution is offered it must be demonstrated as compatible with the Elastimold 600 Series without the use of additional adapters or materials. Otherwise it shall be rejected.

B. Separable Insulated Connectors: Modular system complying with IEEE 386. Disconnecting, single-pole, cable terminators and matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

C. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

D. Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating, designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.
2.3.2 5kV

A. Splicing: As recommended in writing by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors and splices specified. Include all components required for complete splice, with detailed instructions. Products must be capable of operating while submerged in water.

B. Terminations: Comply with IEEE 48, as indicated. Insulation class is equivalent to that of cable.

1. Terminations for shielded cables shall include a shield ground strap.

   a. Class 1 Termination for Shielded Cable: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.

   b. Class 1 Termination for Shielded Cable: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.

   c. Class 1 Termination for Shielded Cable: Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.

2.3.3. Connectors:

A. IEEE 404, 2 hole, compression type, matched to rated voltage, as recommended by cable and splicing kit manufacturer for the application.

2.4 ARC-PROOFING MATERIALS

A. Tape for First Course on Metal Objects: 10-mil- (250-micron-) thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

   1. Arc-Proofing Tape: Fireproofing tape, flexible, conformable, intumescent to 0.3 inch (8 mm) thick, compatible with cable jacket.
2. Glass-Cloth Tape: Pressure-sensitive adhesive type, 3 inch wide.

2.5 Conduit Seals:

A. All spare unused conduits will be sealed with a water tight seal.

B. All used conduits between last Manhole and building and/or vaults shall be sealed with a water tight seal utilizing appropriate Raychem RDSS (Rayflate duct sealing system) at both ends.

PART 3 – EXECUTION

3.1 EXAMINATION & PREPERATION

A. Examine raceways to receive medium-voltage cables for compliance with requirements for installation tolerances and other conditions affecting performance of cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Prepare raceways to receive medium-voltage cables by removing all foreign objects and thoroughly swabbing raceways until clean.

3.2 INSTALLATION

A. Install cables as indicated, according to manufacturer's written instructions and IEEE 576. Where Medium Voltage switches and/or transformers are unable to be installed indoors, consistent with this standard, medium voltage lateral conductors and/or low voltage conductors shall be paralleled full capacity conductors. This paralleling is not for capacity it is for reliability allowing the building to operate at full capacity after any failed conductor is removed.

1. Pull Conductors: Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer’s recommended maximum pulling tensions and sidewall pressure values.

2. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceways. Do not use rope hitches for pulling attachment to cable.
3. Install exposed cables, parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

4. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.

5. Install splices at pull points and elsewhere as indicated; use standard kits. Comply with kit manufacturer's written instructions.

6. Install terminations at ends of conductors and seal multiconductor cable ends with standard kits. Comply with kit manufacturer's written instructions and with classes of terminations indicated.

7. Install separable insulated-connector components where indicated according to manufacturer's written instructions.

B. Quantities: Provide the following quantities of components:

1. Protective Cap: Install at each terminal junction, one on each terminal to which no feeder is indicated to be connected.

2. Portable Feedthrough Accessory: 3.


C. Arc Proofing:

1. When not in a raceway, arc proofing materials are required unless a minimum 12” separation is maintained between all cables.

2. Arc proof medium-voltage cable at locations not protected by conduit, or termination materials, unless otherwise indicated. Apply as follows and as recommended by manufacturer of arc-proofing tape:
   a. Clean cable sheath.
   b. Wrap metallic cable components with 10-mil (250-micron) pipe-wrapping tape.
   c. Smooth surface contours with electrical insulation putty.
d. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.

e. Band arc-proofing tape with 1-inch- (25-mm-) wide bands of half-lapped, adhesive, glass-cloth tape 2 inches (50 mm) o.c.

f. Seal around cables passing through fire-rated elements according to Division 7 Section "Firestopping."

D. Grounding Shields:

1. Ground shields of all shielded cables to grounding conductor at all terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware according to manufacturer's written instructions.

E. Identify cable circuits and phases at entrance and exits of every MH and switch with circuit, phase and destination i.e. E – MH-10 & Brown, Orange & Yellow for 13.8kV and Black, Blue and Red for 2.4kV.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing agency to perform field quality-control testing.

B. Testing: On installation of medium-voltage cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

C. All new cables installed on campus must be tested by an independent testing agency before energization. Test data must be approved by UMass Utility Electrical Department.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.3.2. Certify compliance with test parameters. 
A polarization index equal to or less than 1.25 on new installations SHALL BE CONSIDERED A FAILURE. (MV Cable Test Example Page 60)
2. Correct malfunctioning cables and accessories at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3. Submit test results immediately upon completion to the University prior to energizing circuit.

