

PART 1 GENERAL**1.1 RELATED DOCUMENTS**

- A. The requirements of the General Conditions, Supplementary Conditions and the following specification sections apply to all Work herein:
1. Section 26 00 10 - General Requirements
 2. Section 26 00 20 - Scope of Work
 3. Section 26 05 26 - Grounding and Bonding
 4. Section 26 05 33 - Raceways and Boxes
 5. Section 26 08 13 - Testing

1.2 SUMMARY

- A. Furnish and install 600 Volt electrical conductors, as specified herein, and as required for proper distribution of power, lighting and receptacle loads throughout the Project as indicated on the Drawings.

1.3 REFERENCE STANDARDS

- A. All 600 Volt electrical conductors and all components shall be designed, manufactured and tested in accordance with the latest applicable industry standards including the following:
1. UL Standard 83 - Thermoplastic Insulated wires
 2. UL Standard 44 - Thermoset-Insulated Wires and Cables
 3. UL Standard 1569 - Metal Clad Cables
 4. UL Standard 467 - Electrical Grounding and Bonding Equipment
 5. UL Standard 493 - Thermoplastic Insulated Underground Feeder and Branch Circuit Cables
 6. UL Standard 486 - Wire Connectors and Soldering Lugs
 7. NEMA WC-5 - Thermoplastic Insulated Wire and Cable
 8. NEMA WC-7 - Cross Linked Thermosetting Polyethylene Insulated Wire and Cable
 9. NFPA 70 - National Electrical Code (NEC)
 10. UL 2196 - Tests for Fire Resistive Cables
- B. All equipment and material to be furnished and installed on this Project shall be UL or ETL listed, in accordance with the requirements of the authorities having jurisdiction, and suitable for its intended use on this Project.

1.4 SUBMITTALS

- A. The following submittal data shall be furnished according to the General Conditions and Section 26 00 10 and shall include, but not be limited to:
1. Electric Conductors complete with material list, characteristics, dimensions, ratings, lugs, taps, splice materials, etc.
 2. Where aluminum conductors are being utilized, submit a list of the location, size, quantity, conduit size, and termination type of all aluminum conductors.
 3. Proposed test procedures, recording forms, test equipment, and list of personnel and qualifications for all tests proposed. Refer to Section 26 08 13 titled "Testing" for additional requirements.
 4. Field Test Reports:
 - a. Termination Resistance.
 - b. Insulation Resistance.
 - c. Motor Circuits.
- B. All items or equipment listed above with asterisks (*) shall be certified by the manufacturer using Manufacturer Certification "MCA" as set forth in Section 26 00 10. See Section 26 00 10 for certification requirements.

1.5 WARRANTY

- A. Comply with the requirements of the General Conditions and Section 26 00 10.

PART 2 PRODUCTS**2.1 ACCEPTABLE MANUFACTURERS**

- A. If it complies with these Specifications, electrical conductors manufactured by one of the following manufacturers will be acceptable:
1. Electrical conductors, copper, 600 Volt or less:
 - a. American Insulated Wire
 - b. Essex
 - c. Rome
 - d. Southwire
 - e. United Copper
 2. Electrical conductors, aluminum, 600 Volt or less:
 - a. ALCAN Cable
 - b. Southwire
 3. Type "MC" conductor cables, 600 Volt or less:
 - a. AFC
 - b. Encore Wire
 - c. Southwire
 4. Two-Hour Rated Fire Alarm Cable Assemblies:
 - a. DRAKA
 - b. Raychem
 5. Two-Hour Rated Power Cable Assemblies:
 - a. DRAKA
 - b. Raychem
- B. If it complies with these Specifications wire connectors and lugs manufactured by one of the following manufactures will be acceptable:
1. AMP
 2. Burndy
 3. Homac
 4. Ideal
 5. ITT-Blackburn
 6. Thomas and Betts
- C. If it complies with these Specifications cable pulling lubricants manufactured by one of the following manufactures will be acceptable:
1. American Polywater Corporation - Type "J", "LZ", "Wintergrade LZ", Dynablue
 2. Electro-Compound Company – "Poly-Ease" or "Y-ER Ease"
 3. Ideal Industries – "Wire Lube"; "Yellow 77"

