

SECTION 260519 – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:

1. Section 271500 "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.3 DEFINITIONS

- A. PVC - Polyvinyl Chloride
- B. AWG - American Wire & Gauge

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control reports.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Furnish cables on reels or coils. Each cable and the outside of each reel or coil, shall be plainly marked or tagged to indicate the cable length, voltage rating, conductor size, and manufacturer's lot number and reel number. Each coil or reel of cable shall contain only one continuous cable without splices. Reels shall remain the property of the Owner.
- B. Store in clean, dry space. Protect from dirt, fumes, water, corrosive substances, and construction debris.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications : An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing

Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. 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, Section 3.6.
- B. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Regulatory Requirements:
 1. Comply with NFPA 70 for components and installation.
 2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.8 COORDINATION

- A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 PRODUCTS

2.1 DESCRIPTION

- A. All low voltage conductors shall be copper only. Aluminum conductor is not allowed.
- B. NEMA WC 70; single copper conductor insulated wire; 600 V rated insulation; 90 °C maximum operating temperature for dry and wet or damp locations.
 1. Thermoplastic-insulated wires and cables: NEMA WC 5, UL 83; Type THHN, THWN, THHW, THW-2, THWN-2.

2.2 MATERIALS

- A. Wire Table: Furnish wire and cable in accordance with the requirements of the wire table below, conforming to the detailed requirements specified herein.
- B. Rated Circuit Voltages: All wire and cable shall have minimum rated circuit voltages in accordance with NEMA WC 70 or equal.

2.3 CONDUCTORS AND CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. General Cable Corporation.
 2. Southwire Company.
 3. Allied Wire and Cable.

B. Material for Conductors

1. Conductors shall conform to all the applicable requirements of NEMA WC 70 or equal and shall be ICEA stranded or solid, annealed copper meeting requirements of ASTM B 3, soft drawn. Copper conductors may be bare, or tin- or lead-alloy-coated, if required by the type of insulation used.

C. Size

1. Minimum wire size shall be No. 12 AWG for power and lighting circuits.

D. Stranding

1. Conductor stranding classes cited herein shall be as defined in NEMA WC 70 or equal, as applicable. Lighting conductors No. 10 AWG and smaller shall be solid conductor. No. 8 AWG and larger conductor shall have Class B stranding, or shall meet the requirements of ASTM B 8.

E. Separator Tape

1. Where conductor shielding, strand filling, or other special conductor treatment is not required, a separator tape between conductor and insulation is permitted.

F. Insulation

1. Insulation Material: Provide Polyvinyl Chloride (PVC) insulation meeting the requirements of NEMA WC 70 or equal for all THWN cable types.
2. Insulation Thickness: The insulation thickness for each conductor shall be based on its rated circuit voltage.
 - a. Power Cables, 2,000 Volts and Below - The insulation thickness for single conductor cables rated 2,000 volts and below shall be as required by NEMA WC 70 or equal.

G. Jackets

1. All cables shall have jackets meeting the requirements of NEMA WC 70 or equal, as applicable, and as specified herein. Individual conductors of multiple-conductor cable shall be required to have jackets only if they are necessary for the conductor to meet other specifications herein. Jackets of single-conductor cables and of individual conductors of multiple-conductor cables shall be in direct contact and adhere or be vulcanized to the conductor insulation. Multiple-conductor cables shall be provided with a common overall jacket, which shall be tightly and concentrically formed around the core. Repaired jacket defects found and corrected during manufacturing are permitted if the cable, including jacket, afterward fully meets these specifications and the requirements of the applicable standards.
2. Jacket Material: The jacket shall be one of the materials listed below. Variations from the materials required below will be permitted only if approved for each specific use, upon submittal of sufficient data to prove that they exceed all specified requirements for the particular application.
 - a. Multiconductor
 - 1) Overall jacket - Polyvinyl chloride (PVC) (NEMA WC 70 or approved

- 2) Conductor jacket - Nylon (UL 1581 or UL recognized equal)
- b. Single conductor
 - 1) Nylon (UL 1581 or UL recognized equal)
- 3. Jacket Thickness: The minimum thickness of the jackets at any point shall be not less than 80 percent of the respective nominal thicknesses specified below.
 - a. Multiple-Conductor Cables - Thickness of the jackets of the individual conductors of multiple-conductor cables shall be as required by NEMA WC 70 or equal, and shall be in addition to the conductor insulation thickness required by Column B of Table 3-1 of the applicable NEMA publication for the insulation used. Thickness of the outer jackets or sheaths of the assembled multiple-conductor cables shall be as required by NEMA WC 70 or equal.
 - b. Single-Conductor Cables - Single-conductor cables, if nonshielded, shall have a jacket thickness as specified in NEMA WC 70 or equal. If shielded, the jacket thickness shall be in accordance with the requirements of NEMA WC 70 or equal.