4. Energize cable within 48 hours of acceptance test.

C. Confirm electric phasing between all existing cables, new cables and equipment with an approved electrical testing device. Phasing must be done in the presence of UMA representatives before switching into the UMA electrical grid. The contractor shall fully demonstrate all operations of the switchgear in the presence of UMA representatives.

3.4 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to manufacturer and Installer, to prevent entrance of moisture into the cables and to ensure medium-voltage cables are without damage or deterioration at the time of Substantial Completion.
Medium Voltage Transformers

Specification

MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes distribution and power transformers with medium-voltage (2.001-15kV) primaries.

1.2 SUBMITTALS

A. Product Data: Include data on features, components, ratings, and performance for each type of transformer specified. Include dimensioned plans, sections, and elevation views. Show minimum clearances and installed devices and features.

B. Wiring Diagrams: Detail wiring and identify terminals for tap changing and connecting field-installed wiring.

C. Product Certificates: Signed by manufacturers of transformers certifying that the products furnished comply with requirements.

D. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

E. Factory Test Reports: Certified copies of manufacturer's design and routine factory tests required by referenced standards.

F. Sound-Level Test Reports: Certified copies of manufacturer's sound-level tests applicable to equipment for this Project.

G. Field Test Reports: Indicate and interpret test results for tests specified in Part 3.

H. Maintenance Data: For transformers to include in the maintenance manuals specified in Division 1.

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: In addition to requirements specified in Division 1 Section "Quality Control," an independent testing agency shall meet OSHA criteria for accreditation of testing
laboratories, Title 29, Part 1907; or shall be a full-member company of the InterNational Electrical Testing Association.

B. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.

C. Listing and Labeling: Provide transformers specified in this Section that are listed and labeled.
   1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100 and ANSI Standard C57.12.01.
   2. The transformer shall be UL listed.

D. Comply with IEEE C2.

E. Comply with NFPA 70 and all applicable state and local codes.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: For indoor, dry-type transformers, apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit throughout periods during which equipment is not energized and is not in a space that is continuously under normal control of temperature and humidity.

1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

   1. Notify the UMA Utilities Department at least 10 working days in advance of proposed utility interruptions.

   2. Do not proceed with utility interruptions without the UMA Utilities Department's written permission. Written permission will be via an approved Utility Shutdown Notice.

   3. Prior to the utility shutdown a written procedure that complies with OSHA 1910.269 shall be submitted by the contractor and approved by the UMA Utility Department
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering transformers that may be incorporated into the Work include, but are not limited to, the following:

1. Olsun Electrics Corporation
2. ABB Power T & D Co., Inc.
3. Acme Electric Corp.; Transformer Division.
4. Cooper Industries; Cooper Power Systems Division.
6. GEC Alsthom T&D Balteau.
7. GE Electrical Distribution & Control.
9. MagneTek Inc.
10. Magnetic Windings Hi-Tek, Inc.
11. Neeltran, Inc.
12. Pauwels Transformers, Inc.
17. Virginia Transformer Corp.

2.2 TRANSFORMERS, GENERAL

A. Description: 2-winding type, designed for operation with Medium-voltage windings connected to a 3-phase, 60-Hz, Delta primary, and a 3-phase, 4 Wire, Wye secondary distribution system.

B. Low-Sound-Level Units: Minimum of 5 dB less than NEMA TR 1 standard sound levels for transformer type and rating.

C. Transformers shall be K-rated, depending on load type. Generally, low, medium and high non-linear loads should have K-4, K-9, K-13 rated transformers, respectively.
2.3 DRY-TYPE TRANSFORMERS

A. 13.8 kV, 3 phase, 60 Hertz Delta Primary with 3 phase, 4 wire
________V grounded Wye Secondary:

1. _______ KVA, K__, UL listed, TP1 energy rated, pad-mount, vandal
proof, dry type transformer to comply with NEMA ST 20, IEEE
C.57.12.01, and IEEE C57.94, and list and label as complying with UL
1562

2. Enclosure: The enclosure shall be tamper proof and of heavy gauge
steel. All ventilating openings shall be tamper proof and shall be in
accordance with NEMA and the NEC standards for ventilated
enclosures. The core shall be visibly grounded to the frame by means of
a flexible grounding strap.

3. 80 degree C rise with a 220 degree C insulation system 95 KV BIL
rating (accomplished without the use of supplemental arrestors).

4. Six (6) full capacity primary taps, two (2) taps to be 2½% each above
and four (4) to be 2½% each below normal primary voltage

5. The transformer windings shall be aluminum and vacuum-pressure
impregnated, the encapsulating materials used for the VPI process shall
have 100 percent solids content and be epoxy resin (double dipped).