2.2 RATINGS

- A. All electrical conductors shall be copper, except electrical conductors #1/0 AWG and larger may be aluminum if they can be terminated as specified hereinafter. All electrical conductors used as grounding electrode or equipment grounding conductors shall be copper.
- B. Copper Conductors: Copper conductors shall be soft drawn annealed copper, having a conductivity of not less than 98% of that of pure copper.
- C. Aluminum Conductors: Aluminum conductors shall be AA-8000 series aluminum alloy.
- D. Conductor Insulation:
1. All copper conductor insulation shall be Type "THHN" or "THHN/THWN", except as specified hereinafter in Paragraph 2.02B.1.b.
 2. All conductors within lighting fixtures shall be temperature rated as required by National Electrical Code, latest edition. Branch circuit conductors within 3" of a fluorescent ballast shall be Type "THHW" or "XHHW".
 3. All AA-8000 Aluminum alloy conductors #1/0 and larger insulation shall be "THHN" OR "XHHW-2".

4. All power conductor insulation where utilized as part of 2-hour fire rated assemblies shall be Type "RHW".
5. All fire alarm conductor insulation where utilized as part of 2-hour fire rated assemblies shall be UL Listed for both NEC FPL per UL 1424 and NEC NPFL per UL 1425.

2.3 GENERAL

- A. Circuit Identification: All circuits shall be identified in accordance with the requirements specified in Section 26 00 10.
- B. Conductor Pulling: Conductor pulling tensions shall not exceed manufacturer's recommended values. Where necessary UL listed lubricants, compatible with the type of insulation involved, may be used to facilitate cable pulling.

2.4 CONDUCTOR SIZES

- A. All feeders and branch circuits shall be sized as indicated on the Drawings or as specified herein. Fixture tap conductors shall not be smaller than #14 AWG and shall be in lengths not greater than 6'-0" nor less than 4'-0". All feeders and branch circuits shall be #12 AWG or larger.
- B. Solid and Stranded Requirements: All wire #8 AWG and larger shall be stranded. All conductors in sizes #10, #12 and #14 AWG shall be solid, except motor branch circuit conductors terminating at the motor termination box and NEC Class 1, 2 or 3 wiring, which may be stranded if terminated and spliced as specified hereinafter.

2.5 TYPE "MC" CONDUCTOR CABLE

- A. If agreeable to the authorities having jurisdiction, Type "MC" conductor cable may be used for conductors connecting receptacle and switch devices to lighting and power circuit junction boxes where concealed in the voids of hung ceilings and hollow partitions. The length of each "MC" cable shall be limited to twenty-five (25) feet. Type MC Cable shall not be used for homeruns or for connections between junction boxes. Type "MC" cable shall comply with the following requirements:
 1. Type "MC" cable shall be steel jacketed, consisting of one (1), two (2), three (3) or four (4) #12 AWG or larger copper "THW", "THHN" or "THHN/THWN" insulated phase and neutral conductors and one #12 AWG or larger insulated ground conductor.
 2. Type "MC" steel jacketed cable termination fittings shall be T&B #253, O-Z Gedney C5, Steel City Series XC-400 or approved equal clamp type, malleable iron fittings. Die cast fittings are not acceptable.

2.6 TWO-HOUR RATED CABLE ASSEMBLY

- A. Two Hour Rated Cable Assemblies: Complete cable system shall have a two-hour fire rating as Listed and Classified by Underwriters Laboratories, Inc. or ETL.
 1. Two-hour rated cable assemblies or two-hour rated cable systems that are approved by the authority having jurisdiction shall be used in lieu of two (2) inch concrete encasement or routing in two (2) hour fire rated enclosure for the following applications:
 - a. Trunk cabling for fire alarm detection and annunciation.
 - b. Feeders for fire pumps.
 - c. Emergency feeders.
 - d. Life Safety feeders.
 2. Conduit sizes shall be adjusted to accommodate the larger diameter conductors per the national electrical code.

