

SECTION 260513 - WIRE AND CABLE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Building Wire - Copper
- B. Building Wire - Aluminum or Copper-Clad Aluminum
- C. Cabling for remote control, signal, and power limited circuits
- D. Metal-clad cable (MC)
- E. Nonmetallic-sheathed cable (NM)

1.2 RELATED WORK

- A. Section 260553 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.3 REFERENCES

- A. NEMA WC 70 - Power Cables Rated 2,000V or Less for the Distribution of Electrical Energy
- B. 2020 NFPA 70 - National Electrical Code (NEC) with 2020 Washington amendments Chicago Building (Electrical) Code
- C. UL 44 - Thermoset-Insulated Wires and Cables
- D. UL 83 - Thermoplastic-Insulated Wires and Cables
- E. UL 854 - Service-Entrance Cables
- F. UL 1581 - Standard for Electrical Wires, Cables, and Flexible Cords

PART 2 - PRODUCTS

2.1 BUILDING WIRE - COPPER

- A. Feeders and Branch Circuits 8 AWG and Smaller: Copper, solid or stranded conductor, 600-volt insulation, THHN/THWN, unless otherwise noted on the drawings.
- B. Motor Feeder from Variable Frequency Drives: Copper conductor, 600-volt XHHW-2 insulation, stranded conductor, unless otherwise noted on the drawings. Three conductor stranded copper, 600-volt XHHW-2 insulation, with copper ground and overall helical copper tape shield. Shield shall be terminated at both ends of cable with an approved termination.

- C. Control Circuits: Copper, stranded conductor 600-volt insulation, THHN/THWN.

2.2 BUILDING WIRE - ALUMINUM OR COPPER-CLAD ALUMINUM

- A. Feeders and Branch Circuits 6 AWG and larger: Aluminum, AA-8000 series alloy, compact stranded conductor, 600-volt insulation, USE-2/RHH/RHW-2 or XHHW-2.
- B. Feeders and Branch Circuits 6 AWG and larger in Underground Conduit: Aluminum, AA-8000 series alloy, compact stranded conductor, 600-volt insulation, USE-2/RHH/RHW-2.
- C. Feeders and Branch Circuits 8 AWG and smaller, aluminum conductors not allowed.
- D. Aluminum conductors shall be terminated with compression lugs, copper plated terminal pins, or manufacturer approved method. Apply anti-oxidation paste. Torque test conductor connections and terminations to manufacturer's recommended values.
- E. Aluminum conductors shall NOT be allowed for the following:
 - 1. When prohibited by the manufacturer of the equipment.
 - 2. Grounding and Bonding.

2.3 CABLING FOR REMOTE CONTROL, SIGNAL, AND POWER LIMITED CIRCUITS

- A. Wire for the following specialized systems shall be as designated on the drawings, or elsewhere in these specifications. If not designated on the drawings or specifications, the system manufacturer's recommendations shall be followed.
 - 1. Fire alarm
 - 2. Low voltage switching and lighting control
 - 3. Other specialized cabling, signal, and power limited cabling. Refer to the appropriate Division 23, 27, or 28 requirements; including, but not limited, to the following:
 - a. Information Technology Backbone and Horizontal Cabling, Division 27.
 - b. Electronic Access Control, Intrusion Detection Systems, Video Surveillance, Division 28.
- B. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600-volt insulation, rated 60C, individual conductors twisted together, shielded, and covered with a PVC jacket.
- C. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60C, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.
- D. Plenum Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60C, individual conductors twisted together, shielded, and covered with a nonmetallic jacket; UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

2.4 FIRE-RATED AND CIRCUIT INTEGRITY (CI) CABLE AND ASSEMBLIES

A. Acceptable fire-rated cables and listed assemblies:

1. MC Cable: Copper conductor, 600V thermoset, low smoke zero halogen silicone rubber insulation, continuously welded corrugated copper armor for equipment grounding conductor, rated 90C, UL listed 2196. MC fire rated cable shall not be used for branch circuits that required redundant equipment ground paths per code.
2. Fire rated cable in EMT or IMC raceway: Copper conductor, 300-volt or ethernet power-limited circuit cables low smoke zero halogen (LSZH), rated 105C. Assembly including raceway shall be UL listed 2196 and UL circuit integrity (FHIT).

2.5 METAL-CLAD CABLE (MC)

- A. Conductors shall be copper, 600-volt insulation, THHN. Metal clad cable shall be constructed in strict accordance with Underwriters Laboratories, Inc. Standard for Metal-Clad Cables, UL 1569, exterior of metal interlocked armor.
- B. Minimum conductor size for branch circuit wiring shall be 12 AWG, with larger wires used where specified.
- C. Metal-clad cables may be used for branch circuit wiring as defined in the Electrical Code, subject to acceptance by State and local codes.

