**SECTION 26 05 13**

**MEDIUM-VOLTAGE CABLES**

**BASED ON DFD MASTER ELECTRICAL SPEC DATED 12/26/23**

This section has been written to cover most (but not all) situations that you will encounter. Depending on the requirements of your specific project, you may have to add material, delete items, or modify what is currently written. The Division of Facilities Development expects changes and comments from you.

***In several locations below, two choices of parameters are indicated in square brackets. In general, the first parameter is intended for use at 5 kV and the second is intended for use at 15 kV. Please edit these parameters as necessary for the voltage level of the project.***

**PART 1 - GENERAL**

**SCOPE**

The work under this section includes furnishing and installing medium voltage cable including pulling, racking, splicing, and terminating. Included are the following topics:

PART 1 - GENERAL

 Scope

 Related Work

 Definition

 Submittals

 Project Record Documents

 Quality Assurance

 Delivery, Storage, and Handling

PART 2 - PRODUCTS

 General

 Medium Voltage Cable - Shielded

 Jumper Cable

 Cable Terminations

 Cable Splices

 Cable Labeling

PART 3 - EXECUTION

 Cable Pulling

 Cable Routing in Manholes and Switchgear

 Splices and Terminations Installation

 Fireproofing of Medium Voltage Cables

 Cable Acceptance Tests

 Cable Identification and Labeling

 Construction Verification Items

RELATED WORK

Applicable provisions of Division 1 govern work under this Section.

Section 01 91 01 or 01 91 02 – Commissioning Process

Section 26 08 00 - Commissioning of Electrical

**DEFINITION**

Manufacturer: The company which owns controlling interest in the factory actually producing the cable being furnished for this project.

**SUBMITTALS**

Submit product data indicating cable and accessory construction, materials, ratings, and all other parameters identified in Part 2 - Products below.

Submit manufacturer's installation instructions.

Submit manufacturer's certificate stating approval for field acceptance testing per National Electrical Testing Association standards (at least 35 kV DC for 5 kV rated cable and 64 kV DC for 15 kV rated cable).

Submit manufacturer's certificate stating that medium voltage cable meets or exceeds all requirements specified below.

**PROJECT RECORD DOCUMENTS**

Accurately record exact sizes, lengths, types, locations, and quantities of cables. Also show where all splices are located for each cable.

**QUALITY ASSURANCE**

The manufacturer shall be a company specializing in the manufacture of medium voltage cable and/or accessories with minimum five years documented experience in producing cable and/or accessories similar to those specified below.

The cable materials and manufacture shall meet or exceed all applicable requirements of the latest editions of ICEA Standard S-93-639, UL 1072 and NEMA standards.

The cable shall be manufactured using a triple extrusion process in which the conductor shield, insulation, and insulation shield are installed at essentially the same time without an intervening storage period on reels or other storage devices.

Project staff shall have experience in the coordination and procurement of medium voltage cable, medium voltage equipment and components used on this project.

A minimum of two electricians working on this project shall be trained and experienced (completed minimum of 2 similar medium voltage installations) with medium voltage cable, medium voltage equipment and components.

Electricians involved in splicing and termination of cables shall be trained and experienced in the procedures required for the splices and terminations used on this project.

At the discretion of the Engineer, documentation of training and experience in medium voltage installations shall be provided.

**DELIVERY, STORAGE, AND HANDLING**

Cable shall be stored according to manufacturer's recommendations as a minimum. In addition, cable must be stored in a location protected from vandalism and weather. If cable is stored outside, it must be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 32 degrees F., the cable shall be moved to a heated (50 degrees F minimum) location. If necessary, cable will be stored off site at the Contractor's expense.

**PART 2 - PRODUCTS**

**GENERAL**

All cable shall be new, delivered to the site, and be less than two years since manufacture. It shall be from manufacturer's stock; not suppliers' warehouse stock. Manufacturer's certification of factory test values shall be submitted for all cable furnished. All specified dimensions are nominal.

Provide a 600 volt insulated copper ground conductor in all conduits with medium voltage cable. This ground conductor shall be the same size as the phase conductors. See Section 26 05 26 for more grounding requirements.

**MEDIUM VOLTAGE CABLE - SHIELDED**

Usage: This cable shall be used for all above and underground applications (except for jumper cable applications, see JUMPER CABLE below) and shall be contained in conduit or other raceways.