6. The unit shall have provisions for changing the tap settings (when de-
energized) by flexible links on the face of each HV coil.

7. Minimum of 5 dB less than NEMA TR 1 standard sound levels for
transformer type and rating.

8. Outdoor transformer enclosures shall be finished with UL listed
outdoor polyester powder paint, Munsell 7GY3.29/1.5 olive green paint.

9. Indoor transformers shall be grey.

10. Factory installed accessories shall include the following:

   a. Replaceable air filters.

   b. Lightning arrestors. Rated at 15kv class, 12.7 MCOV.
B. 2.4 kV, 3 phase, 60 Hertz Delta Primary with 3 phase, 4 wire
V grounded Wye Secondary:

1. _______ KVA, K__, UL listed, TP1 energy rated, padmount, vandal proof, dry type transformer to comply with NEMA ST 20, IEEE C.57.12.01, and IEEE C57.94, and list and label as complying with UL 1562

2. Enclosure: The enclosure shall be tamper proof and of heavy gauge steel. All ventilating openings shall be tamper proof and shall be in accordance with NEMA and the NEC standards for ventilated enclosures. The core shall be visibly grounded to the frame by means of a flexible grounding strap.

3. 80 degree C rise with a 220 degree C insulation system 60 KV BIL rating (accomplished without the use of supplemental arrestors).

4. Six (6) full capacity primary taps, two (2) taps to be 2½% each above and four (4) 2½% each below normal primary voltage.

5. The transformer windings shall be aluminum and vacuum-pressure impregnated, the encapsulating materials used for the VPI process shall have 100 percent solids content and be epoxy resin (double dipped).

6. The unit shall have provisions for changing the tap settings (when de-energized) by flexible links on the face of each HV coil.

7. Minimum of 5 dB less than NEMA TR 1 standard sound levels for transformer type and rating.

8. Outdoor transformer enclosures shall be finished with UL listed outdoor polyester powder paint, Munsell 7GY3.29/1.5 olive green paint.

9. Indoor transformers shall be grey.

10. Factory installed accessories shall include the following:

   a. Replicable air filters.

   b. Lightning arrestors.
2.4 LIQUID-FILLED/PAD-MOUNTED TRANSFORMERS

A. Due to the environmental issues associated with oil filled transformers, they are not used for new or replacement installations on the Amherst campus.

2.5 FINISHES

A. All exterior transformer enclosures shall be finished with UL listed outdoor polyester powder paint, Munsell 7GY3.29/1.5 olive green paint color.

2.6 TRANSFORMER PADS

A. Transformer pads shall be fiberglass, 36 inch deep, manufactured to meet transformer requirements for size and weight.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering transformers pads that may be incorporated into the Work include, but are not limited to, the following:

   a. Nordic Fiberglass Inc.
   b. Highline Products
   c. Concast Fibercrete

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with IEEE C2.

B. Identify transformers and install warning signs according to Division 16 Section "Electrical Identification." and "Basic Electrical Materials and Methods."

C. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.

3.2 GROUNDING
A. Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping as indicated to comply with NFPA 70.

B. Comply with Division 16 Section "Grounding" for materials and installation requirements.

3.3 QUALITY CONTROL

A. Independent Testing Agency: Engage an independent electrical testing agency to test medium-voltage transformer installations as specified below.

B. Test Objectives: To ensure transformer is operational within industry and manufacturer's tolerances, is installed according to the Contract Documents, and is suitable for energizing.

C. Test Labeling: On satisfactory completion of tests for each transformer, attach a dated and signed "Satisfactory Test" label to tested component.

D. Schedule tests and provide notification at least 10 working days in advance of test commencement.


F. Tests: Include the following minimum inspections and tests according to manufacturer's written instructions. Comply with IEEE C57.12.91 for dry-type units.

G. Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage or deterioration. Verify that temporary shipping bracing has been removed. Include internal inspection through access panels and covers for dry-type transformers. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, if not available, those specified in UL 486A and UL 486B.

H. Insulation Resistance: Perform megohmmeter tests of primary and secondary winding to winding and winding to ground.

I. For Windings' Ratings from 0 to 600 V: 1000-V, dc minimum test voltage; and 500 megohms for dry-type transformers.
J. For Windings' Ratings from 601 to 5000 V: 2500-V, dc minimum test voltage; and 5000 megohms for dry-type transformers.

K. For Windings' Ratings from 5000 to 35,000 V: 5000-V, dc minimum test voltage; and 25,000 megohms for dry-type transformers.