2.6 NONMETALLIC-SHEATHED CABLE

A. Nonmetallic-Sheathed Cable, Size 14 through 4 AWG:

1. Copper conductor, 600-volt insulation, rated 90C, Type NM. Nonmetallic-sheathed cable shall be constructed in strict accordance with Underwriters Laboratories, Inc. Standard for Nonmetallic-sheathed Cables, UL 719.
2. An equipment grounding conductor shall be provided with circuit conductors in all cables. Size per Electrical Code.
3. Nonmetallic-sheathed cables may be used for branch circuit wiring as defined in the Electrical Code. Nonmetallic-sheathed cables shall not be used for other circuits.

PART 3 - EXECUTION

3.1 WIRE AND CABLE INSTALLATION SCHEDULE

A. Above Accessible Ceilings:

1. Metal clad cable, Type MC, 1/2" size with minimum #12 conductors and ground, shall be allowed for flexible whips to individual luminaires on non-essential circuits. The flexible whips shall be between 18" to 72" in length per Electrical Code.

B. Above Grade: All conductors installed above grade shall be type "THHN".

- C. Underground or In Slab: All conductors shall be type "THWN" or "XHHW".
- D. Low Voltage Cable (less than 100 volts): Low voltage cables in ducts, plenums, and other air handling spaces shall be plenum listed. Low voltage cables in non-accessible areas shall be installed in conduit. Low voltage cable may be installed without conduit in accessible areas using the following types of cable supports. Cable support types/systems shall comply with the warranty requirements of the low voltage cable manufacturer.
 - 1. J-hooks
 - 2. Bridle rings with saddle supports

3.2 CONTRACTOR CHANGES

- A.  The basis of design ~~is~~ allows both aluminum and copper conductors installed in ~~raceway~~ MC cables based on ambient temperature of 30C,. Service entrance conductors are based on copper conductor installed in underground electrical ducts. Copper NC and MC cabling is allowed for branch circuiting.
- B. The Contractor shall be responsible for derating and sizing conductors and conduits to equal or exceed the ampacity of the basis of design circuits, if other than the basis of design.
- C. Underground electrical duct ampacity rating shall be in accordance with NEC Table 310.16 (2011 - 2017 edition 310.15(B)(16)) or calculated in accordance with Annex B Application Information for Ampacity Calculation The calculations and a sketch of the proposed installation shall be submitted prior to any conduit being installed.
- D. Conductor length(s) listed on plans and schedules. The drawings are diagrammatic with intent to convey the components of the electrical distribution system. Conductor length(s) when listed on plans and schedules are for engineering calculation purposes. Conductor length(s) shall NOT be used for bidding purposes.
- E. Record drawing shall include the calculations and sketches.

3.3 GENERAL WIRING METHODS

- A. Use no wire smaller than 12 AWG for power and lighting circuits, and no smaller than 14 AWG for control wiring 100 volts or greater.
- B. Low voltage control wiring, use no wire smaller than 18 AWG for low voltage control wiring below 100 volts.
- C. Use 10 AWG conductor for 20 ampere, 120-volt branch circuit home runs longer than 75 feet, and for 20 ampere, 277-volt branch circuit home runs longer than 200 feet.
- D. The ampacity of multiple conductors in one conduit shall be derated per the Electrical Code. In no case shall more than 4 conductors be installed in one conduit to such loads as motors larger than 1/4 HP, panelboards, motor control centers, etc.

- E. Where installing parallel feeders, place an equal number of conductors for each phase of a circuit in same raceway or cable.
- F. Splice only in junction or outlet boxes.
- G. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- H. Make conductor lengths for parallel circuits equal.
- I. All conductors shall be continuous in conduit from last outlet to their termination.
- J. Care shall be taken so as not to subject the cable or wire to high mechanical stresses that would cause damage to the wire and cable.
- K. At least six (6)-inch loops or ends shall be left at each outlet for installation connection of luminaires or other devices.
- L. All wires in outlet boxes not connected to fixtures or other devices shall be rolled up, spliced if continuity of circuit is required, and insulated.

3.4 WIRING INSTALLATION IN RACEWAYS

- A. Pull all conductors into a raceway at the same time. Use UL listed wire pulling lubricant for pulling 4 AWG and larger wires.
- B. Where reels of cable or wire are used, they shall be set up on jacks close to the point where the wire or cable enters the conduit or duct so that the cable or wire may be unreeled and run into the conduit or duct with a minimum of change in the direction of the bend.
- C. Conductor Supports in Vertical Raceways:
 - 1. Support conductors in vertical raceways in accordance with the Electrical Code Spacing of Conductors Supports.

