

## SECTION 26 05 13 – MEDIUM-VOLTAGE CABLES

### 1.01 SUMMARY:

- A. **BASIC FUNCTION:** <sup>A7</sup>The medium-voltage cable system shall supply electrical power to the locks with redundancy, so that any one section of the medium-voltage cable system can be taken out of service for maintenance or repair without compromising the operation of the rest of the medium-voltage cable system.<sup>A7</sup>
- B. **SCOPE OF WORK:** <sup>A7</sup>This Section contains the technical specifications for designing, supplying, installing, testing, and commissioning medium-voltage cable systems. The medium-voltage cable installation shall be fully coordinated with the duct banks and cable tray systems.<sup>A7</sup>

### 1.02 <sup>A16</sup>REFERENCES: <sup>A16</sup>

- A. **Association of Edison Illuminating Companies (AEIC) Publications:**
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|---------|---|
| CS 8-07 | Extruded Dielectric Shielded Power Cables Rated 5 through 46 kV |
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- B. **American National Standard Institute (ANSI) / Insulated Cable Engineers Association (ICEA) Standards:**
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|-------------------------|---|
| ANSI / ICEA S-94-649-04 | Concentric Neutral Cables Rated 5-46 kV |
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- C. <sup>A7</sup>**American Society of Mechanical Engineers (ASME)**
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|-----------|--|
| Y14.5M-94 | Dimensioning and Tolerancing <sup>A7</sup> |
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- D. **American Society for Testing and Materials (ASTM) International Standards:**
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|-------|--|
| B8-04 | Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft. |
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- E. **Institute of Electrical and Electronics Engineers (IEEE) Standards:**
- |        |  |
|--------|--|
| 48-96  | Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV |
| 141-93 | Recommended Practice for Electric Power Distribution for Industrial Plants ( <b>IEEE Red Book</b> )(R1999) |
| 142-91 | IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems                         |
| 386-95 | Standard for Separable Insulated Connector Systems for Power Distribution Systems above 600 V              |

404-00	Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 to 500000 V
446-95	IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications
592-90	Standard for Exposed Semi-conducting Shields on High Voltage Cable Joints and Separable Insulated Connectors
902-98	Guide for Maintenance, Operation and Safety of Industrial and Commercial Power Systems (Yellow Book)
<sup>A7</sup> C2-07	National Electrical Safety Code (NESC) <sup>A7</sup>

F. **National Electrical Manufacturers Association (NEMA) Standards:**

WC74-(00)	5-46kV Shielded Power Cable for use in the Transmission & Distribution of Electric Energy (ICEA S-93-639)
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G. **National Fire Protection Association (NFPA) Publications:**

70-08	National Electrical Code
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H. **Underwriters Laboratories (UL) Safety Standards**

1072-06	Medium-Voltage Power Cables, Fourth Edition
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**1.03 REQUIREMENTS:**

- A. **General.** Each locks complex shall be provided with a medium-voltage cable system, which shall supply power to the locks and distribute it to the medium-voltage electrical rooms.
- B. **Redundancy Requirements.** <sup>A7</sup>Medium-voltage cable system shall be designed for redundancy so that any one section of the system can be taken out of service for maintenance or repair without compromising the operation of the rest of the medium-voltage cable system and the locks.<sup>A7</sup>
- C. **Design Life:** Medium-voltage cable system shall be designed for a life of 50 years.
- D. **Short-Circuit Capacity:** In addition to the concentric neutral, all medium-voltage cable feeders shall include a # 2/0 AWG bare copper ground conductor installed with the three-phase conductors in the same conduit.