2.7 CONNECTORS

- A. Copper Conductors: All #6 AWG and larger copper conductors shall be connected with high conductivity, wrought copper, color keyed compression connectors.
 1. Terminations: Thomas & Betts Series 54200 (or approved equal) two hole connectors shall be used. Exceptions are as follows:

- a. Where equipment or device cannot be provided by the manufacturer to accept two hole connectors, T&B Series 54100 (or approved equal) single hole connectors with antirotation lug or restraint shall be used.
 - b. Where equipment or devices cannot be provided by the manufacturer to accept either two-hole or single hole compression connectors, set screw type connectors may be submitted. For a set screw connector to be considered by the Engineer, the manufacturer of the equipment being connected shall provide certification with the equipment submittals that the equipment will not accommodate the required compression connectors. Refer to the individual equipment specifications for additional termination requirements. See Section 26 00 10 for certification requirements.
 2. Copper to Copper Splices, if allowed, shall be with T&B Series 54500 (or approved equal) compression connectors.
 3. Tapping of Copper Conductors shall be with T&B Series 54700 (or approved equal) compression taps.
 4. Connectors shall be suitable and specifically listed for use on a current carrying conductor or on grounding and bonding conductor as appropriate for its use on this Project. Connectors used on grounding and bonding conductors be meet UL467 Grounding and Bonding Equipment requirements and shall be UL listed and labeled appropriately for the application.
 5. All #8 AWG and smaller solid conductors shall be spliced with preinsulated spring connectors. Connectors shall be Scotch-lok, Buchanan B-Cap or approved equal. All #10 AWG and smaller stranded conductors for NEC Class 1, 2 or 3 wiring shall be terminated with AMP, Inc. "PIDG", UL listed premium grade insulated compression fork connectors or approved equal and shall be spliced in a junction box with AMP, Inc. "Plastic-Grip" UL listed, standard grade insulated butt splices or approved equal. All motor branch circuit conductors terminating at the motor termination box shall be spliced with compression type connectors.
 6. No modifications to any connector or fitting shall be permitted.
 7. The approved connector manufacturer's recommended installation tool and procedures shall be used.
 8. Water chilling unit motor terminations shall be made with compression connectors, which accommodate the conductor size indicated on the Drawings and have a hole size to fit the water chilling unit motor connection stud. Subcontractor shall coordinate the compression connector with the water chilling unit manufacturer's termination requirements. Field modification to the compression lug or the motor stud will not be permitted.
 9. All bolt and screw connections shall be torqued in accordance with the manufacturer's recommendations. Subcontractor shall include a copy of the manufacturer's recommendations with all applicable submittals.
- B. Aluminum Conductors: Aluminum conductors shall be series AA-8000 alloy aluminum and are permitted in sizes #1/0 AWG and larger, where terminated as specified hereinafter. The Electrical Subcontractor shall adjust conduit size as necessary for the cable size selected to satisfy the National Electrical Code percentage fill requirements and shall submit to the Engineer for review, a list of each location where aluminum conductors will be utilized, the size of the conductors and conduit, and the type termination to be utilized. Cable size shall be sufficient to limit voltage drop to that of the copper wire it is replacing. All aluminum conductors shall be terminated with compression fittings (no exception). The Electrical Subcontractor shall provide copper conductors of the size indicated on the Drawings, instead of aluminum conductors, for all electrical equipment that will not properly accept compression fittings. In all cases, conductors for all grounding electrode and equipment grounding conductors shall be copper. All aluminum conductor insulation shall be Type "THW", "THHN" or "XHHW" black cross linked polyethylene Type "USE".
1. Terminations: All #1/0 AWG and larger aluminum conductors shall be terminated with high conductivity wrought aluminum, color keyed compression connectors. Thomas & Betts Series 60200 (or approved equal) two hole connectors shall be used. Exceptions are as follows:
 - a. Where equipment or devices cannot be provided by the manufacturer to accept two hole connectors, T&B Series 60100 (or approved equal) single hole connectors with antirotation lug or restraint shall be used.
 - b. Where equipment or devices cannot be provided by the manufacturer to accept either two hole or single hole connectors, T&B Series 61100 (or approved equal) reduced size, single hole connectors with antirotation lug or restraint shall be used in place of mechanical connectors where these lugs are provided with the equipment or device.
 - c. The Subcontractor must provide adequate space to accommodate compression fitting terminations when purchasing electrical equipment. If space cannot or is not provided, the conductors shall be changed to copper (no exceptions). The use of cable adapters (aluminum to copper) is not acceptable.
 2. "Bellville" Type compression washers shall be used with all aluminum terminations. T&B Series 60800 (or approved equal).

