

## SECTION 26 05 13

### 300/600 VOLT CABLE, WIRE AND CONNECTORS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 26 00 01, "Electrical General Provisions", govern this Section.

##### 1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide 300 and 600 volt electrical cable, wire, and connector work as shown, scheduled, indicated, and as specified.
- B. Types: The types of 300 and 600 volt cables, wire, and connectors required for the project include, but are not limited to, the following:
  - 1. 600 volt building wire and cable.
  - 2. 600 volt building wire and cable connectors.
  - 3. 600 volt mineral insulated (MI) cable.
  - 4. 600 volt mineral insulated (MI) cable connectors.
  - 5. 600 volt building 2 hr rated wire
  - 6. 300 volt control/signal wire and cable.
  - 7. 300 volt control/signal wire and cable connectors.
- C. Application: The applications for cable, wire, and connectors required on the project are as follows:
  - 1. Power distribution circuitry.
  - 2. Lighting branch circuitry.
  - 3. Appliance, receptacle and equipment branch circuitry.
  - 4. Motor branch circuitry.
  - 5. Control wiring.
  - 6. Outdoor lighting and power.

##### 1.3 STANDARDS:

- A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:
  - 1. NEMA WC 3 Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
  - 2. NEMA WC 5 Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
  - 3. ASTM B3 Standard for Specification for Soft or Annealed Copper Wire for Electrical Purposes.

4. ANSI/UL 83: Thermoplastic – insulated wires and cables.

- B. Where application of applicable codes, Trade Association standards, or publications appears to be in conflict with the requirements of this Section, an interpretation shall be obtained from the Architect/ Engineer.

#### 1.4 QUALITY ASSURANCE:

- A. Manufacturers: Provide products complying with these specifications and produced by one of the following:

1. 600 Volt Building Wire and Cable:

- a. Aetna.
- b. Alcan.
- c. American Insulated Wire Corporation.
- d. Cerro Wire and Cable Company.
- e. Essex Group, Inc.
- f. General Cable Corporation.
- g. General Cable.
- h. Okonite Company.
- i. Republic Wire.
- j. Southwire Company.
- k. United Copper.

2. 600 Volt 2HR rated Building wire and cable.

- a. Drake USA. (2 Hr rated cable)

3. 600 Volt Mineral Insulated Cable:

- a. Des Cables (Wrexham).
- b. Pyrotenax Cable.

4. Type MC Cable:

- a. AFC.

5. Type HCF-90 Cable:

6. AFC

7. 300 Volt Wire and Cable:

- a. Alpha.
- b. Belden.
- c. West Penn.

8. Connectors:

- a. AMP, Inc.
- b. Buchannan.

- c. Burndy Corporation.
- d. O. Z. Gedney Company.
- e. General Electric Company.
- f. Ideal Industries, Inc.
- g. NSI.
- h. Mac Products, Inc.
- i. Minnesota Mining and Manufacturing Company.
- j. Pyrotenax Cable (MI Cable).
- k. Teledyne Penn-Union.
- l. Thomas & Betts Company.

- B. UL Label: All cable, wire, and connectors shall be UL-labeled.

### 1.5 SUBMITTALS:

- A. Shop Drawing submittals shall include, but not be limited to, the following:
  - 1. The Contractor shall submit to the Engineer for review, a list of the proposed manufacturers of wire and cable, cable lugs, cable connectors and termination fittings listed herein. The Contractor may install wire and cable, cable lugs, cable connectors and termination fittings furnished by any manufacturer listed on the approved submittal.
  - 2. Cut sheets on all 300 and 600 volt conductors with manufacturers name, ratings and capacities, insulation characteristics, and available colors, clearly listed.
  - 3. Cut sheets indicating all cable lugs, termination fittings and cable connectors.
  - 4. Cut sheets indicating types of conductor identification bands.
  - 5. **[Information on aluminum wire and cable, conductor and conduit sizing and compression lugs, if the aluminum option is taken.]**
  - 6. Additional information as required in Section 26 00 01.