2.4 CABLE IDENTIFICATION

A. Color-Coding

- 1. Single conductor cable shall have a black color insulation or covering.
- 2. Multiconductor cable shall use Method 4 conductor identification per NEMA WC 57.

B. Cabling

- 1. Individual conductors of multiple-conductor cables shall be assembled with flame-and moisture-resistant fillers, binders, and a lay conforming to NEMA WC 70, except that flat twin cables will not be permitted. Fillers shall be used in the interstices of multiple conductor round cables with a common covering where necessary to give the completed cable a substantially circular cross section. Fillers shall be non- hygroscopic material, compatible with the cable insulation, jacket, and other components of the cable. The rubber-filled or other approved type of binding tape shall consist of a material that is compatible with the other components of the cable and shall be lapped at least 10 percent of its width.

C. Dimensional Tolerance

- 1. The outside diameters of single-conductor cables and of multiple-conductor cables shall not vary more than 5 percent and 10 percent, respectively, from the manufacturer's published catalog data.

2.5 REMOTE CONTROL AND SIGNAL CIRCUITS

A. Class 1

- 1. Copper conductor, single insulated wire.
- 2. Insulation type THHN, THHW, XHHW rated 90°C, 600 V insulation class. Degrees C, 600 V insulation class.
- 3. Type XHHW for ambient temperature less than 0°C.

4. UL 83 listed, ASTM B 1 for solid conductors; ASTM B 8 for stranded conductors.
- B. Classes 2 and 3
1. Copper conductor, multiple twisted conductors covered with an overall non-metallic jacket unless otherwise noted.
 2. Insulation type XLE, rated 105°C, 300 V insulation class.
 3. UL listed for use in space in which circuits will be installed
- 2.6 CONNECTORS AND SPLICES, AND TERMINALS
- A. Manufacturers:
1. Hubbell Power Systems, Inc.
 2. O-Z/Gedney; EGS Electrical Group LLC.
 3. 3M; Electrical Products Division
- B. Description: UL 486A-486B, UL 486C, UL 486D, UL 486E; factory-fabricated connectors, splices, and terminals of size, ampacity rating, material, type, and class for application and service indicated.
- 2.7 TERMINATIONS
- A. Compression set, bolted or screw type lug, or direct to bolted or screw type terminal.
- 2.8 PLASTIC CABLE TIES
- A. Nylon or approved; locking type; metallic ties not permitted.
- 2.9 TERMINATIONS
- A. Compression set, bolted or screw type lug, or direct to bolted or screw type terminal.
- 2.10 PLASTIC CABLE TIES
- A. Nylon or approved; locking type; metallic ties not permitted.

PART 3 EXECUTION

3.1 INSTALLATION OF CONDUCTORS AND CABLES

- A. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- B. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- C. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

- D. Identify and color-code conductors and cables according to Section 260553 – Electrical Systems Identification.
- E. Install conductors in a raceway system.
- F. Install conductors only after:
 - 1. Building interior is enclosed and weather tight
 - 2. Mechanical work likely to damage conductors has been completed
 - 3. Raceway installation is complete and supported
- G. Pull conductors into raceway at same time.
- H. Neatly train and lace conductors inside boxes, equipment, and panelboards.
- I. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- J. 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.
- K. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- L. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- M. Wiring at Outlets: Install conductor at each outlet, with minimum 12" of slack.
- N. Install stranded conductors where conductors terminate in crimp type lugs. Do not place bare stranded conductors directly under screws.

3.2 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. Minimum conductor sizes shall be as follows:
- D. No. 12 AWG – Branch circuits of any kind
- E. Minimum conductor sizes shall be as follows:
 - 1. No. 12 AWG – Branch circuits of any kind.
 - 2. No. 16 AWG – Remote control and signal systems, fire alarm system.
- F. Branch wiring length limitations:
 - 1. 208Y/120 V circuits over 100 ft in length: Increase wire size one size for each 100 ft of length. Increase conduit size as required.

2. 480Y/277 V circuits over 150 ft in length: Increase wire size one size for each 150 ft of length. Increase conduit size as required.