***Consultant to specify voltage rating for the application.***

Cable: Single conductor, insulated cable rated [5] [15] KV, 133% insulation level, ungrounded, NEC-UL Type MV-105. Sizes as indicated on the Drawings.

Conductor: Soft copper, annealed, uncoated, Class B compressed, compact, or concentric stranded, having nominal direct-current resistance equal to or less than that required in section 2.4.1 or 2.4.2 and Table 2-2 of ICEA S-93-639.

Conductor shield: extruded semiconductor with resistivity requirements of section 3.3 of ICEA S-93-639 for discharge-free designs and nonconducting high permittivity compound for discharge-resistant designs. Material shall be clean stripping from the conductor and firmly bonded to the overlying insulation.

***Use the following paragraph for 5 kV applications.***

Insulation: Extruded EPR (ethylene propylene rubber), rated at 5 KV, 133 per cent insulation level, nominal thickness of .115 inches.

***Use the following paragraph for 15 kV applications.***

Insulation: Extruded EPR (ethylene propylene rubber), rated at 15 KV, 133 per cent insulation level, nominal thickness of .220 inches.

Insulation Shield: The insulation shield shall consist of an extruded semiconducting layer directly over the insulation and a copper tape over the semiconducting covering. The tape shall be at least 5 mils (0.127 mm) thick and be spiral wrapped with a minimum 12.5 per cent overlap. The insulation shield shall meet all requirements of section 5 of ICEA S-93-639.

Jacket: Polyvinyl Chloride (PVC), black color with a jacket thickness meeting all requirements of ICEA S-93-639.

Cable Rating: Continuous duty at 105 degrees C., wet or dry locations, suitable for underground duct installations, UL type MV-105.

**JUMPER CABLE**

Usage: This cable may only be used as a flexible power lead between close-coupled equipment such as between a primary switch and close-coupled transformer. This cable is not rated for and shall not be used in conduit, nipples, or random lay applications. This cable may only be used where adequate through-air separation can be achieved from conductor-to-conductor and from conductor-to-ground.

Cable: Single conductor, flexible, non-shielded, insulated cable rated 15 KV, ungrounded. Size as indicated on the Drawings.

Conductor: Stranded, soft annealed copper.

Conductor shield: extruded semiconductor, clean stripping from the conductor and firmly bonded to the overlying insulation.

Insulation: Extruded EPR (ethylene propylene rubber), rated at 15 KV, minimum thickness of .175 inches

Cable Rating: Continuous duty at 90 degrees C., dry locations.

***Consultant to specify voltage rating for the application.***

**CABLE TERMINATIONS**

Modular Molded Shrink Type Termination: IEEE 48; Class 1; [5] [15] KV. Kit form, suitable for use with cable specified, including slip-on type flexible skirted polymer or silicon rubber insulator. All terminations shall be skirted type. Termination shall be hot or cold shrink type with internal stress relief tube to distribute electric field (10% to 90% equipotential lines) over entire length of skirted insulator.

Submittal for approval shall show electric field distribution (via equipotential lines) of termination device.

Lugs shall be copper, long barrel, two hole or four hole and rated for the voltage applied. The lugs shall match the pads on the equipment to which the cable will be mounted.

If there will be more than one cable on an equipment pad approved spiders (or spacers) must be used. Cable attachment to equipment must match the equipment manufacturers UL labeling requirements (if the equipment is UL Listed) as a minimum. Unless the equipment is designed or listed for it, cable lugs may not be placed back to back on the equipment pad. In all cases, the termination and equipment must be taped with approved anti-tracking tape.

***Consultant to specify voltage rating for the application.***

**CABLE SPLICES**

Modular Molded Shrink Type Splice: IEEE 404-1986; Class 1; [5] [15] KV. Kit form, suitable for use with cable specified, including slip-on type flexible polymer or silicon rubber insulator. Splice shall be hot or cold shrink type with internal stress relief tube to distribute electric field (10% to 90% equipotential lines) over entire length of insulating material.

Molded body shall contain a built-in internal semiconducting layer which covers and contacts the splice barrel and the cable insulation layer to prevent electrical stress buildup inside the body. This semiconducting layer shall be bonded to and covered with a cured EPDM rubber or polymer insulating layer which, in turn, shall be bonded to and covered with a semiconducting layer and metallic shield and jacket.

Splicing sleeves shall be long barrel type and rated for the voltage applied.