L. Duration of Each Test: 10 minutes.

M. Temperature Correction: Correct results for test temperature deviation from 20 deg C standard.

N. Turns Ratio: Measure between windings at each tap setting. Measured ratios deviating more than 0.5 percent from calculated or measured ratio for an adjacent coil are not acceptable.

O. Winding Resistance: Measure for windings at nominal tap setting. Measured resistance deviating more than 1 percent from that of adjacent windings is not acceptable.

P. Test Failures: Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest. Verify that transformers meet specified requirements.

3.4 CLEANING

A. On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.5 ADJUSTING

A. Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility. Record primary and secondary voltages and tap settings and submit with test results.

END OF SECTION 16350
Building Service Metering

Overview

UMass Amherst has adopted Schneider Electric Square D PowerLogic monitors. Monitors are located throughout campus on all electrical distribution feeders and many building electrical services. The system includes Ethernet communication to the campus System Manager Software that is maintained giving consistently formatted monitoring and reporting of power quality, energy and demand.

METERING COMPARTMENT

(This section must be included with all switchgear specifications. This will allow competitive bidding for switchgear while maintaining our PowerLogic Metering system)
Provide separate customer metering compartment with front hinged door, .2% accuracy current transformer wired to current transformer shorting blocks with shorting pins installed and .2% accuracy potential transformers (where required) or bus taps wired to fuse blocks with disconnect switches as required.

Electric Meters

Electric Metering shall be install at each Service, Medium Voltage Feeder, Building Service Transformer and separately derived system. Meters supplied and installed shall be as follows:

1. Generation and Utility Feeds - ION 7650
2. Medium Voltage Feeders - PM8000
3. Science and Data processing - ION 7650
4. Other Buildings, Generators & Separately derived systems - PM8000

Communication

All meters shall be connected back to the campus System Manager Software server via the campus SCADA monitoring network as follows:
1. RS-485 wiring (between devices) shall be Belden 8723 cable with an MCTAS-485 Terminator at last device.

2. Power logic meter system shall be Ethernet communications compatible. It will be wired to the campus network. It can utilize a PowerLogic EGX150 web-enabled Ethernet gateways with RS 485 communications, or via direct Ethernet connection to the meter.
Exterior Lighting

SECTION 16521 - EXTERIOR LIGHTING

PART 1- GENERAL

1.1 SUMMARY

A. This Section includes exterior lighting units with luminaires, lamps, ballasts, poles/support structures, raceways, circuitry, conductors, identification and accessories.

B. Related Sections include the following:

1. Division 16 Section "Lighting Control Equipment" for programmable lighting control systems, time switches, additional photoelectric relays, power relays, and contactors.

1.2 DEFINITIONS

A. Lighting Unit: A luminaire or an assembly of luminaires complete with a common support, including pole, post, or other structure, and mounting and support accessories.

B. Luminaire (Light Fixture): A complete lighting device consisting of lamp(s) and ballast(s), when applicable, together with parts designed to distribute light, to position and protect lamps, and to connect lamps to power supply.

1.3 SUBMITTALS

A. Product Data: For each type of lighting unit indicated, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Materials and dimensions of luminaires and poles.

2. Certified results of independent laboratory tests for fixtures and lamps for electrical ratings and photometric data.

3. Certified results of laboratory tests for fixtures and lamps for photometric performance.

B. Product Data: For poles submit for verification of color and texture for comparison to existing poles.
C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

D. Maintenance Data: For lighting units to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Luminaires and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for their indicated use, location, and installation conditions by a testing agency acceptable to authorities having jurisdiction.

B. Comply with ANSI C2.

C. Comply with NFPA 70.

1.5 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.

2. Glass and Plastic Lenses, Covers, and Other Optical Parts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

3. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

4. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2- PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include.
2.2 LUMINAIRES (LED)

A. **Walkway Luminaire:** King Luminaire K118R-BAPR-III-60(SSL)-5000-90:277=K14/K12-GR-SST-XPG-C/W #1 VENTED FINIAL. See page 52 for drawing.

B. **Roadway Luminaire:** Eaton/Cooper Navion luminaire, LED Cobra head type. Typical Walkway lighting is either 480vac, single phase, 120vac single phase, or 277volt with neutral. There are two specifications based on voltage available. See pages 54-56 for more detail.

   a. 120-277 volt model. #NVN-AE-03-EUT3R-10K-BK.
   b. 480 volt model. #NVN-AE-03-E8T3R-10K-BK.
2.3 LUMINAIRE SUPPORT COMPONENTS

A. Description: Comply with AASHTO LTS-3 for pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation.

B. Wind-Load Strength of Total Support Assembly: Adequate to carry support assembly plus luminaires at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of 80 mph (160 km/h) with a gust factor of 1.3. Support assembly includes pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation.