3.3 CONDUCTOR INSULATIONS AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Exposed Feeders: Type THHW, THWN, XHHW, rated 75°C for wet locations, single conductors in raceway.
- B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHW, THWN, XHHW, rated 75°C for wet locations, single conductors in raceway.
- C. Exposed Branch Circuits, Including in Crawl Spaces: Type THHN, THW-2, THWN-2, XHHW-2, rated 90°C for dry and wet or damp locations, single conductors in raceway.
- D. Motor Circuit Branch Wiring and Associated Control Wiring: Type THHN, rated 90°C for dry and damp locations, single conductors in raceway, Metal-clad cable, Type MC, stranded. Limit the length of the MC cable whip to maximum length of 6-feet.
- E. Branch Circuits Single Conductors in Raceway: 90°C rated conductors sized at 75°C rating for connection to equipment and devices.
- F. Metal-clad cable, Type MC, use for the following:
 1. For Mechanical Connections only.
 2. Maximum length shall be limited to 6-feet.
- G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless steel, wire-mesh, strain relief device at terminations to suit application.
- H. Feeders from VFD's to motors shall be "VFD" type Belden Classic Symmetrical design with 3 symmetrical bare grounds or equivalent in metal conduit. P/N series 295XX.

3.4 REMOTE CONTROL AND SIGNAL CIRCUITS

- A. Sizing - #16 AWG minimum.
- B. Installation:
 1. All conductors shall be installed in conduits.
 2. Use suitable cable fittings and connectors.

3.5 CONNECTORS, SPLICES, AND TERMINALS

- A. Connectors:
 1. Except where equipment is furnished with bolted or screw type lug, use compression set pressure connectors with insulating covers. Use compression tools and die compatible with connectors being installed.
 2. Use bolt or compression-set type with application of insulating tape, pre-stretched or heat shrinkable insulating tubing for splices and taps of #8 AWG conductors and larger. Install with hydraulic compression tool.

3. Use pre-insulated "twist-on" connectors with integral spring for splices and taps of #10 AWG conductors and smaller.
4. 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-486B.

B. Splices:

1. Splice wires and cable only in accessible locations such as within junction boxes.
2. Make splices to carry full capacity of conductors with no perceptible temperature rise.
3. Use electrical tape to build up insulation level equivalent to cable insulation and cover with not less than two half-lapped layers of plastic electrical tape, for joints, taps, and splices of #1 AWG conductors and larger.
4. Plastic snap-on splice insulators are not allowed.
5. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Terminals:

1. Insulate ends of spare conductors with electrical tape and identify spare circuit number where appropriate.
2. Eye type crimped terminal for removable screw type terminal. Forked torque terminal when screw terminal cannot be removed.
3. Train wires to eliminate fanning of strands, crimp with proper tool and die.
4. Torque screw termination per manufacturer's recommended values.

3.6 CABLE TIES

- A. Neatly bundle conductors and cables together for support. Size cable ties sufficiently to accommodate the multiple cables being supported.

3.7 CONNECTIONS

- A. 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-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

3.8 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

- 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors.

- B. Test 600 volt conductors and cables per NETA requirement.

- 1. Inspection and Test Procedures: Comply with NETA.

- a. Visual and Mechanical Inspection:

- 1) Compare cable data with drawing and specifications.
 - 2) Inspect exposed sections of cables for physical damage.
 - 3) Verify tightness of accessible bolted electrical connections by calibrated torque wrench in accordance with manufacturer's published data or Table 12.
 - 4) Inspect compression-applied connectors for correct cable match and indentation.
 - 5) Verify visible cable bends meet or exceed ICEA and manufacturer's minimum allowable bending radius.
 - 6) For cables are terminated through window-type current transformers, provide an inspection to verify neutral and ground conductors are correctly placed for operation of protective devices.
 - 7) Inspect for correct identification and arrangements.
 - 8) Inspect jacket and insulation condition.

- b. Electrical Tests:

- 1) Perform insulation-resistance test using megohm meter. Applied potential to be 1000 VDC. Individually test each conductor with other conductors grounded. Test duration shall be one minute.
 - 2) Perform continuity tests to insure correct cable connection.

- c. Test Values:

- 1) Insulation-resistance values should not be less than 50 megohms.

- C. Interpret test results in writing and submit to Engineer.

- D. Replace conductors and cables that are found defective, at no expense to Owner

- E. Infrared Scanning:

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
 - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
 - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- F. Test and Inspection Reports: Prepare a written report to record the following:
 1. Procedures used.
 2. Results that comply with requirements.
 3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- G. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 260519