### 1.6 DELIVERY, STORAGE AND HANDLING:

- A. Provide factory-wrapped waterproof flexible barrier material for covering wire and cable wood reels, where applicable; and weather resistant fiberboard containers for factory-packaging of cable, wire and connectors, to protect against physical damage in transit. Damaged cable, wire, or connectors shall be removed from project site.
- B. Store cable, wire, and connectors in their factory-furnished coverings, and in a clean, dry indoor space which provides protection against the weather.

## PART 2 - PRODUCTS

### 2.1 600 VOLT BUILDING CABLE, WIRE AND CONNECTORS:

- A. General: Except as otherwise indicated, provide cable, wire, and connectors of manufacturer's standard materials, as indicated by his published product information, designed and constructed as instructed by the manufacturer, and as required for the installation.

- B. Wire and Cable: Provide factory-fabricated wire and cable of the size, rating, material, and type as indicated for each service. Where not indicated, provide proper selection as required to comply with installation requirements and with NEC standards. The minimum size wire to be used for power or lighting circuits shall be No. 12 copper with insulation as noted below. Minimum size for control wiring shall be No. 14 standard copper.
- C. Conductors: Provide soft or annealed copper wires meeting, before stranding, the requirements of ASTM B3, "Standard Specification for Soft or Annealed Copper Wire for Electrical Purposes", latest edition.
  - 1. All conductors for power wiring shall be stranded screws and stranded conductors shall be provided for connections to vibrating or movable equipment. Stranded conductors may be terminated on back wired wiring devices where wiring is mechanically secured via a side screw. Conductors for control wiring shall be stranded, or stranded conductors with UL Listed crimp on connectors shall be provided where conductors are terminated under terminal screws.
  - 2. Conductors sized No. 8 AWG and larger shall be stranded. Stranding shall be Class B meeting the requirements of ASTM B8, "Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, or Soft".

[VERIFY ALUMINUM OPTIONS]

- D. Insulation: Insulation shall meet or exceed the requirements of UL 83, "Standard for Thermoplastic Insulated Wires".
  - 1. Insulation for conductors sized No. 10 AWG and smaller shall be UL Type ["**THW**" (rated at 75°C in dry locations and 60°C in wet locations) or] "THHN/THWN" (rated at 90°C in dry locations and 75°C in wet locations).
  - 2. Insulation for conductors sized No. 8 AWG and larger shall be UL Type ["**THW**" (rated at 75°C in dry locations and 60°C in wet locations) or] "THHN/THWN" (rated at 90°C in dry locations and 75°C in wet locations).
  - 3. **Insulation for conductors sized No. 8 AWG and larger shall be UL Type "RHH" for 2 HR fire rated cable (rated at 90°C in dry locations).**
  - 4. All wiring inside lighting fixtures shall be temperature rated per the NEC.
  - 5. Branch circuit wiring within 3" of fluorescent ballasts shall be temperature rated for 90°C.
  - 6. **[In the ceiling areas of equipment rooms where the temperature may exceed 102°F under operating conditions, higher temperature insulation shall be used on conductors. Acceptable types are "RHH", "THHN", and "XHHW".]**
  - 7. **[All branch circuit and grounding conductors from isolation panels in critical care units, in operating rooms, trauma rooms, and delivery rooms of Health Care Facilities shall be XHHW, 600 volt, stranded, with a moisture and heat resistant cross-linked synthetic polymer insulation having a dielectric constant of 3.5 or less, rated at 90°C in dry locations, and 75°C in wet locations. Refer to Section 16670, "Isolated Power Panels and Accessories", for additional requirements.]**
- E. Connectors for Building Wire and Cable: Provide factory-fabricated, metal connectors of the size, rating, material, type, and class required for each use.