   1. Strength Analysis: For each pole type and luminaire combination, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

C. Manufacture: Appurtenance, arm, bracket, and tenon mount materials shall be as manufactured for the luminaire required.

D. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

   1. Materials: Will not cause galvanic action at contact points.
   2. Mountings: Correctly position luminaire to provide indicated light distribution.

E. Light Poles:

   1. General: All light poles and light support arms are now black.


   3. Walkway and Mall standards: shall be equal to CMT Legacy composite light poles. Catalog number LV(W)B12-T-#-T300-S. 12 foot exposed height. See page 53 for drawing.

E. Pole Identification Tag:
A. General: Pole identification tags shall include:
   Building or Area #____ as identified by the Physical Plant
   Utility Department.
   Circuit # ______ and
   Fixture letter______

   Identification tags shall match those installed on the
   University of Massachusetts, Amherst Campus, in color and
   texture. Location of samples shall be verified through the
   Associate Director for Utilities.

B. Materials: Shall be 1/8 inch thick, Three ply, laminated
   impacted acrylic, matt finish 3-632 UMASS BURGANDY/White,
   Gravel Ply material with .80 high @ 85%, Helvetica Medium
   Font as manufactured by Rowmark Sign Materials 1-800-595-
   6660 (SATINS) or approved equal.

C. Identification tags shall be made & installed by contractor per
   Physical Plant Electrical Utility Department sample tag.
2.4 LUMINAIRE CIRCUITRY COMPONENTS

A. General: Circuitry Components shall include; raceways, hand-holes, conductors and splices.

B. Raceways:
   1. Minimum 2”, Schedule 40 PVC. All conduits shall include Bell Ends in all hand-holes.
   2. 3/4” Liquid tight Flexible nonmetallic conduit from Hand Hole to base of pole for sleeve of UF Cable.

C. Hand-Holes: Heavy Traffic Tier 22, stackable, open bottom with cover engraved “ELECTRIC” as manufactured by:

   Quazite
   13 X 24, #PG1324BA18 BOX WITH XTRA HEAVY, 13 X 24, COVER #PG1324HH0017.
   17 X 30, #PG1730BA18 BOX WITH XTRA HEAVY, 17 X 30, COVER #PG1730HH0017

   NewBasis
   13 X 24, #PCB132418SN32 BOX WITH XTRA HEAVY, 13 X 24, COVER #PCC1324A1A32 WITH “ELECTRIC” ENGRAVED.
   17 X 30, #PCB173018SN20 BOX WITH XTRA HEAVY, 17 X 30, COVER #PCC1730A1A32 WITH “ELECTRIC” ENGRAVED.

   or approved equal.

D. Conductors:
   1. Circuits, minimum # 6 AWG, stranded copper conductor with USE-2 insulation.
   2. Circuit taps from hand hole to fixture # 12 AWG solid copper conductor with UF insulation.

E. Splices: Appropriate splices for application shall be Raychem Gel Cap-SL-2/0-3 hole & Raychem GTAP 1.

PART 3 EXECUTION
3.1 INSTALLATION

A. Raceways: All circuitry shall be in raceways with hand-holes for future access, direct buried cable is not acceptable.

1. Raceways: Raceways; shall be installed for all circuitry with one additional spare conduit of equal size. At hand-holes conduits shall be stubbed up with sweeps. No continuous conduit run shall have more that 270 degrees of bends. Raceways shall not be filled in excess of 50% of their fill capacity.

2. Hand-holes: Hand-holes shall be installed at each lighting unit and at intervals not greater than 100 feet. Hand-holes shall be located no closer than 12” from edge of hand-hole to edge of pole and no greater than 24” from edge of hand-hole to edge of pole. Hand-holes shall be installed flush with finished grade.

B. Circuitry: all circuitry shall be contactor controlled at one central location with one photo-cell rated for contactor, and with a test switch to by-pass photo-cell for testing. Circuits shall be arranged so that in the event that a circuit is lost only every third Luminaire will be de-energized.

1. Conductors shall be color coded along their continuous length and circuit numbers shall be marked at all accessible locations with numbers suitable for the location. For 480/277 circuits (Brown, Orange, Yellow, Gray), for 208 circuits (Black, Red, Blue) and grounds Green; 120 volts not allowed.

2. An equipment grounding conductor shall be installed with all circuits.

3. No circuit overcurrent device shall be rated greater than twenty amps. Circuits shall not be loaded greater than 12 amps with a maximum voltage drop of 3% at furthest luminaire.