The completed splice shall be approved for underground direct burial and water immersion service.

Submittal for approval shall show electric field distribution (via equipotential lines) of termination device.

**CABLE LABELING**

Cable labels shall be engraved, laminated plastic plates suitable for use from -40 deg. F. to 150 deg. F., and shall be resistant to oil, water and solvents. Nameplate shall be minimum size 1-1/2" X 4". Face shall be white and the letters shall be black. Fasten label to cable with nylon tie-wraps. See paragraphs below for information type and label locations.

**PART 3 - EXECUTION**

**CABLE PULLING**

Pump all water out of the manholes prior to beginning work.

Prior to pulling cable, a mandrel/swab 1/4 inch smaller than the duct diameter shall be pulled through duct run to insure adequate opening of duct run. Thoroughly swab conduits to remove foreign material before pulling cables.

Cables shall not be pulled from an outdoor (exterior) location when the outdoor (exterior) air temperature is below 32 degrees F.

Contractor shall furnish all required installation tools to facilitate cable pulling without damage to the cable jacket. Such equipment is to include, but be not limited to, sheaves, winches, cable reels and/or cable reel jacks, duct entrance funnels, pulling tension gauge, and similar devices. All equipment shall be of substantial construction to allow steady progress once pulling has begun. Makeshift devices which may move or wear in a manner to pose a hazard to the cable shall not be used.

Cable ends shall be sealed and firmly held in the pulling device during the pulling operation.

Cable pulling shall be done in accordance with cable manufacturer's recommendations, except as modified herein, and ANSI/IEEE C2 standards. Manufacturer's recommendations shall be a part of the cable submittal. Recommended pulling tensions shall not be exceeded. Pulling bending radius shall not be less than that determined by the manufacturer or the NEC. Restrictions of pulling bending radius dimensions shall be strictly observed. Training bending radius shall not be less than 12 times cable diameter. Any cable bent or kinked to radius less than recommended dimension shall not be installed.

Actual pulling tensions shall be continuously monitored and permanently recorded in a log and submitted to the Engineer at the end of the project.

During pulling operation an adequate number of persons shall be present to allow cable observation at all points of duct entry and exit as well as to feed cable and operate pulling machinery.

Pulling lubricant shall be used to ease pulling tensions. Lubricant shall be water or silicone based of a type which is noninjurious to the cable material used. Wax based lubricants are not allowed. Lubricant shall not harden or become adhesive with age.

Avoid abrasion and other damage to cables during installation.

Where cables are left in manhole or switchgear overnight or more than 8 hours prior to termination, the cable ends shall be sealed with paraffin or shrink wrap caps and supported in a manner which will prevent entrance of moisture into the cable. Cable shall be terminated and energized as soon as possible.

**CABLE ROUTING IN MANHOLES AND SWITCHGEAR**

Certain manholes shall have the cable looped around the walls. If not indicated on drawings, the manhole nearest building plus every third manhole if feeder contains multiple manholes shall contain cable loop. In such cases, the cable shall circle the manhole at least 360 degrees. Where manholes are not to be looped, cable shall be routed on the walls with the longest distance between points of entry and exit. Arrange cables to avoid interference with duct entrances into manhole.

All new and existing cable in manholes shall be secured to racks on the manhole walls. Cables shall be secured to racks with split porcelain or polymer insulators and clamps or mounted on a heavy duty nonmetallic multi-mount cable support arm as manufactured by Underground Devices, Inc. Insulators shall be of adequate size to contain all three phases and the ground of a given circuit. Fastening cables directly to support channel will not be accepted.

Cables within switchgear shall be routed in a manner which will allow adequate room for bending and terminating cables. Cables must be secured in a manner which will not result in cable weight being placed on the termination electrical joint. Cable support shall be made in a manner that does not force cable against grounded metal or which compresses cable diameter. Cable training bending radius shall be at least 12 times cable diameter. Any cable bent to a radius less than recommended dimension will not be accepted.

Jumper cable shall be routed in a manner that maintains adequate through-air separation between adjacent conductors and between conductors and any metallic or grounded surface.

**SPLICES AND TERMINATIONS INSTALLATION**

Splices are to be held to a minimum. Splice locations shall be determined by cable lengths available, pulling conditions and termination points. Splice locations are to be listed by the Contractor prior to cable purchase and a listing of such locations submitted to the Engineer for approval before final cable lengths are determined.