2.2 TYPE MC CABLE:

- A. Metal-clad Type MC Cable: At the Contractor's option, and subject to the approval of the local electrical inspection department and where allowed in the NEC, Type MC cable may be used for receptacle circuits in existing walls or modular furniture, switch legs, and lighting fixture connections to the junction box grid system in finished areas. Type MC cable shall consist of two No. 12 AWG copper THHN insulated phase conductors

and one No. 12 AWG green THHN insulated copper ground conductor, all enclosed in cable tape and an aluminum or galvanized steel flexible armor. Type MC cable terminations shall be made using approved anti-short fittings. **Refer to NEC 517 where use is approved by the nec for emergency wiring only in existing walls.**

**[VERIFY THE FOLLOWING HEALTH CARE FACILITIES]**

2.3 TYPE HCF-90 CABLE:

- A. Metal-clad Type HCF hospital grade Cable: At the Contractor's option, and subject to the approval of the local electrical inspection department and where allowed in the NEC, Type HCF cable may be used for receptacle circuits in existing walls or modular furniture, switch legs, and lighting fixture connections to the junction box grid system in finished areas. Type HCF cable shall consist of two No. 12 AWG copper THHN insulated phase conductors and one No. 12 AWG green THHN insulated copper ground conductor, and bare aluminum bonding strip, all enclosed in cable tape and an aluminum or galvanized steel flexible armor with color coded green indicator. Type HCF cable terminations shall be made using approved anti-short fittings. **Refer to NEC 517 where use is approved by the nec for emergency wiring only in existing walls.**

2.4 300 VOLT CONTROL/SIGNAL CABLE, WIRE AND CONNECTORS:

- A. General: Except as otherwise indicated, provide cable, wire, and connectors of manufacturer's standard materials, as indicated by his published product information, designed and constructed as instructed by the manufacturer, and as required for the installation.
- B. Wire and Cable: Provide factory-fabricated wire and cable of the size, rating, material, and type as indicated for each use.
- C. Conductors: Provide soft or annealed copper wires as individual conductors, twisted together or shielded, where required, and meeting, before stranding, the requirements of ASTM B3, "Standard Specification for Soft or Annealed Copper Wire for Electrical Purposes", latest edition.
- D. Conductor Gauge: Provide conductor gauge as required for the application with a minimum of 24 AWG. Conductors shall be stranded or solid as required by the application or manufacturer.
- E. Insulation: Insulation shall meet or exceed the requirements of UL 83, "Standard for Thermoplastic Insulated Wires", and the requirements of NEC Article 725 for Class 2 wiring.
  - 1. Insulation shall be rated for a maximum working voltage of 300 volts; PVC jacket; UL-listed.
  - 2. Insulation of cables used in environmental air spaces shall be nonmetallic jacket UL-listed for use in air plenums.
- F. Connectors: Provide factory-fabricated, metal connectors of the size, rating, material, type, and class required for the application.

**PART 3 - EXECUTION**

3.1 INSTALLATION:

- A. General: Install electrical cable, wire and connectors as shown, in accordance with the manufacturer's written instructions, the applicable requirements of NEC, the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended functions.
- B. Coordination:

1. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.
  2. Installer shall examine the areas and conditions under which cable, wire and connectors are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Inspect wire and cable for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.
- C. 600 Volt Building Wire and Cable:
1. Pull all conductors together when more than one conductor is being installed in a raceway. Where more than nine power conductors are installed in a single conduit, a minimum 50% derating factor shall be applied. Refer to NEC Table 310-15(B)(2)(a).
  2. 2 HR rated cables shall be installed in conduit and supported per UL to provide 2 hour rating.
  3. Mains and feeders are to be run their entire length in continuous pieces without joints or splices[, **unless otherwise indicated or noted**].
  4. Conductors may be run in multiple on sizes No. 1/0 AWG through 600 kcmil inclusive, provided all multiple conductors are the same size, length, and type of insulation, and are so arranged and terminated as to ensure equal division of the total current between all conductors involved.
  5. Before any wire is pulled into 3" and larger conduit, the conduit shall be thoroughly swabbed in such a manner as to remove all foreign material and to permit the wire itself to be pulled into a clean, dry conduit.
  6. Cables shall be selected on the basis of their purpose and UL-listing. Generally, use Types ["**THW**",] "THWN" and "THHN" in building interiors and other dry locations. Outdoors and underground in raceways, use Type "THWN". Conductors subject to abrasion, such as in lighting poles, shall be Type "THWN" or "THHN".
  7. Only non-wax based cable lubricants may be use as manufactured by American Polywater or approved equal may be used as a lubricant where necessary. Wire pulling lubricant shall not be used when installing branch circuit conductors from panelboards with "isolation" transformers.
  8. No conductor smaller than No. 12 AWG shall be used for power or lighting purposes (except light fixture tails). Switch legs shall be No. 12 AWG. Control circuit wiring may be No. 14 AWG minimum, and shall not be run in same conduit with power wiring.
  9. For 120 volt, 20 amp branch circuits with a length of 75' or more to the homerun junction box or first outlet, provide minimum No. 10 AWG conductors to the homerun junction box or first outlet. Where the additional circuit length from the homerun junction box or first outlet to the last outlet exceeds 75', provide minimum No. 10 AWG conductors to the last outlet.
  10. For 208 volt, 20 amp branch circuits with a length of 100' or more, provide No. 10 AWG conductors for the entire branch circuit.
  11. For 208 volt, 30 amp branch circuits with a length of 100' or more, provide No. 8 AWG conductors for the entire branch circuit.
  12. For 277 volt, 20 amp branch circuits with a length of 150' or more, to the first outlet provide No. 10 AWG conductors to the center of the load (minimum first outlet, where there is only one outlet).
  13. Conductors for lighting and power branch circuits shall be of such a size that the drop in potential from the panelboards to the farthest point on the circuits shall not exceed 2% at maximum load and 70% power factor, at 120/208 volts and 1% at maximum load at 277/480 volts.
  14. Lighting fixtures shall not be used for raceways for circuits other than parallel wiring of fixtures.

15. Conductors for connection to individual light fixtures in grid type ceilings from their associated junction boxes, shall be 3 No. 14 AWG THHN copper 600 volt, solid conductors in 72" long 3/8" flexible metal conduit fixture-tails, or by Type MC cable fixture tails where permitted by the local authority having jurisdiction, in lengths not to exceed 8'.
16. All conductors in vertical conduits or raceways shall be supported in the manner set forth in the latest edition of the National Electrical Code.
17. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.
18. Install exposed wire and cable, parallel and perpendicular to surface or exposed structural members and follow the surface contours, where possible.
19. All wire on this project shall be new, unused, in good condition, and shall be delivered in standard coils, package, or rolls. Samples of all wire shall be submitted by the Contractor when requested by the Engineer for the purpose of determining acceptability of the wire.
20. Wire which has been rejected by the Engineer shall not be used again. Decisions as to the quality of the wire furnished and the acceptance of such wire shall be made by the Owner's duly authorized representative.
21. Do not permit conductors entering or leaving a junction or pull box to deflect so as to cause pressure on the conductor insulation.
22. Splices and taps on branch circuits shall occur only when such circuits divide as shown on the drawings and shall consist of one "through" circuit to which the circuit shall be spliced or tapped. Through wiring of receptacles and other devices is not allowed, except for GFI devices noted on the drawings to protect downstream devices..
23. No splices or taps shall be made in any conductor except in outlet boxes, junction boxes, splice boxes, or other devices and equipment in exposed and accessible locations approved for the purpose by the latest edition of the NEC.
24. All wire connections or splices on conductors No. 18 AWG through No. 8 AWG shall be made with pre-insulated spring type connectors. No other type of mechanical connector shall be used for No. 8 AWG and smaller conductors. Polaris taps on #8 is acceptable for motors.
25. **[All copper main service feeder conductors terminated on the "line" side bus of all service entrance switchboards shall be terminated with hydraulically applied high conductivity, copper compression lugs approved for the purpose.]**
26. **[All approved aluminum feeder conductors [No. 1/0 AWG minimum and larger] shall be terminated at each end with hydraulically applied, high conductivity, compression lugs or fittings approved for the purpose.]**
27. All No. 6 AWG and larger copper conductors terminated on the "load" side lugs of all switchboard circuit devices, and the "line" and "load" side lugs of all other devices shall be terminated with set-screw type pressure connectors approved for the purpose or compression type lugs.
28. All No. 6 AWG and larger copper conductors which are to be spliced or tapped in wireways, gutters, or junction boxes shall be spliced or tapped using hydraulically applied, high conductivity compression connectors, or with set-screw type pressure connectors approved for the purpose, using 3-M electrical tape or manufactured connector covers approved for the purpose.
29. The manufacturer's recommended installing tool shall be used for the installation of all hydraulically applied compression type lugs or connectors.