4. All contactors shall have 25% spare capacity for future expansion.

5. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If
manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

6. Nonmetallic Poles: Ground metallic components of lighting units and foundations. Connect luminaires to grounding system with No. 6 AWG conductor.

7. Run all three circuits or more if required in that run to the last hand hole of every circuit group.

C. Embedded Poles: Set poles to indicated depth below finished grade. Dig holes large enough to permit use of tampers the full depth of hole. Backfill in 6-inch (150-mm) layers with clean fill and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.

1. Roadway Lighting Standards: shall be equal to ACD #906-B24-AD4, 24 foot exposed height, 5 foot butt and 4 foot bracket arm.

2. Walkway and Mall standards: shall be equal to ACD #901-B12, “Campus” design, 12 foot exposed height and 4 foot butt.


4. Use web fabric slings (not chain or cable) to raise and set poles.

5. Secure poles level, plumb, and square.

D. Luminaire: Install luminaires at intervals and wattages as follows:

1. Roadway Lighting Standards: Spacing: 80’ on center, Light level: IEEE: Roadway Collector (serving traffic between major and local roadways); Lux - 13, Footcandles - 1.2. Local (direct access to residential, commercial or abutting property; Lux - 10, Footcandles - 0.9. (Average Maintained Illuminance on the Horizontal).
   - Traffic Conflict Areas, intersections and pedestrian crosswalks shall be illuminated at least 150% of the average route value.
8. SIDEWALKS LIGHTS (roadside): Spacing: 80’ on center cut-off and/or 60’ on center King Luminaire. Luminaire and spacing depend on the ability of the roadway lighting to establish footcandle levels required, ie; side of the road, trees between walk and roadway e.t.c. Light level: IEEE: Intermediate areas (Moderately heavy night-time pedestrian activity). Minimum Average Levels; Lux - 6, Footcandles - 0.6. (Average Maintained Illuminance on the Horizontal).

3. WALKWAY LIGHTS (distant from roadways): Spacing: 60’ on center Light level: IEEE: Minimum Average Levels Park walkways and bikeways; Lux - 5, Footcandles - 0.5. Pedestrian stairways; Lux - 6, Footcandles - 0.6. (Average Maintained Illuminance on the Horizontal).

4. PARKING LOT LIGHTS: Arms: 2’, Single or double depending on layout.
   Spacing: 116’ in lot (every other row), 117 or 126’ in rows depending on layout, poles must be between spacing. Light level: IEEE: Educational facility parking (Low Activity). Vehicular Traffic; Lux - 5, Footcandles - 0.5, Uniformity Ratio - 4:1 Pedestrian Safety & Security; Lux - 9, Footcandles - 0.8, Uniformity Ratio - 5:1 (Average to Minimum Illuminance).

5. These levels represent average Illuminance when the luminaires are at their lowest output. Since Illuminance values depreciate as much as 50% or more, IEEE (LLD) lamp lumen depreciation and (LDD) luminaire dirt depreciation factors must be used in designs.
   ** In addition to these requirements all other IES recommendation shall be followed.


7. Luminaire Attachment with Adjustable Features or Aiming: Attach luminaires and supports to allow aiming for indicated light distribution.

8. Lamp luminaires with indicated lamps according to manufacturer's written instructions. Replace malfunctioning lamps.

3.2 FIELD QUALITY CONTROL
A. Inspect each installed unit for damage. Replace damaged units.

B. Advance Notice: Give dates and times for field tests.

C. Provide instruments to make and record test results.

D. Tests and Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source, and as follows:

1. Measure light intensities at night if specific illumination performance is indicated. Use photometers with calibration referenced to NIST standards.

2. Check intensity and uniformity of illumination.

3. Check excessively noisy ballasts.

E. Prepare a written report of tests, inspections, observations and verifications indicating and interpreting results.

F. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

3.3 CLEANING AND ADJUSTING

A. Clean units after installation. Use methods and materials recommended by manufacturer.

B. Adjust amiable luminaires and luminaires with adjustable lamp position to provide required light distributions and intensities.

END OF SECTION 16521
UMass Amherst
5 kV Open Loop
Feeders and UHSs to be determined by UMass Utility Department in accordance with projected load.

UMass Amherst Standard
MV 4/0 Paralleled Cable
100% Spare Capacity Duct Bank

Manual Transfer

Medium Voltage Room with
Direct Access to Outside
Egress opening must be large
enough for equipment replacement.
Doors will be Keyed with
UMass Best Key RO-0-17.

UMass Amherst Standard
Dry Type Transformers
Each transformer will be
sized for 125% capacity

Fault Current Calculations
will consider Unlimited supply
on primary side of transformers.