#### 1.04 DESIGN CRITERIA/SYSTEM DESCRIPTION AND PERFORMANCE REQUIREMENTS:

- A. **General:** The medium-voltage cable system installation shall conform to the requirements of IEEE 141; IEEE 142; IEEE 446; IEEE 902; NFPA 70; ANSI/IEEE C2.
- B. **Materials:** This Section contains the specifications for products and materials used for medium-voltage cable installations.
1. **Medium-Voltage Power Cable:** <sup>A7</sup>Shall be single-conductor, concentric-lay-stranded, copper conductor, concentric neutral power cable, sizes as per requirements and with tree-retardant cross-linked polyethylene insulation, a 15-kV 133% insulation level, and polyvinyl chloride jacketing. It shall be able to withstand temperatures of 90 degrees centigrade for continuous normal operation, 130 degrees centigrade for emergency-overload conditions, and 250 degrees centigrade for short-circuit conditions. Cables are intended for general-purpose power use, with applications in wet or dry locations, including conduit, duct, cable tray, direct burial, submersible, and aerial installations. They shall have all black jacketing, but different color markers shall identify each cable phase. The cable shall meet the applicable requirements of ICEA S-94-649, AEIC CS-8, and UL 1072. However, where these specifications exceed the requirements set forth by those standards, these specifications shall apply. Cables shall be in accordance with the requirements of NFPA 70. All cable shall be identified by means of surface ink printing to indicate the manufacturer, conductor size, insulation type, voltage rating, and UL designations.<sup>A7</sup>
- a. **Conductor:** <sup>A7</sup>The conductor shall be soft drawn, Class B stranded, uncoated copper per ASTM B8, with the lengths and sizes required.<sup>A7</sup>
- b. **Conductor Shield:** The conductor shall have an extruded layer of semi-conducting cross-linked polyethylene conductor shielding meeting the requirements of ICEA S-94-649. The thickness of the conductor shield shall be according to AEIC CS-8.
- c. **Insulation:** Cables shall utilize tree-retardant cross-linked thermosetting polyethylene (XLPE) insulation meeting the requirements of ICEA Standard S-94-649. Insulation thickness shall be in accordance with AEIC CS-8.
- d. **Insulation Shielding:**
- 1) A layer of semi-conducting cross-linked polyethylene meeting the requirements of ICEA Standard S-94-649 shall be extruded over the insulation to serve as an electrostatic shield. The shield compound shall be compatible with the insulation and legibly identified as conducting. The thickness of the shielding shall be in accordance with AEIC CS-8. Semi-conducting shielding shall be free stripping from the insulation with a strip tension of 27N to 107N (6 to 24 pounds) when tested in accordance with AEIC CS-8.

- 2) **Metallic Shield:** <sup>A7</sup>Cable rated for a circuit nominal voltage of 15 kV (133% insulation), shall have helically applied, annealed, solid bare copper wires directly over the extruded insulation shield.<sup>A7</sup> This wire shield shall meet the requirements of ICEA Standard S-94-649 and AEIC CS-8.
  - 3) Concentric neutral shall be one-third phase conductor capacity.
  - e. **Outer Jacket:** The cable shall be provided with an overall black PVC jacket. The jacket shall be tight fitting, but allow for free stripping from the insulation shield. <sup>A7</sup>The jacket shall be suitable for dry and wet locations, meeting or exceeding the physical requirements of ICEA Standard S-94-649 and AEIC CS-8 and be sunlight resistant as per UL Standard 1072.<sup>A7</sup> Jacket shall moisture and oil resistant and flame retardant and shall encapsulate the concentric neutral wires.
2. **Medium-Voltage Cable Splices and Terminations:** <sup>A7</sup>Shall be standard products of a manufacturer and suitable for their intended application.<sup>A7</sup> Use of splices is allowed only upon prior approval of the Employer's Representative. Splices shall only be permitted in manholes. All splices shall be certified by the manufacturer for waterproof, submersible applications.
- a. **Inline Splice, 15 kV:** Shall be cold shrink rubber type designed for splicing 15 kV tape or wire-shielded cable. Cable splices shall meet the requirements of IEEE 404.
  - b. **Cable Terminations:** Cable terminations shall be the standard product of a manufacturer, containing all stress cones, tapes, lugs, and required parts. All terminations shall be suitable for their intended application. Terminations, where required, shall be provided with mounting brackets suitable for the intended installation, lugs, and grounding provisions for the cable shielding. Cable terminations shall meet the requirements of IEEE 48.
    - 1) <sup>A7</sup>Indoor kit terminations for the 15 kV, 133% insulation level single-conductor shielded copper cables shall be silicon rubber, cold shrink terminations using standard termination kits providing terminal connectors, and stress cones.<sup>A7</sup> Termination length from the end of the tapered cable jacket to the start of the terminal connector shall be not less than the kit manufacturer's recommendations.
    - 2) <sup>A7</sup>Outdoor kit terminations for the 15 kV, 133% insulation level single-conductor shielded copper cables shall be silicon rubber, cold shrink terminations using standard termination kits providing terminal connectors, and stress cones.<sup>A7</sup> Termination length from the end of the tapered cable jacket to the start of the terminal connector shall be not less than the kit manufacturer's recommendations.