30. Connections to devices (receptacles, switches, etc.) shall be made with individual conductors. The devices shall not be used for "feed-thru" purposes. Where "feed-thru" conditions exist, use "pig-tail" splices as described above. Color coding of "pig-tail" splices shall conform to Section 16100, "Basic Materials and Methods".
31. Support cables above accessible ceilings; do not rest on ceiling tiles. Use spring metal clips or plastic cable ties to support cables from structure. Include bridle rings or drive rings.
32. Multiple circuit wires in bundles or harnesses terminating in control panels, switchboards, panelboards, etc., shall be loosely bundled, trained, and laced to achieve a neat and workmanlike appearance.
33. Surplus wire shall be trimmed to proper length. Do not fold and stuff surplus wires into wiring gutters.
34. Wires exiting harness shall be trained at 90 degree angles to termination point.
35. Refer to Section 16100 for color coding and identification of conductors.

D. 600 Volt Mineral Insulated Cable:

1. Install MI cable, connectors and bands in accordance with manufacturers written instructions. The applicable requirements of the NEC and recognized industry practices to ensure that products serve the intended function.
2. Provide all tools and accessories as required for a complete install.
3. Provide a continuous length of MI cable from source to load as shown. Factory shall provide 2-hour fire-rated joints as required to obtain a continuous length.

**[VERIFY THE FOLLOWING NON HEALTH CARE FACILITIES]**

E. Type MC Cable:

1. Type MC cable may be used, for drops in partitions to receptacles; for lay-in fixture pigtails (8' maximum length); for switch leg drops; from fixture junction boxes to nonlay-in fixtures.
2. Type MC cable shall not be used for branch circuit homeruns. Type MC cable shall not be used for receptacle to receptacle wiring in partitions; where more than three conductors (phase/neutral/ground) are required; where exposed; or in lengths exceeding 20'.
3. Type MC cable in partitions shall be protected in accordance with the requirements of the NEC.
4. Type MC cable shall be supported as specified herein and in accordance with the NEC.
5. Refer to the Drawings for additional requirements concerning the use of Type MC cable.

**[VERIFY THE FOLLOWING FOR HEALTH CARE FACILITIES]**

F. Type HCF-90 Cable:

1. Type HCF cable may be used, where approved by the local authority having jurisdiction and allowed in the NEC: for drops in partitions to receptacles; for lay-in fixture pigtails (8' maximum length); for switch leg drops; from fixture junction boxes to nonlay-in fixtures.
2. Type HCF cable shall not be used for branch circuit homeruns. Type HCF cable shall not be used for receptacle to receptacle wiring in partitions; where more than three conductors (phase/neutral/ground) are required; where exposed; or in lengths exceeding 20'.
3. Type HCF cable in partitions shall be protected in accordance with the requirements of the NEC.
4. Type HCF cable shall be supported as specified herein and in accordance with the NEC.