Only experienced electricians shall be employed in this phase of the work. Refer to **QUALITY ASSURANCE** above.

Follow cable manufacturer's and splice or termination manufacturer's installation instructions and ANSI/IEEE C2 standards.

Clean, white lint-free gloves shall be used to handle end of cable during tape wrapping procedures.

Termination or splicing of the copper conductors (both power and ground conductors) shall be made only with tool applied compression (swaged) fittings.

Ground system connections:

Cable to bus: compression cable fitting bolted to bus with lock washers under nut.

Cable to ground rod: approved bolted fitting with backing plate between cable and rod.

Ground cable shield at each termination and splice.

Splice or termination failure upon high potential acceptance test will require complete reconstruction of the joint to manufacturer's specifications. Make sure that there is enough free cable at each termination or splice for two more terminations or splices to be performed.

Install Scotch #70 tape for anti-tracking on all exposed terminations.

All splices and terminations are to be tagged using embossed plastic tags with plastic attachment devices indicating date splice or termination was made, name of electrician involved, name of Contractor installing cable, feeder number and circuit to and from data.

All cable splices in manholes shall be supported on both sides of the splice within 2'0" of the splice. Splices shall not rely on cable for support.

Lugs shall be bolted to termination pads in equipment using corrosion resistant bolts, nuts, and washers. Use Belleville washers for bolting aluminum to aluminum, and lock washers for bolting copper to copper or as recommended by equipment manufacturer. Torque to manufacturer's recommendations.

**FIREPROOFING OF MEDIUM VOLTAGE CABLES**

Exposed cables in manholes, vaults, and cable trays shall be fireproofed. Additionally, cables shall be fireproofed in pull boxes, troughs, switchgear pull sections and pulling pits containing two or more sets of cable. Entire installation shall conform to manufacturer's recommendations.

Arc proofing material shall be Scotch #77 electrical arc and fireproofing tape, or approved equal.

Install the fireproofing on the cables as follows:

Install tightly applied fireproofing tape, approximately 1/16 inch thick by 1-1/2 inches wide minimum, around **each** cable spirally in one half-lapped wrapping.

Install the tape with the coated side towards the cable and extend it not less than one inch into each duct.

Install random wrappings of Scotch #69 glass cloth tape around the installed fire proofing tape per manufacturer's instructions to prevent it from unraveling.

**CABLE ACCEPTANCE TESTS**

Acceptance tests will be performed by an independent Testing Consultant under separate contract with DFD. The Contractor shall coordinate the scheduling of the tests and provide labor and services necessary to allow the Testing Consultant to test each completed cable circuit. This includes opening and closing equipment, providing temporary light and power as needed, etc.

Acceptable testing method shall be either DC voltage or VLF IEEE 400.2.

Acceptance tests will be performed on all cable after installation and prior to energization. All splices and terminations are to be completed and tested as part of the acceptance test.

In the event that test results are not satisfactory, the Contractor shall make repairs and replace components as necessary to correct faults. Following corrections, tests will be repeated to the extent required to prove the deficiencies are corrected.

**CABLE IDENTIFICATION AND LABELING**

Provide the following information on cable identification label:

Main feeder circuit number

To and From Data

EXAMPLE:

FDR: 1

TO: ACADEMIC HALL

FROM: MH P25

Install cable labels on each conductor at each cable termination, each cable splice, in each manhole and in each pullbox. Additionally, at these locations, provide one inch (1") colored vinyl plastic electrical tape wrap identification, (Scotch 35 or approved equal) around each conductor and cable as follows:

 5 KV individual conductor system

 A - phase - one (1) yellow wrap

 B - phase - two (2) yellow wraps with 1/2" space between wraps

 C - phase - three (3) yellow wraps with 1/2" space between wraps

 15 KV individual conductor system

 A - phase - one (1) red wrap

 B - phase - two (2) red wraps with 1/2" space between wraps

 C - phase - three (3) red wraps with 1/2" space between wraps

See paragraph above under **SPLICES AND TERMINATIONS INSTALLATION** for splice label requirements. This is in addition to identification labels.

During entire cable installation, phasing of conductors shall be maintained and identified. Where final connections to equipment are made, phasing shall be verified and proper phase rotation determined prior to connection.

**CONSTRUCTION VERIFICATION**

Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 26 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

END OF SECTION