3. **Load-Break Elbow Connectors:** <sup>A7</sup> Shall be standard products of a manufacturer and suitable for their intended application.<sup>A7</sup> Load-break elbow connectors shall be used for connecting underground cables to transformers, switching cabinets, and junctions equipped with load-break bushings.
  - a. **Load-Break Elbow Connectors, 200 amps., 15 kV:** <sup>A7</sup> Shall be molded using high quality EPDM rubber insulation for 15 kV tape or wire-shielded cable.<sup>A7</sup> Load-break elbow connectors shall meet the requirements of IEEE 386.
4. **Cable -Identification tags:** <sup>A7</sup> In manholes (at conduit entrances and splices) and at equipment terminations, the cables shall have identification tags indicating feeder number and routing. (For example, "Feeder 3501" and "To MH-36" or "To SW0893-1B.")<sup>A7</sup> The tags shall be one-inch polypropylene plastic affixed to cables with plastic or nylon ties. Cables shall be tagged in accordance with Section 26 05 53 (*Identification for Electrical Systems*).
5. **Mounting Hardware and Sealant:** Mounting hardware, including flat washers and lock washers, shall be provided for all equipment, and shall be as recommended by the manufacturer, if applicable. In general, hot dip galvanized steel hardware shall be provided for mounting equipment on galvanized structures, and bronze alloy hardware shall be provided for bronze terminals and connectors. The diameter of holes in washers shall be the correct standard size for the bolts on which the washers are used. Insulator supports at manholes shall be as per Section 26 05 43 (*Underground Ducts and Raceways for Electrical Systems*).
6. **Cable-Pulling Lubricant:** <sup>A7</sup> Shall be water-based, non-staining, with residual lubricity, non-hardening or crusting in storage, and suitable for all kinds of cable and conduit.<sup>A7</sup>

## 1.05 SUBMITTALS:

- A. **Before Manufacturing:** Whenever the use of a commercial component is proposed, the Contractor shall clearly indicate it. The preliminary design shall, as a minimum, include the following:
  1. **Descriptive Data:** <sup>A7</sup> Descriptive literature, which shall include manufacturer's name, standard compliance, manufacturer's certifications, and factory tests descriptions. Literature shall establish clearly what the Contractor is furnishing. The descriptive literature and the data sheets will be used for review purposes. Catalog clippings, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the Contract documents shall be submitted for the following, in accordance with Section 01 33 00 (*Submittal Procedures*):<sup>A7</sup>
    - a. Medium-voltage power cable.
    - b. Medium-voltage cable splices and terminations.

- c. Medium -voltage load-break elbows.
- d. Cable-identification tags.
- e. Mounting hardware and sealant.
- f. Cable-pulling lubricant.
- g. <sup>A7</sup>Medium-voltage cable supports and accessories to be installed in cable trenches and manholes.<sup>A7</sup>

**B. Before Shipping:**

1. **Factory-Test Reports:** Submit certified factory-test reports of all factory tests performed by the manufacturer, including tests required by the applicable standards. <sup>A7</sup>Results of factory tests performed shall be certified by the manufacturer or an approved testing laboratory and shall be submitted following successful completion of the tests.<sup>A7</sup>
2. **Installation Manuals and Field-Test Procedures:** Submit copies of installation manuals and field-test procedures for the medium-voltage cables. The manufacturer's pass/fail criteria for field tests shall be included.
3. **Field-Test Plan:** Submit a proposed field test plan prior to testing equipment and subsystems. No field test shall be performed until the test plan has been reviewed by the Employer's Representative. <sup>A7</sup>The test plan shall consist of a complete description of field-test procedures, including tests to be performed, qualifications of personnel performing the testing, test equipment required, and tolerance limits.<sup>A7</sup> After completion of field testing, submit certified field test reports.

**C. Before Installation or Construction:**

1. **Installation Plan:** <sup>A7</sup>Shall be submitted in accordance with the Section 01 33 00 (*Submittal Procedures*) and shall include detailed drawings showing size, spacing, location, layout, and installation details of the medium-voltage cable system.<sup>A7</sup> Cable shall be installed strictly in accordance with the cable manufacturer's recommendations. Each circuit shall be identified as per Section 26 05 53 (*Identification for Electrical Systems*).
2. **Cable-Installation Plan:** A written cable-pulling procedure shall be submitted, describing the proposed equipment and techniques to install the underground cables, as well as the maximum length of cable pull and the cable-pulling tension recommended by the manufacturer. All equipment proposed for use shall be inspected by the Employer's Representative. Calculations of cable-pulling tensions and side-wall pressure values for each section of cable installed shall be submitted for the applicable pull profile: horizontal pull, horizontal bend, slope up, slope down, vertical dip, convex bend down, convex bend up, concave bend down, and concave bend up. <sup>A7</sup>Splices will be allowed only at manholes and shall be limited to

those included in the cable-installation plan.<sup>A7</sup> The cable-installation plan shall include:

- a. Site-layout drawing with cable pulls identified in numeric order of expected pulling sequence and direction of cable pull.
  - b. List of cable-installation equipment.
  - c. Lubricant manufacturer's application instructions.
  - d. Procedure for resealing cable ends to prevent moisture from entering cable.
  - e. <sup>A7</sup>Cable-pulling tension calculations for all cable pulls.<sup>A7</sup>
  - f. Cable percentage conduit fill.
  - g. Cable side wall thrust pressure.
  - h. Cable minimum bend radius and minimum diameter of pulling wheels used.
  - i. Cable jam ratio.
  - j. Maximum allowable pulling tension on each different type and size of conductor.
  - k. Maximum allowable pulling tension on pulling device.
  - l. Location of splices.
3. **Cable-Tension Monitor:** A cable tension monitor shall be used for the cable installation. The monitor shall have a gauge or other device that indicates applied pulling tension and a clutch or other device to allow a preset tension release.
  4. **Cable-Installer Qualifications:** The Contractor shall provide at least one on-site person in a supervisory position with a creditable level of competency and experience to supervise all cable-pulling operations. A resume shall be provided showing the cable installers' experience in the last three years.
  5. **Confined-Space Monitoring Equipment:** <sup>A7</sup>Information on the safety equipment to be utilized at the entry to confined spaces and the procedural responsibilities for monitoring this equipment shall be submitted to the Employer's Representative.<sup>A7</sup>
  6. **General Plan:** General plan arrangement of each lock's medium-voltage cable system, in coordination with the requirements in Section 26 05 73 (*Short Circuit and Load Flow Coordination Study*).
  7. **Cable Data:** Manufacturer's cable damage curve.

**D. Taking-Over Submittal:**

1. **Installation Data:** <sup>A7</sup>Shall be submitted in accordance with the Section 01 33 00 (*Submittal Procedures*) and Section 01 77 00 (*Taking Over Procedures*) and shall include detailed drawing showing size, spacing, location, layout, and installation details for medium-voltage cable system installation, including:<sup>A7</sup>
  - a. Site-layout drawing with all cable pulls numerically identified.
  - b. <sup>A7</sup>A list of all equipment used, with calibration certifications, as well as the manufacturer of and quantity of lubricant used for cable pulls.<sup>A7</sup>
  - c. The cable manufacturer and type of cable.
  - d. The dates of cable pulls, time of day, and ambient temperature.
  - e. The length of cable pull and calculated cable-pulling tensions.
  - f. <sup>A7</sup>The actual cable-pulling tensions encountered during the pulls.<sup>A7</sup>
2. **Reproducible Drawings:** Reproducible drawings shall be provided upon the installation of the medium-voltage cables.
3. **Digital-Computer Drawings:** <sup>A7</sup>The Contractor shall furnish digital format reproducible drawings, as per Section 01 33 00 (*Submittal Procedures*).<sup>A7</sup>
4. **"As-Built" Drawings:** As-built drawings shall be delivered to the Employer's Representative. After delivery, a revised general arrangement plan shall be handed to Employer's Representative. The as-built drawings shall be a record of the construction as installed. The drawings shall include the information shown on the Contract drawings, as well as deviations, modifications, and changes from the Contract drawings, however minor. The as-built drawings shall be marked to reflect deviations, modifications, and changes. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Employer's Representative prior to the completion of the work. The Contractor shall provide marked prints to the Employer's Representative for review.
- <sup>A16</sup>5. **Reserved.** <sup>A16</sup>
6. **Test Reports:** Test reports shall include both routine tests as well as product tests performed. Test reports shall include:
  - a. A list of all equipment used, with calibration certification.
  - b. A copy of all measurements taken.
  - c. The dates of testing.



- d. The equipment and values verified
- e. The condition specified for the test.
- f. The test results, signed and dated.
- g. A description of all adjustments made.

<sup>A16</sup>E. **Reserved** <sup>A16</sup>

**1.06 Quality Assurance:**

- A. **Manufacturer:** <sup>A7</sup>The manufacturer shall be a firm specialized in manufacturing medium-voltage power cables with minimum of ten years' documented experience. <sup>A7</sup>
- B. **Applicable Standards:** The medium-voltage power cable shall be designed and tested by the manufacturer in accordance with applicable ANSI, IEEE, and NEMA standards. <sup>A7</sup>When applicable, certified tests on similar equipment are acceptable. <sup>A7</sup>
- C. **Defective Material:** Defective material or material damaged in the course of shipment, transportation, or testing shall be replaced or repaired in a manner meeting with the approval of the Employer's Representative.
- D. <sup>A7</sup>**Redundancy:** Refer to paragraphs 1.01. A and 1.03.B. <sup>A7</sup>

**END OF SECTION**

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