5. Refer to the Drawings for additional requirements concerning the use of Type HCF [cable.

G. 300 Volt Control/Signal Cable and Wire:

1. Install all low voltage wiring in a suitable raceway except in areas with accessible (lay-in) ceilings unless otherwise noted on Drawings or other Division 16 sections. Where cable is routed without a raceway, bundle all cables and suspend to one foot above ceiling using loop rings on 5'centers. Do not run cable loose on top of suspended ceilings. Do not attach cables to suspended ceiling supports or any mechanical, plumbing, or sprinkler piping. Conceal conduit except in mechanical rooms and areas where other conduit and piping are exposed. Fasten flexible conductors, which bridge cabinets and doors, neatly along hinge side and protect against abrasion. Tie and support the conductors neatly.
2. Remote control wires shall be no smaller than No. 14 AWG. Control wires shall be run in separate conduits. Departures from the sizes so determined shall be made only in those cases in which the National Electrical Code required the use of larger conductors. The sizes as determined from these tables shall be regarded as the acceptable minimum under all other circumstances. In no case, however, shall there be a voltage drop greater than that specified in any feeder or branch circuit. This voltage drop shall be based on the full load, 70% power factor, the total impedance drop of 60 Hz alternating current and with the reactance drop in the respective metal conduits duly considered. The Contractor may, if he deems it necessary or advisable, use larger sized conductors than those shown. Under no circumstances, however, shall the Contractor use any conductors sized in a manner which does not conform to the above mentioned tables without having first secured the written approval of the Owner's duly authorized representative.
3. Number code or color code conductors appropriately for future identification and servicing of the system. Refer to Section 16100 for additional requirements.
4. Make all splices and connections in stranded conductors using UL-approved solderless crimp connectors.

3.2 TESTING:

A. Feeder Insulation Resistance Test: Each new **[and reused existing]** 600 volt feeder conductor shall have its insulation resistance tested after the installation is complete except for connection at its source and point of termination.

1. Tests shall be made using a Biddle Megger or equivalent test instrument at a voltage of not less than 1000 volt dc. Resistance shall be measured between phase, neutral, and ground conductors and from conductors to raceway (ground). Readings shall be taken after 30 seconds and 60 seconds of Megger operation at slip speed and insulation resistance shall not be less than the following:

| <u>Wire Size (AWG)</u> | <u>Insulation<br/>Resistance (Ohms)</u> |
|------------------------|---|
| No. 12                 | 1,000 K                                 |
| No. 10 through No. 8   | 250 K                                   |
| No. 6 through No. 2    | 100 K                                   |
| No. 1 through No. 4/0  | 50 K                                    |
| Larger than No. 4/0    | 25 K                                    |

2. New conductors which do not meet or exceed the insulation resistance values listed above shall be removed, replaced, and retested.
3. **[Where reused existing feeders fail to meet the above insulation requirements, notify the Engineer in writing for direction prior to placing the existing feeders back in service.]**

B. Neutral Testing: After all feeder and branch circuit conductors are terminated, neutral to ground testing shall comply with the following:

1. The resistance of the system's neutral to ground shall be greater than 10 Kohms with the system bonding jumper disconnected.
  2. Repeat neutral ground test for neutrals of separately derived systems.
- C. Pre-energization Check: Prior to energization, check all new **[and reused existing]** branch circuit cable and wire for continuity of circuitry and for short circuits. Correct malfunction when detected. No submittal is required for this test.
- D. Voltage and Current Values: The voltage and current in each main feeder conductor shall be measured and recorded after all connections have been made and the feeder is under load.
- E. Submittals: Contractor shall furnish all instruments and personnel required for tests. Submit four copies of certified test results to Architect for review. Test reports shall include conductor tested, date and time of test, test results, relative humidity, temperature, and weather conditions. Refer to Section 16020, "Electrical Testing", for additional requirements.

### 3.3 AS BUILT DRAWINGS:

- A. Refer to Section 26 00 01 for applicable requirements.

### 3.4 IDENTIFICATION:

- A. Refer to Section 26 00 01 for color-coding and markings for all conductors.

**END OF SECTION 26 05 13**