3. All aluminum connection surfaces shall be wire brushed prior to termination.
4. Aluminum to Aluminum Splices, if allowed, shall be with T&B Series 60500 (or approved equal) compression connectors.
5. Tapping of Aluminum Conductors shall be with T&B Series 63100 (or approved equal) compression taps.
6. Connectors shall be suitable and specifically listed for use on a current carrying conductor or on a grounding and bonding conduit as appropriate for its use on this Project.
7. No modifications to any connector or fitting shall be permitted.
8. The approved connector manufacturer's recommended installation tool and procedures shall be used.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Splicing and Tapping: Conductors shall not be spliced between the points of origin and termination as shown on the Drawings. Exception: If splices are necessary, their use must be approved in writing by the Engineer before installation. Splices, if allowed, and taps shall be made in boxes or gutters.
- B. Transformers with pigtails shall be terminated as specified for splices, for the size of conductor involved.
- C. The installation of Two-Hour Fire-Rated Cable Assemblies shall be conducted in accordance with UL and the manufacturer's recommendations including cables, conduit, cable supports, pull boxes, termination boxes and all items required to maintain the UL Listed and Classified 2-hour fire rating.
- D. Vertical Supports:
 1. Conductors in vertical raceways shall be supported at intervals as required by the National Electrical Code. Provide additional supports if so indicated on the Drawings. Supports shall be of the insulating type and shall be installed in suitable boxes with covers. Insulated supports shall properly secure the conductors and shall have the strength to carry the weight of the conductors attached thereto.
- E. Terminations: Terminations shall be performed using the manufacturers recommended tools, hardware, and procedures. Bolted terminations shall be bolted to torque levels in accordance with equipment manufacturers published data utilizing a torque wrench that has been calibrated and is appropriate for the application. In the absence of connector or equipment manufacturer's recommended torque values, use those specified in UL 486A and UL 486B.

3.2 COLOR CODING

- A. All branch or distribution circuit conductors No. 8 AWG and smaller shall have continuously color-coded insulation as follows or as required by the authorities having jurisdiction.
 1. 208Y/120 Volts System:
 - a. Phase A: Black
 - b. Phase B: Red
 - c. Phase C: Blue
 - d. Neutral: White
 - e. Ground: Green.
 2. 480Y/277 Volts System:
 - a. Phase A: Brown
 - b. Phase B: Orange
 - c. Phase C: Yellow
 - d. Neutral: Gray
 - e. Ground: Green
- B. All conductors larger than No. 8 AWG shall have color coded tape as described above; installed on conductors at all equipment terminations and where conductor passes through pull boxes.

3.3 FACTORY TESTING

- A. All electrical conductors shall be tested in accordance with the latest applicable industry standards.

