

SECTION 16120

WIRE AND CABLE (600 VOLTS AND BELOW)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the contract including General and Special Conditions and General Requirements shall apply to all work under this Section.

1.2 DESCRIPTION OF WORK

- A. Provide 600 volt insulated wire and cable.

1.3 RELATED WORK IN OTHER SECTIONS

- A. Related work in other sections:
 - 1. Electrical General Provisions Section 16010
 - 2. Raceways and Boxes Section 16110
 - 3. Cable Trays Section 16115
 - 4. Wiring Devices Section 16140
 - 5. Electrical Identification Section 16195
 - 6. Switchboards Section 16425
 - 7. Grounding Section 16450
 - 8. Panelboards Section 16470
 - 9. Motor Control Centers Section 16480
 - 10. Individual Motor Controllers Section 16481
 - 11. Luminaries and Accessories Section 16500

1.4 STANDARDS

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
 - 1. General: Underwriters' Laboratories labeling of all insulation and jackets.
 - 2. Rubber Insulated Wire and Cables
 - a) ICEA pub. No. S-19-81 (NEMA Pub. No. WC 3): Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - b) UL 44: Rubber-Insulated Wires and Cables.
 - 3. Thermoplastic Insulated Wire and Cables
 - a) ICEA pub. No. 1 S-61-402 (NEMA Pub. No. WC 3): Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - b) UL 83: Wires, Thermoplastic-Insulated.
 - 4. Cross-Linked Thermosetting-Polyethylene Insulated Wire and Cables
 - a) ICEA pub. No. S-66-524: (NEMA Pub. No. WC 7): Cross-Linked Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - b) UL 44: Rubber-Insulated Wires and Cables.
 - c) UL 854: Service-Entrance Cables.
 - 5. Annealed Copper Wire for Conductors
 - a) ASTM B-3: Soft or Annealed Copper Wire.
 - 6. Insulation Thickness for Individual conductors
 - a) N.E.C. Table 310-13: Conductor Application and Insulation.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver wire and cable to job site on reels or coils marked in accordance with N.E.C. Section 310-11.

PART 2 - PRODUCTS

2.1 WIRE AND CABLE

A. General

- 1. Provide wire with a minimum insulating rating of 600 volts, except for wire, used in 50 volts or below applications for control of signal systems use 300 volt minimum or 600 volt where permitted to be incorporated with other wiring systems.

B. Conductor

- 1. Electrical grade annealed copper, tinned if rubber insulated, and fabricated in accordance with ASTM standards. Minimum size # 12 for branch circuits and # 14 for control wiring.
- 2. The conductors illustrated on the drawings are copper. Except as otherwise noted.

C. Stranding.

- 1. # 12 and # 10 solid.
- 2. Cables larger than # 10, stranded in accordance with ASTM Class B stranding designations.
- 3. Control wires stranded in accordance with ASTM Class B stranding designations.

D. Insulated Single Conductors

- 1. Type THHN/THWN - Flame retardant: Heat-resistant thermoplastic insulation, nylon jacket rated for 90 C dry/75C wet operation. Use for branch circuit wiring.
- 2. Use type THHN/THWN or RHW or XHHW, rated for 90 C, for feeder circuits.

E. Multi-Conductor Power Cable

- 1. Sizes No. 12 AWG through No. 2 AWG as shown on Drawings.
- 2. Suitable for direct burial, duct, open air or conduit installation.
- 3. Temperature Rating: 90 Dry/75 C wet.
- 4. Three uninsulated ground wires for three conductor cables and two uninsulated ground wires for four conductor cables in cable interstices with conductivity of approximately one-half that of one phase conductor.
- 5. Cross-linked polyethylene conductor insulation: insulation thickness satisfying requirements of ICEA Pub. No. S-66-524 (NEMA WC 7), Table 3-1.
- 6. Overall polyvinyl chloride jacket satisfying requirements of ICEA Pub. S-66-524 (NEMA WC 7), Table 4-5.

F. Multi-Conductor Control and Supervisory Control Cables

- 1. Sizes No. 10 AWG.
- 2. Suitable for direct burial, open air, duct, or conduit installation.
- 3. Temperature Rating: 75 C Wet or Dry.
- 4. Uninsulated ground wire.
- 5. PVC or cross-linked polyethylene conductor insulation: thickness satisfying requirements of ICEA Pub. No. S-66-524 (NEMA WC 7), Table 3-1, for cross-linked thermosetting polyethylene insulated conductors or ICEA Pub. No. S-61-402 (NEMA WC 5), for polyvinyl chloride insulated conductors.
- 6. Flame retardant overall polyvinyl jacket satisfying requirements of ICEA Pub. S-61-402 (NEMA WC 5), Table 7.4-2 or ICEA Pub. No. S-55-524 (NEMA WC 7), Table 4-5.

7. Individual conductors bound together with overall binder tape prior to jacket application.
 8. Individual conductors rating of 300 volts (instead of 600 volts) for cables designated Supervisory Control Cable.
- G. Color Coding
1. Provide consistent color coding of all circuits as follows:
 - a) 120/208 volts code
 - i) Phase A - Black.
 - ii) Phase B - Red.
 - iii) Phase C - Blue.
 - iv) Neutral - White.
 - v) Ground - Green.
 - b) 277/480 Volt Code
 - i) Phase A - Brown.
 - ii) Phase B - Orange.
 - iii) Phase C - Yellow.
 - iv) Neutral - Gray.
 - v) Ground - Green.
 2. Color-code wiring for control systems installed in conjunction with mechanical and/or miscellaneous equipment in accordance with the wiring diagrams furnished with the equipment. Factory color code wire number 6 and smaller. Wire number 4 and larger may be color coded by color tapping of the entire length of the exposed ends.
 3. Multi-Conductor Control, Signal, and Communication (100 conductors or fewer per cable): In accordance with Table 5-1, Part 5 of ICEA Pub. S-61-402 (NEMA WC 5).
 4. Substitutions for Color-Coded Wire: with approval of Owner's Representative and where color coding cannot be readily provided because of limited quantities involved, either of the following:
 - a) Plastic tape applied spirally and half-lapped over exposed portions of conductors within manholes, boxes, and similar enclosures.
 - b) Colored tubing cut and inserted over ends of wire prior to installing terminals.
 5. Substitutions for Color Coding for Multi-Conductor Control Cable: Printed conductor identification instead of color-coding is acceptable.

