

SECTION 26 05 19 – WIRE AND CABLES

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide wires and cable, complete and operable, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

- A. The CONTRACTOR shall submit Shop Drawings in accordance with MASS Section 10.05 Article 5.6, and 26 05 00 – Electrical Work, General.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Conductors, include grounding conductors, shall be copper. Aluminum conductor wire and cable will not be permitted. Insulation shall bear the label of Underwriters' Laboratories, Inc. (UL), the manufacturer's trademark, and identify the type, voltage, and conductor size. All conductors except flexible cords and cables, fixture wires, and conductors that form an integral part of equipment, such as motors and controllers, shall conform to the requirements of Article 310 of the National Electric Code, latest edition, for current carrying capacity. Flexible cords and cables shall conform to Article 400, and fixture wires shall conform to Article 402. Wiring shall have wire markers at each end.

2.2 LOW VOLTAGE WIRE AND CABLE

- A. Power and Lighting Wire
 1. Power and lighting wire shall be No. 12 copper AWG minimum size.
 2. Wire rated for 600 volts in duct or conduit for all power shall be
 - a. In above grade interior locations: Class B Type THWN-2
 - b. In underground and below grade installations XHHW-2
 - c. Direct burial shall use XLPE outer jacketed cable.
 3. Wiring for 600 volt class power and lighting shall be as manufactured by **General Cable, Okonite, or Rome Cable**.
- B. Control Wire
 1. Control wire in duct or conduit shall be the same type as power and lighting wire indicated above.
 2. Control wiring shall be No.14 19-strand copper AWG.
- C. Instrumentation Cable

1. Instrumentation cable shall be rated at 600 volts.
 2. Individual conductors shall be No. 18 AWG stranded, tinned copper. Insulation shall be color-coded polyethylene: black-red for two-conductor cable, and black-red-white for three-conductor cable.
 3. Instrumentation cables shall be composed of the individual conductors, an aluminum polyester foil shield, a No. 18 AWG stranded, tinned copper drain wire, and a PVC outer jacket with a thickness of 0.048-inches.
 4. Single pair, No. 18 AWG, twisted, shielded cable shall be **Belden Part No. 9341**, or equal.
 5. Single triad, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 1119A**, or equal.
- D. Tray Cable - Tray cable is not to be used.
- E. Cat 5 Cable: Cat 5 patch cable shall be 4-pair 24-gauge twisted pair rated to TIA/EIA 568-B Cat. SE and UL-listed. The CONTRACTOR shall install RJ-45 connectors as required.
- F. ControlNet RG-6 Coax Cable: The ControlNet coax cable shall be type RG-6 with 75 Ohms impedance. The cable shall have 18-gauge copper conductor, a bonded aluminum foil-polyester tape to braided aluminum shield, quad shield, FEP foam insulation, a PVC jacket and a diameter of 0.25 inches. The cable shall have no more than 3db loss per 100 feet at 200 MHz. The cable shall be **Belden 1189AP**, or equal.
- G. Radio Cable: Feedline cable for radios shall be a 50 ohm low loss 5/8" Helix cable (less than 1.9 db per 100 feet) type suited for 900 MHz and rated for outdoor use with foam core. Provide type N connectors on each end of cable and provide a TNC to type N connector converter for each radio end. Cable shall be **Andrew LDF4.50A**, or equal.
1. Coaxial radio jumper cable inside the SCADA panel shall be **Times Microwave LMR-240**, or equal.
- H. DeviceNet Cable: Shall be 600-volt rated sunlight resistant, 65% braid coverage, UL Listed, **Allen-Bradley DeviceNet Trunk Cable, Type TC**, or equal.
- I. Submersible Pump Power Cable: Submersible pumps shall be wired with submersible multi-conductor cable as required by the Drawings. The cable shall be Type W Portable Power Cable rated at 600V and 70C temperature with (2) #14 control cables. The insulation shall be EPR, and conduction shall be rope-lay-stranded copper per UL-62. The cabling shall be round with round or flat fillers as needed, with an extra-hard usage, oil resistant, thermoset, CPE jacket, per UL-1581. Cable shall be **Flygt SubCab**, or equal.
- J. VFD motor branch cable: Motors circuits operated under VFD control shall be run with shielded cable. Cable shall be **Belden 295xx** (where xx= wire gauge) or VFD Manufacturer recommended equal. Twisted shielded THHN is not permitted.

2.3 CABLE TERMINATIONS

- A. Compression connectors shall be **Burndy "Hi Lug", Thomas & Betts "Sta-Kon,"** or equal. Threaded connectors shall be split bolt type of high strength copper alloy. Pressure type, twist-on connectors will not be acceptable.
- B. Pre-insulated fork tongue lugs shall be **Thomas & Betts, Burndy,** or equal.
- C. General purpose insulating tape shall be **Scotch No. 33, Plymouth "Slip-knot,"** or equal. High temperature tape shall be polyvinyl as manufactured by **Plymouth, 3M,** or equal.
- D. Labels for coding 600-volt wiring shall be heat-shrink plastic tubing type with machine print. Lettering shall read from left to right, and face the front of the panel. Field wires terminating at a Control Panel shall be labeled with the wire number shown on the LCP Panel wiring diagrams. The CONTRACTOR shall mark all as-built drawings with wire labels.
- E. See Section 25 14 05 – Local Control Stations and Miscellaneous Electrical Devices, paragraph 2.4, for a list of pump types.

PART 3 - EXECUTION

3.1 GENERAL

- A. The CONTRACTOR shall provide and terminate all power, control, and instrumentation conductors, except where indicated.