3.4 FIELD TESTING

- A. Prior to execution of testing, submit test procedures, recording forms, and test equipment to the Engineer for review. Refer to Section 26 00 20 titled "Scope of Work" for "Scheduling Procedures".
- B. Termination Resistance:
1. Tests shall be performed with low-resistance ohmmeter to measure resistance of all bolted terminations. Compare resistance measurements between like terminals. Where resistance is measured to be 50% or above the lowest terminal reading, adjust, or replace termination until resistance is within 50% of lowest reading. For compression connectors, the resistance measurement shall include both the compression connection and the bolted termination.
 2. The Subcontractor shall record and tabulate readings observed at terminations for all Aluminum conductors and all copper conductors # 3/0 and larger. These tabulated field test results shall be submitted by the Subcontractor for review. Field test reports shall include, but not be limited to:
 - a. Test performed.
 - b. Test procedure.
 - c. Conductor section tested and conductor description (Manufacturer, size, type, rating, location, etc.).
 - d. Termination Type (ie: two (2) hole compression connector; bus connection).
 - e. Date(s) and time(s) of test.
 - f. Weather conditions including temperature and relative humidity.
 - g. Test criteria.
 - h. Test results.
 - i. Percent variation above the lowest reading of like terminal (shall not exceed 50% above lowest terminal reading).
 - j. Additional pertinent data.
 - k. Instruments including documentation that such instruments were properly calibrated at the time of the testing.
 - l. Personnel printed name, title, company, and signature of persons who performed the test.
- C. Insulation Resistance:
1. Insulation resistance of all conductors shall be tested. Each conductor shall have its insulation resistance tested after the installation is completed and all splices, taps and connections are made except connection to or into its source and point (or points) of termination. Each conductor shall have insulation resistance tested with respect to ground and adjacent conductors within the same raceway.
 2. Insulation resistance of conductors, which are to operate at 600V or less shall be tested by using Biddle (or approved equal) Megger with an output of not less than 1000V DC. Resistance shall be measured by connecting one terminal of Megger to conductor and other terminal to conduit in which conductor is installed. Reading shall be observed after 15 seconds of operation of the Megger. Insulation resistance of conductors rated at 600V shall be not less than one (1) megaohm (1,000,000 ohms) or the latest NEMA (IPCEA) Standard requirement for the conductor type.
 3. Conductors that do not exceed insulation resistance values listed above shall be removed and replaced and test repeated. The Subcontractor shall furnish all instruments and personnel required for tests.
 4. For all conductors size #3/0 and larger, the Subcontractor shall tabulate readings observed and shall forward test readings to the Engineer for review. Any conductor or splice, which is found defective, shall be promptly removed and replaced and additional tests shall be performed. Field test reports shall include, but not be limited to:
 - a. Test performed.
 - b. Test procedure.
 - c. Conductor section tested and conductor description (Manufacturer, size, type, rating, location, etc.).
 - d. Date(s) and time(s) of test.
 - e. Weather conditions including temperature and relative humidity.
 - f. Test criteria.
 - g. Test results.
 - h. Additional pertinent data.
 - i. Instruments including documentation that such instruments were properly calibrated at the time of the testing.
 - j. Personnel printed name, title, company, and signature of persons who performed the test.
- D. Motor Circuits:
1. A record of current and voltage for all motors 10 horsepower and larger shall be provided. These readings shall reflect normal operating conditions and include all line-to-line voltages and line currents.

Subcontractor shall tabulate readings observed and shall forward test results to the Engineer for review. Each test shall be signed by party making the test. Field test reports shall include, but not be limited to:

- a. Test performed.
 - b. Test procedure.
 - c. Motor description (identification, horsepower, location, etc.)
 - d. Date(s) and time(s) of test.
 - e. Line-to Line-Voltage (A-B, B-C, C-A).
 - f. Line-Current (per phase).
 - g. Additional pertinent data.
 - h. Instruments including documentation that such instruments were properly calibrated at the time of the testing.
 - i. Personnel printed name, title, company, and signature of persons who performed the test.
2. Coordinate this testing with each trade to simulate normal operation and to insure safe operation of the equipment during the test procedure.
- E. Refer to Section 26 08 13 for additional testing requirements for electrical conductors.

END OF SECTION