

**SECTION 260518 - WIRE & CABLE**

- 1.0 ASHRAE 90.1 Compliance: University of Pennsylvania buildings shall comply with the Commercial Energy Efficiency Requirements of ASHRAE Standard 90.1-2016. The ASHRAE 90.1-2016 compliance paths shall be followed instead of the International Energy Conservation Code (IECC) requirements as permitted by 2018 IECC Section 401.2 Application.
- 2.0 All wiring and cables shall conform to the latest NFPA 70 and applicable ASTM and NEMA Standards and shall be UL Listed for the application.
- 3.0 Conductor Material:
  - A. Comply with NEMA WC 70/ICEA S-95-658 for types THHN/THWN and XHHW-2.
  - B. All conductors shall be copper.
  - C. Aluminum conductors shall not be installed.
- 4.0 Building Wire and Cable:
  - A. Description: Single, annealed, conductor, insulated wire; 98 percent conductivity at 20 degrees C. Wires and cables manufactured more than 12 months prior to date of delivery to site shall not be used.
  - B. Insulation Voltage Rating: 600 volts.
  - C. Insulation Temperature Rating: 90 degrees C.
  - D. Insulation Material: Thermoplastic - dual rated THHN/THWN-2 or XHHW-2
  - E. Use solid conductor for wire sizes 12 AWG and smaller. Larger conductors shall be stranded.
  - F. Use stranded conductors for all control and communication circuits.
  - G. High Temperature Areas: Wire installed in areas and locations subject to temperature unsafe for the thermoplastic insulation shall be heat resistant and be type V, FEP, TFE, SA OR Z as required.
  - H. All feeder and branch circuits shall be installed with a suitably sized (in accordance with NEC requirements) equipment grounding conductor, to be run with the phase and neutral conductors. Metallic conduit systems shall not be used as the equipment grounding conductor.
  - I. All secondary conductors for separately derived sources shall be run with a suitably sized (in accordance with NEC requirements) grounding electrode conductor. Metallic conduit systems shall not be as the grounding electrode conductor.
  - J. All splices, including low voltage or Class 2 wiring, shall be made in suitable enclosures or boxes.

- K. Acceptable manufacturers – building wire:
  - 1. Southwire Company
  - 2. American Insulated Wire Corp
  - 3. General Cable Corporation
  - 4. Senator Wire and Cable Company
- L. Shielded, twisted pairs for wiring of analog inputs and outputs to BAS and similar systems shall be Belden # 8760. Shielded, twisted triads for wiring of RTD inputs to BAS and similar systems shall be Belden # 8770.

#### 5.0 Medium Voltage Cable (5 kV and 15 kV)


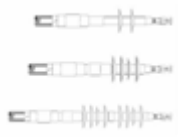


- A. Comply with UL 1072, AEIC CS 8, ICEA S-93-639, and ICEA S-97-682.
- B. Description: Single, annealed, stranded conductor, 98 percent conductivity at 20 degrees C., semiconducting EPR conductor shield, EPR dielectric insulation - 133% thickness, 5 mil copper tape shield wound @ 12.5% overlap, PVC outer jacket. Wires and cables manufactured more than 12 months prior to date of delivery to site shall not be used.
- C. Multi-conductor medium voltage cable assemblies (other than triplexed single conductors) shall not be used unless permission is obtained from the University Engineer Department.
- D. Medium voltage cable shields shall be solidly grounded at every splice or termination.
- E. All medium voltage circuits shall include a suitably sized (in accordance with NEC requirements) equipment grounding conductor, to be run with the phase conductors. Do not use metallic conduit systems as the equipment grounding conductor.
- F. Acceptable manufacturers – medium voltage cable:
  - 1. Okonite
  - 2. Southwire
  - 3. Prysmian (formerly Pirelli)
  - 4. General Cable Tech
- G. Cables shall be continuous. Splices are not permitted, unless permitted by the University.

#### 6.0 Connectors and Splices:

- A. UL-Listed, factory-fabricated, wiring connectors of size, ampacity rating, material, type, and class for application and for service indicated. Cable termination lugs shall be compression type.
- B. All low voltage cable splices in manholes or handholes shall be made using University Engineering Department approved kits from Tyco, 3M, Polaris or Elastimold.
- C. All medium voltage terminations and splices shall be made using heat shrink or cold shrink splice and termination kits from Tyco (Raychem), 3M, or Elastimold.
- D. All disconnectable medium voltage cable elbows shall be Richards (preferred) or Elastimold.

- 7.0 Color Coding:
- A. 120/240V, 1 Phase: Black, Red, White, Green.
  - B. 120/208V, 3 Phase: Black, Red, Blue, White, and Green.
  - C. 277/480V, 3 Phase: Brown, Orange, Yellow, Gray, and Green. This also applies to 277V lighting branch circuits (apply color code to maintain phase identity).
  - D. Isolated Ground Conductors: Green with yellow tracer(s).
  - E. Medium Voltage, 3 Phase: Identify each phase with the letters A, B and C.
- 8.0 Refer to Section 260553 – Electrical Identification for additional requirements.
- 9.0 ASHRAE 90.1-2016 Compliance Requirements: Perform all required voltage drop calculations to confirm that the total voltage drop on each feeder circuit does not exceed the smaller of the guidelines outlined in ASHRAE Standard 90.1-2016. The feeder conductors and branch circuits combined shall be sized for a maximum 5% voltage drop total.
- 10.0 Pulling tension calculations shall be performed to confirm that the allowable (per code or manufacturer requirements) pulling tension and side wall bearing pressure is not exceeded. Use manufacturers approved non-conductive pulling compound or lubricant.
- 11.0 A dedicated neutral shall be installed with each lighting and appliance panelboard branch circuit. A shared neutral is not permitted. For electrified furniture systems, the preferred furniture wiring arrangement is to provide a separate neutral for each phase conductor. If a shared neutral is provided in electrified furniture, a common neutral of #10 minimum size shall be provided in the branch circuit(s).
- 12.0 As a minimum, cables shall be sized in accordance with the National Electrical Code. The cable sizing shall also take into consideration future loads/upgrades which may be planned, force-cooled transformer ratings, etc. Cable ampacities shall be taken from the applicable tables in NEC article 310. Where required by installation conditions, appropriate de-rating factors required by the NEC shall be applied.
- 13.0 In areas where solid-state power supplies for computers or instrumentation are used (for example, in laboratories, server/IT rooms, data centers, etc.), the design shall be based on the effect of harmonics. In such cases, the harmonic design shall include mitigation strategies including K-rated transformers, oversized feeder neutrals, and panelboards with 200 percent neutral bus. K9 transformers shall be used in laboratory branch circuit applications.
- 14.0 Minimum conductor sizes:
- A. Power circuits: No. 12 AWG, minimum.
  - B. Controls circuits: No. 14 AWG, minimum.

15.0 PRODUCTS

|                            |   |
|----------------------------|---|
| <p>Low voltage splices</p> |   |
| <p>15 kV Terminator</p>    |   |
| <p>15 kV Splice</p>        |   |
| <p>15 kV Elbow</p>         |  |