Metering Cabinet with
Revenue quality CTs
CT shorting Blocks
Meter Fuses &
Disconnect Switch
For meter see
UMass Meter Standard

All Low Voltage gear shall have
a minimum 25% spare circuit
space and capacity.

Low Voltage Room
Egress opening must be large enough
for equipment replacement.
Doors will be Keyed with
UMass Best Key RO-0-17.
UMass Amherst Standard

Electrical Distribution & Outdoor Lighting

Medium Voltage Room with Direct Access to Outside. Egress opening must be large enough for equipment replacement. Doors will be Keyed with UMass Best Key RO-0-17.

All Low Voltage gear shall have a minimum 25% spare circuit space and capacity.

Low Voltage Room. Egress opening must be large enough for equipment replacement. Doors will be Keyed with UMass Best Key RO-0-17.

Fault Current Calculations will consider Unlimited supply on primary side of transformers.

NO Tie with Kirk Key Interlock. Closed transition will be demonstrated by contractor. Defeater Key will be given UMass Amherst Utility Department.

Automatic Transfer with pre-charge option for All Critical Buildings. Otherwise, Manual Transfer.

UMass Amherst Standard

5" PVC with MV 350 kCM Cable 100% Spare Capacity Duct Bank.

UMass Amherst Standard

Typical 15 kV Building Service

11/23/05
1) Voltage – All fixtures shall be 480 or 208.

2) Circuit Layout – Circuits shall alternate as shown to prevent area blackouts when circuit fails.

3) Conductors (SEE SPECIFICATION) shall be color coded entire length, insulation USE-2.

4) Fixtures: (SEE SPECIFICATION)
   a. Walkway (King Luminare)
   b. Street & Parking (Cutoff)

5) Poles: (SEE SPECIFICATION)
   a. Walkway 12' Exposed 4' Butt
   b. Roadway 24' Exposed 5' Butt
   c. Parking 29' Exposed 5' Butt

6) Handholes: (SEE SPECIFICATION)
   a. Handhole Extra Heavy Traffic
   b. Cover Extra Heavy Traffic.

7) Spacing: (SEE SPECIFICATION)
Walkway light remains the same
Changed to black fiberglass, 16 foot pole for walkways, V5.0
Versatility and Simplicity

The Navion luminaire is designed to meet a wide range of outdoor lighting needs, from single fixture applications to multi-lane highways. Utilities and municipalities will find it ideal for streets, rural roads, bridges, substations and small area security lighting applications. With multiple optical configurations and fixture sizes, the Navion luminaire allows lumen and energy output to be customized to fulfill the exact needs of the outdoor space — eliminating wasted energy and obtrusive spill light. The larger configurations excel in multi-lane highway projects, while the smaller lumen packages work well in substation areas and along neighborhood streets.

Municipalities

For cities and towns, the Navion luminaire delivers superior optical performance in a durable, modern design, while providing up to 70 percent less energy usage compared to typical HID luminaires. With greater than 90 percent lumen maintenance at 60,000 hours (over 15 years at 10 hours daily use), the Navion fixture offers a long life and maximum savings in maintenance costs.

The Navion luminaire offers a choice of 10 optical packages to meet the exact needs of the outdoor area, and the fixture’s size and construction are scaled to the specific lumen package. Designed to withstand harsh environments, the luminaire’s rugged, die-cast aluminum construction and 2.5 mil powder-coat finish provide superior protection. The Navion luminaire is 30 vibration rated and comes standard with 10kV dual-mode surge protection.

Performance and Versatility

The Navion luminaire is built around LED technology and designed to accommodate ongoing improvements in LED chips and drivers, making it the ideal solution for both current and future lighting requirements.

LED street light cobrahead, V5.0
## Ordering Information

**Sample Number:** WNI-1E-50-E-U3X-50K-100-2-AP

### Dimensions

<table>
<thead>
<tr>
<th>Number of Light Squares</th>
<th>&quot;A&quot; Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>21-1/2&quot; (544mm)</td>
</tr>
<tr>
<td>2</td>
<td>21-5/8&quot; (551mm)</td>
</tr>
<tr>
<td>3</td>
<td>33-5/8&quot; (862mm)</td>
</tr>
<tr>
<td>4</td>
<td>37-6/8&quot; (961mm)</td>
</tr>
<tr>
<td>6</td>
<td>39-5/8&quot; (961mm)</td>
</tr>
</tbody>
</table>