3.5 CABLE INSTALLATION

- A. Provide protection for exposed cables where subject to damage.
- B. Cable fittings, connectors, and supports shall be listed.
- C. Run all open cable parallel or perpendicular to walls, ceilings, and exposed structural members. Follow the routing as illustrated on the drawings as closely as possible. Cable routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatical, unless noted otherwise. The correct routing, when shown diagrammatically, shall be chosen by the Contractor based on information in the contract documents; in accordance with the manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", recognized industry standards; and coordinated with other contractors.

- D. Open cable shall be supported by the appropriate size J-hooks or other means if called for on the drawings. Wire and cable from different systems shall not be installed in the same J-hook. J-hooks shall be sized with 20% spare capacity. J-hooks shall provide proper bend radius support for data cable and fiber cables.
- E. Open cable installed above suspended ceilings shall not rest on the suspended ceiling construction, nor utilize the ceiling support system for wire and cable support.
- F. J-hook support spans shall be based on the smaller of the manufacturer's load ratings and code requirements. In no case shall horizontal spans exceed 5 feet and vertical spans exceed 4 feet. All J-hooks shall be installed where completely accessible and not blocked by piping, ductwork, inaccessible ceilings, etc. J-hooks shall be independently rigidly attached to a structural element. J-hooks shall be installed to provide 2" horizontal separation and 6" vertical separation between systems.
- G. Underground installations; direct buried and conductors within raceways. Provide a warning ribbon with tracer wire at least twelve inches above the underground raceway.
- H. Open cable shall only be installed where specifically shown on the drawings or permitted in these specifications.

3.6 WIRING CONNECTIONS AND TERMINATIONS

- A. Splice and tap only in accessible junction boxes.
- B. Use solderless, tin-plated copper, compression terminals (lugs) applied with circumferential crimp for conductor terminations, 8 AWG and larger.
- C. Use solderless pressure connectors with insulating covers for copper wire splices and taps in exterior locations, 8 AWG and larger. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps.
- D. Lever style insulated splicing connectors, reversible, listed. Application limited to 14-10 awg, stranded/solid, copper conductor, and manufacturer's listing. Obtain Engineer/Owner written approval by Request For Information RFI or addendum prior to use. Example manufacturers Wago lever nuts, Ideal lever connectors.
- E. Thoroughly clean wires before installing lugs and connectors.
- F. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.
- G. Phase Sequence: All apparatus shall be connected to operate in the phase sequence A-B-C representing the time sequence in which the phase conductors so identified reach positive maximum voltage.
- H. As a general rule, applicable to switches, circuit breakers, starters, panelboards, switchgear and the like, the connections to phase conductors are intended thus:

1. Facing the front and operating side of the equipment, the phase identification shall be:
 - a. Left to Right - A-B-C
 - b. Top to Bottom - A-B-C

- I. Connection revisions as required to achieve correct rotation of motors shall be made at the load terminals of the starters or disconnect switches.
- J. Use antioxidant joint compound on all aluminum conductor terminations. Apply antioxidant joint compound per manufacturer's recommendations.

3.7 MC AND NONMETALLIC-SHEATHED CABLE INSTALLATION

- A. MC shall NOT be used for circuits serving the Essential Electrical System.
- B. Cable shall be supported by an approved means every 4.5' and within 12" of outlet boxes, junction boxes, cabinets, or fittings.
- C. Cable may be unsupported in the following conditions:
 1. Cable is no longer than 2' in length at terminals where flexibility is necessary.
 2. Cable is not more than 4.5' from the last point of support for connections within an accessible ceiling to light fixtures or equipment.
- D. Conductor ampacity shall be derated as required by the Electrical Code where more than three current carrying conductors are used.
- E. Each 120 and 277-volt circuit shall have a dedicated neutral conductor. Neutral conductors shall be considered current-carrying conductors for cable derating.
- F. Bending radius shall comply with the requirements listed in the Electrical Code for the type and size of cable being installed, but shall not be less than 5-times the diameter of the cable in any case.
- G. At cable terminations, a fitting shall be provided to protect wires from abrasion, unless the design of the outlet boxes or fittings is such as to afford equivalent protection, and, in addition, an insulating bushing or its equivalent protection shall be provided between the conductors and the armor.
- H. All wiring devices supplied by nonmetallic-sheathed cables shall be mounted in an outlet box.

3.8 FIELD QUALITY CONTROL

- A. Inspect wire and cable for physical damage and proper connection.
- B. Torque test conductor connections and terminations to manufacturer's recommended values.

- C. Provide documentation of the manufacturer's recommended lug torque value for copper and aluminum conductors, the date the lugs were torqued, and installed torque readings. Documentation indicating that the torque wrench has been calibrated not more than 30 days prior to tightening of lugs shall be provided.
- D. Protection of wire and cable from foreign materials:
 - 1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any wire or cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited to, overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid, or compound that could come in contact with the cable, cable jacket, or cable termination components.

END OF SECTION