2.2 CONNECTORS

- A. Make connections, splices, and taps and joints with solderless devices, mechanically and electrically secure. Protect exposed wires and connecting devices with electrical tape or insulation to provide protection not less than that of the conductor.

2.3 ELECTRICAL TAPE

- A. Specifically designed for use as insulating tape.
- B. Super 33+ Scotch vinyl electrical tape as manufactured by 3M.

2.4 LUBRICANT

- A. Use lubricant where the possibility of damage to conductors exists. Use only a lubricant approved by the cable manufacturer and one which is compatible with cable and raceways.

PART 3 - EXECUTION

3.1 WIRE AND CABLE

- A. Provide a complete system of conductors in raceway system. All conductors of all systems shall be installed in a raceway system.
- B. Use No. 12 AWG, minimum. For branch circuits whose length from panel to furthest outlet exceeds 100 feet for 120-volt circuits or 200 feet for 277-volt circuits, use number 10 or larger.
- C. Do not install wire in incomplete conduit runs or until after the concrete work and plastering is completed and moisture is swabbed from conduits. Eliminate splices wherever possible. Where necessary, splice in readily accessible pull, junction, or outlet box.
- D. Flashover or insulation value of joints shall be equal to that of the conductor. Provide Underwriters' Laboratories listed connectors rated to 600 volts for general use and 1,000 volts for use between ballasts and lamps or gaseous discharge fixtures.
- E. Use terminating fittings, connectors, etc., of a type suitable for the specified cable furnished. Make bends in cable at termination prior to installing compression device. Make fittings tight.
- F. Apply an anti-oxide inhibitor equivalent to "Penetrox" (Burndy) or "Noalox" (Ideal) to aluminum terminations.
- G. Extend wire sizing for the entire length of a circuit, feeder, etc. unless specifically noted otherwise.

3.2 INSTALLATION

- A. General
 - 1. Provide tools, equipment, and materials to pull all wire and cable into place and to make required splices and termination.
- B. Wire and Cable in Conduit, Duct or Wireway
 - 1. Utilize roller bearing swivel to prevent twisting of cable entering conduit or duct.
 - 2. Take precautions to avoid entrance of dirt and water into conduit and ducts.
 - 3. Clean existing conduits and ducts to remove any pulling compound prior to pulling new cables.
 - 4. Do not damage conductor insulation, braid jacket or sheath.
 - 5. Do not bend conductors to less than manufacturer's recommended radius.
 - 6. Make splices only in pull boxes, junction boxes and outlet boxes.
 - 7. Utilize cable reels on jacks for pulling through pull boxes, ducts and conduits so bends will not be excessive and conductors will not touch sharp edges; use feeding tube where required.
 - 8. For large diameter cables, utilize properly sized pulling grips (endless woven basket two to four feet long of ductile steel).
 - 9. Do not exceed maximum recommended pulling tension of wire and cable.
- C. Splices, Terminations, and Connections
 - 1. General: Except where lugs are furnished with equipment, provide terminals and connectors suitable for quantity, conductor size and direction of entry (top or bottom).
 - 2. Insulated Flanged Terminals: Install for connection of conductors No. 12 AWG and smaller to device terminals; do not exceed three terminals at single connections.

3. Circumferential Compression Type Connectors: Install for splices and connections No. 4 AWG and larger.
 - a) Use for incoming and outgoing cable connections at enclosures and for ground connections.
 - b) Use manufacturer's approved tool and correct hex head that embosses die number on connector lug.
 - c) Make crimped indentations parallel with conductor.
 - d) Fill voids and irregularities with insulation putty.
 - e) Cover neatly with four (4) layers of vinyl plastic tape except where insulated covers are permitted; half-lap tape in two directions.
 - f) Use spring-held bakelite covers over splices or taps only with approval of Owner's Representative.
4. Conductor Arcproofing
 - a) Cover two or more power feeder cables occurring in the same switchboard section, junction box or pull box (including pull boxes over switchboards) with arcproof and flameproof tape.
 - b) Provide tape "Scotch" Irvington Tape No. 7700 or Plymouth Rubber Co. Slipknot No. 30 to provide an insulation capable of withstanding a 200-amp arc for not less than 30 seconds.
 - c) Apply tape in a single layer, half lapped, or as recommended by the manufacturer to conform to the above requirements. Apply with a random wrap of 1/2 inch (15mm) wide pressure-sensitive, plastic film tape color coded as specified in the "conductor identification" paragraph.

3.3 FIELD QUALITY CONTROL

A. Testing

1. Test system wiring for continuity, grounds and short circuits prior to connection of any equipment.
2. Test final equipment connections for continuity of grounds and short circuits.
3. Insulation Resistance of Feeders and Subfeeders
 - a) Test with megger for insulation resistance.
 - b) Correct faults and replace sections with faulty insulation.
 - c) Demonstrate installation is free of grounds and short circuits and that insulation resistance complies with ICEA values.
4. Test direct burial cables after completion of backfilling.

-- End of Section --