3.2 INSTALLATION

- A. Conductors for feeders as defined in Article 100 of the NEC shall be sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
- B. Conductors for branch circuits as defined in Article 100 of the NEC, shall be sized to prevent a voltage drop exceeding 3 percent at the farthest connected load or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
- C. Conductors shall not be pulled into raceway until raceway has been cleared of moisture and debris.
- D. Pulling tensions on raceway cables shall be within the limits recommended by the cable manufacturer. Wire pulling lubricant, where needed, shall be UL-approved.
- E. The following wiring shall be run in separate raceways:

1. 24 VDC discrete signal and instrument power supply.
 2. 4-20 mA analog signal.
 3. All AC circuits.
- F. Wire in panels, cabinets, and wireways shall be neatly grouped using nylon tie straps, and shall be fanned out to terminals.
- G. Wet Well Conduit Seals: Conduit entering wet wells shall be sealed with duct seal at the end of the conduit where the conduit enters the wet well. Provide cloth rag backing and 1" of duct seal so duct seal can be removed in the future.

3.3 SPLICES AND TERMINATIONS

A. General

1. Wire taps and splices are not to be used unless the CONTRACTOR can convince the ENGINEER that they are essential and the ENGINEER gives written permission.
2. There shall be no cable splices in underground manholes or pullboxes.
3. Stranded conductors shall be terminated directly on equipment box lugs, making sure that all conductor strands are confined within the lug. Use forked-tongue lugs where equipment box lugs have not been provided.
4. Excess control and instrumentation wire shall be properly taped and terminated as spares.

B. Control Wire and Cable

1. Control conductors shall be spliced or terminated only on terminal strips in panels or vendor-furnished equipment.
2. In terminal cabinets, junction boxes, motor control centers, and control panels, control wire and spare wire shall be terminated to terminal strips.

C. Instrumentation Wire and Cable

1. Shielded instrumentation cables shall be grounded at one end only, the receiving end (i.e., in the SCADA panel) on a 4-20 mA system.

D. Power Wire and Cable

1. No 120/208-volt, 120/240-volt, and 480/277-volt branch circuit conductors may be spliced unless the CONTRACTOR can convince the ENGINEER that they are essential and the ENGINEER gives written permission.
2. Shielded power cable shall be terminated with pre-assembled stress cones in a manner approved by the cable and terminal manufacturer. The CONTRACTOR shall submit the proposed termination procedure as a Shop Drawing.

3.4 CABLE IDENTIFICATION

- A. General: Wires and cables shall be identified for proper control of circuits and equipment and to reduce maintenance effort.

- B. Identification Numbers: The CONTRACTOR shall assign to each control and instrumentation wire and cable a unique identification number. Numbers shall be assigned to all conductors having common terminals and shall be shown on "as built" drawings. Identification numbers shall appear within 3 inches of conductor terminals. "Control Conductor" shall be defined as any conductor used for alarm, annunciator, or signal purposes.
1. Multiconductor cable:
 - a. Assign a number that shall be attached to the cable at intermediate pull boxes and at stub-up locations beneath freestanding equipment.
 - b. Cable number shall form a part of the individual wire number.
 - c. Individual control conductors and instrumentation cable shall be identified at pull points as described above.
 - d. The instrumentation cable numbers shall incorporate the loop numbers assigned in the Contract Documents.
 2. All 120/208-volt system feeder cables and branch circuit conductors shall be color-coded as follows:
 - a. Phase A - Black
 - b. Phase B - Red
 - c. Phase C - Blue
 - d. Neutral - White
 3. The 120/240-volt system conductors shall be color-coded as follows:
 - a. Line 1 - Black
 - b. Line 2 - Red
 - c. Neutral - White
 4. The 480/277-volt system conductors shall be color-coded as follows:
 - a. Phase A - Brown
 - b. Phase B - Orange
 - c. Phase C - Yellow
 - d. Neutral - Gray
 5. Color-coding tape shall be used where colored insulation is not available.
 - a. Branch circuit switch shall be Yellow.
 - b. Insulated ground wire shall be Green.
 - c. Neutral shall be Gray.
 6. Color coding and phasing shall be consistent throughout the Site, but bars at panelboards, switchboards, and motor control centers shall be connected Phase A-B-C, top to bottom, or left to right, facing connecting lugs.
 7. General purpose AC control cables shall be Red.
 8. General purpose DC control cables shall be Blue.
 9. Spare cable shall be terminated on terminal screws and shall be identified with a unique number as well as with destination.
 10. Terminal strips shall be identified by computer-printable, cloth, self-sticking marker strips attached under the terminal strip.

3.5 TESTING

- A. Cable Assembly and Testing: Cable assembly and testing shall comply with applicable requirements of ICEA Publication No. S-68-516 - Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy. Factory test results shall be submitted in accordance with Section 01300 – Contractor Submittals, prior to shipment of cable. The following field tests shall be the minimum requirements:
1. Power cable rated at 600 volts shall be tested for insulation resistance between phases and from each phase to a ground using a megohmmeter.
 2. Field testing shall be done after cables are installed in the raceways.
 3. Field tests shall be performed by a certified test organization acceptable to the cable manufacturer. Test results shall be submitted to the ENGINEER for review and acceptance.
 4. Cables failing the tests shall be replaced with a new cable or be repaired. Repair methods shall be as recommended by the cable manufacturer and shall be performed by persons certified by the industry.
- B. Continuity Test: Control and instrumentation cables shall be tested for continuity, polarity, undesirable ground, and origination. Such tests shall be performed after installation and prior to placing all wires and cables in service.

END OF SECTION 26 05 19