### Lumen Multiplier

<table>
<thead>
<tr>
<th>Lumen Multiplier</th>
<th>Ambient Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°C</td>
<td>1.00</td>
</tr>
<tr>
<td>10°C</td>
<td>1.03</td>
</tr>
<tr>
<td>35°C</td>
<td>1.00</td>
</tr>
<tr>
<td>40°C</td>
<td>0.93</td>
</tr>
<tr>
<td>50°C</td>
<td>0.83</td>
</tr>
</tbody>
</table>

### Lumen Maintenance

- 25°C: >95% >300,000
- 42°C: >96% >500,000
- 52°C: >96% >1,000,000

### Optional Arm

<table>
<thead>
<tr>
<th>Optional Arm</th>
<th>&quot;A&quot; Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>30&quot; Uplight Arm</td>
<td>7-3/8&quot; (198mm)</td>
</tr>
<tr>
<td>48&quot; Uplight Arm</td>
<td>15&quot; (381mm)</td>
</tr>
</tbody>
</table>

### Additional Information

- **Compliance:** UL and cUL, Max Location Listed
- **OSRAM Light Equivalency:** 200W Light Equivalency
- **TUV/HARMA Compliant:** ISO9001

LED street light cobrahead, V5.0

UMass Amherst Utility Standards
Electrical Distribution & Outdoor Lighting 5.0
LED street light cobrahead, V5.0
For road ways and parking lots.
Pole arms are black.
### 15kV Cable Test Sheet

<table>
<thead>
<tr>
<th>Feeder</th>
<th>Location</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEW CHILLER FEEDER</td>
<td>ULLIBRARY: INCOMING COMM BUS TO CHILLER SWITCH &amp; NEW GEAR</td>
<td>5/27/1997</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cable Size:</th>
<th>Manufacture:</th>
<th>Insulation Type:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/0 COPPER</td>
<td>OXONITE</td>
<td>MN: 9C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Length:</th>
<th>Insulation Level:</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>133%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Air Temp:</th>
<th>RH:</th>
</tr>
</thead>
<tbody>
<tr>
<td>71 DEGREES F</td>
<td>37.60%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test Set:</th>
<th>Last Calibration Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIDDLE</td>
<td>03/04/04</td>
</tr>
</tbody>
</table>

### Shield Ohms:

<table>
<thead>
<tr>
<th>TIME (MIN)</th>
<th>TEST</th>
<th>LEAKAGE CURRENT (uAMPS)</th>
<th>POLARIZATION INDEX</th>
<th>#VALUE!</th>
<th>#DIV/0!</th>
<th>#DIV/0!</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Phase A</td>
<td>Phase B</td>
<td>Phase C</td>
<td>Neutral</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.4</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>1.2</td>
<td>1.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>14.4</td>
<td>16.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>39</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>148</td>
<td>199</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>198</td>
<td>198</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>200</td>
<td>210</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) min 65</td>
<td>65</td>
<td>689</td>
<td>197</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) min 65</td>
<td>65</td>
<td>687</td>
<td>170</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) min 65</td>
<td>65</td>
<td>687</td>
<td>170</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) min 65</td>
<td>65</td>
<td>210</td>
<td>165</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5) min 65</td>
<td>65</td>
<td>690</td>
<td>690</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6) min 65</td>
<td>65</td>
<td>690</td>
<td>690</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(12) min 65</td>
<td>65</td>
<td>690</td>
<td>690</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(15) min 65</td>
<td>65</td>
<td>690</td>
<td>690</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Conclusion/Recommendation:**

THE TESTER INDICATED "THE SWITCH IS A HAZARD IN IT'S PRESENT CONDITION" & THAT IT NEEDS TO BE CLEANED & RETESTED.


**Tester/Company:**

TEST ELECTRIC

Signature of Tester: NOT SIGNED

TESTER: John Doe
Manhole cover, cast iron type.
Revision History: Version 4.0. (All V4.0 changes in red).

1. Replaced PHM style outdoor pad-mounted switchgear with Vista Style for buildings. See page 9 of 57.
2. Manhole cover specification changed to McGard FiberShield Type. See page 11 of 57.
3. Lightning Arrestors must be rated at 15kv min. See page 28 of 57.
5. Changed Exterior Walkway Luminaire LED specification. See page 37 of 57.
6. Change Powerlogic meter types as existing meters are obsolete. Page 33 of 57.
7. All new buildings shall provide, SKM modelling software to UMA Utilities, to be added to campus load model. See page 4 of 57.
8. All new buildings will have a circuit breaker co-ordination study done and implemented. See page 4 of 57.

Revision History: V 5.0. (All V5.0 changes in blue).

1. Index sheet updated.
7. Page 36-37. PM8000 Power logic meter spec added for medium voltage feeders and non-research buildings. Ethernet Gateway specification updated to EGX150.