SECTION 25 0519

LOW VOLTAGE ELECTRICAL CONDUCTORS AND CABLES

FOR BAS ELECTRICAL SYSTEMS

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LANL MASTER SPECIFICATION SECTION

Word file at <https://engstandards.lanl.gov>

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| Rev. 2 Summary of changes: Minor clarifications throughout. |

This template must be edited for each project. In doing so, Specifier must add job-specific requirements. Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.  Once the choice is made or text supplied, remove the brackets.  Also, edit to delete specification requirements for processes, items, or designs that are not included in the project -- and specifier’s notes such as these.

To seek a variance from requirements that are applicable, contact the Engineering Standards Manual Chapter 8[POC](https://engstandards.lanl.gov/POCs.shtml#ic). Please contact POC with suggestions for improvement as well.  
  
When assembling a specification package, include applicable Sections from all Divisions, especially Division 1, General requirements.  
  
Section developed for ML-4 projects.  For ML-1, 2, and 3 applications, additional requirements and independent reviews should be added if increased confidence in procurement or execution is desired; see ESM Chapter 1 Section Z10 Specifications and Quality sections.

NOTE: This Section overrides Division 26 electrical installation requirements for BAS systems only. If the designer wishes to use Division 26 installation requirements for specific portions of the BAS design, then these must be clearly noted on the drawings as a deviation from this Section.

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1. GENERAL
   1. SECTION INCLUDES
      1. Conductors and cable used for low voltage (<100 VDC and < 50 VAC) building automation systems (BAS)
         1. BAS wire (600 V/300 V)
         2. BAS cable (300 V)
         3. Wire and cable connectors
         4. Wire pulling lubricant
   2. LANL-Performed Work
      1. None
   3. QUALITY ASSURANCE
      1. Comply with the *National Electrical Code* (NEC) for installation requirements.
      2. Provide products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL)
   4. ACTION SUBMITTALS
      1. Submit the following per Section 01 3300 Submittal Procedures:

NOTE: Submittals not required when supplying parts specifically called out on design drawings or listed by manufacturer and model number in LANL’s standard BAS product list.

* + - 1. Catalog Data: BAS wire
      2. Catalog Data: BAS cable
      3. Catalog Data: Compression connectors.
  1. Receiving, Storing and Protecting
     1. Receive, store, protect, and handle products per NECA 1, *Standard Practices for Good Workmanship in Electrical Construction*.

1. PRODUCTS
2. PRODUCT OPTIONS AND SUBSTITUTIONS
   * 1. Refer to Section 01 2500 Substitution Procedures.
3. WIRE for bas applications
   * 1. Provide NRTL-Listed wire with the following characteristics:
        1. Description:
           1. Single-conductor, 600 V insulated wire.
        2. Conductor:
           1. 18 to 14 AWG Copper
           2. Stranded
        3. Insulation: the following types
           1. Type THHN/THWN-2 Per UL Standard 83
           2. Type MTW per UL Standard 1063
           3. Type TFFN per UL Standard 1408
           4. Type MTW per UL Standard 1015   
              Used in BAS control panel fabrication only
        4. Exceptions:
           1. If alternate types or sizes are specified on the Drawings they shall be used in place of the above.
           2. If the BAS manufacturer installation instructions indicate alternate type or sizes are required for installation, they shall be used in place of the above.
     2. Color-code conductors as follows:
        1. Use the following color codes for low-voltage Class 2 power system conductors:
4. Positive DC: Red  
   Ungrounded AC: Yellow
5. Negative DC: Black  
   Grounded AC: Blue

2. Exception: If colors are specified on the Drawings, they shall override the colors above.

1. Cable for bas applications
   * 1. Provide NRTL-listed cable with the following characteristics:
        1. Description:
           1. Multi-conductor 300 V insulated cables.
           2. Multi-conductor 600 V insulated cables where the separation distances and requirements of NEC 725.136 cannot be met, or, when the cable required for the application is only available with 600 V insulation.
        2. Conductor:
           1. 22 to 18 AWG Copper
           2. Stranded
           3. Shield with drain wire when specified in drawings
           4. Maximum 12 conductors plus a shield conductor per cable
           5. Cables used for BACnet MSTP, Arcnet, MODBUS RTU, and similar RS-485 type communications shall be 2 conductors, shielded, twisted pair, low capacitance (~22pF/ft) cable unless specified otherwise in Drawings. Cables used for this type of application shall have an orange outer jacket.
        3. Cable Type:
           1. All cable types approved under NEC Article 725 when installed per NEC Article 725 requirements.
        4. Exceptions:
           1. If alternate types or sizes are specified on the Drawings, they shall be used in place of the above specifications in Para. 2.3.A.
           2. If the BAS manufacturer installation instructions indicate alternate type or sizes are required for installation, they shall be used in place of the above specifications in Para. 2.3.A.
     2. Color-code conductors as follows:
        1. Use the following color codes for low-voltage Class 2 power system conductors found in cables:

Positive DC or Ungrounded AC: Red

Negative DC or Grounded AC: Black or Green

Signal Wire: White

Network Wire + Signal: White or Red

Network Wire – Signal: Black

* + - 1. Use the following color codes for standard thermostat connections as follows:

24 VAC: Red

Fan: Green

Heat: White

Cool: Yellow

Compressor: Yellow

Rev Valve: Orange

Common: Blue or Black

* + - 1. Exceptions
         1. If the alternate colors codes are specified on the drawings or dictated by the BAS manufacturer’s standard installation recommendations, they shall be used in place of color codes specified in Para. 2.3.B

1. WIRING CONNECTORS
   * 1. For control wiring, use nylon-insulated, crimp-on terminals with insulation grip that meet the requirements of UL 486A-486B. Manufacturer: 3M “Scotchlok MNG,” Thomas & Betts “Sta-Kon.”
        1. Use ring tongue terminals for nutted studs.
        2. Use flanged fork terminals for barrier terminal blocks.
     2. Insulation-piercing-type connectors are not acceptable for power or control wiring.
     3. Exceptions:
        1. Wiring connectors are not required where wires terminate in cage clamp, pressure plate or equivalent terminals.
        2. Insulation-piercing type connectors may be used to connect Ethernet/RJ type connectors when installed using the correct installation tools for the connector type.
        3. Devices with pigtails may be terminated using wire nuts.
2. WIRE-PULLING LUBRICANT
   * 1. Provide NRTL-listed wire pulling lubricant that is compatible with the conductor insulation or jacket, has a maximum coefficient of dynamic friction of 0.25, and leaves no flammable residue. For cold weather installations, provide wire pulling lubricant suitable for conduit temperature.
3. EXECUTION
   1. EXAMINATION
      1. Verify that work of other trades likely to damage wire and cable is completed.
      2. Verify raceway installation is complete and supported.
      3. Wire and cable routing shown on Drawings is approximate unless dimensioned.
         1. Route wire and cable as required to meet project conditions.
         2. Where cable routing is not shown, and destination only is indicated, determine exact routing and lengths required to meet Project conditions.
   2. PREPARATION
      1. Examine raceways and building finishes that are to receive wires and cables for compliance with installation tolerances and other conditions. Do not proceed with installation until unsatisfactory conditions have been corrected.
      2. Do not handle or pull cables that are colder than +14 degrees F. Store cold cables for at least 24 hours in a heated building prior to installation.
   3. EXISTING WORK
      1. Remove abandoned wire and cable associated with the BAS control system or its previous electric control system, including abandoned wire and cable above accessible ceiling finishes. Patch surfaces where removed cables pass through building finishes when specified on Drawings.
         1. Exception: If Drawings specify that existing wire is to remain.
      2. Disconnect abandoned circuits feeding controls and remove circuit wire and cable. Remove abandoned boxes when wire and cable servicing boxes are abandoned and removed. Install blank cover for abandoned boxes not removed.
         1. Exception: If Drawings specify that existing conduit and boxes are to remain.
      3. Provide access to existing wiring connections remaining active and requiring access. Modify installation or install access panel.
      4. Extend existing circuits using materials and methods as specified.
   4. BAS Wire ANd CABLE Installation
      1. Install building wire according to the NEC, the requirements in this Section, and, as applicable, NECA 1 *Standard for Good Workmanship in Electrical Construction* (ANSI):
      2. Do not damage conductor, insulation, or jacket by excessive installation pulling tension or sidewall bearing pressure.
      3. Do not “through-pull” conductors at boxes, fittings, or cabinets where a change of raceway alignment occurs.
      4. Terminate cable ends neatly by removing exposed parts of shielding (not drain wire) and splitting strings or reinforcing strings.
      5. Terminate cable shielding drain conductor at one end only. Unless specified otherwise on drawings the controller end of the shield shall be the grounded end.
      6. At un-terminated end of cable shielding drain conductor, ensure the drain conductor is insulated from possible contact with grounded surfaces with insulating tape or heat shrink tubing. Leave at least ½” length of drain conductor under the insulation for future testing needs.
      7. Do not cut off unused conductors in cable assemblies. Either bundle the spare conductors neatly or twist them back around the cable for future use.
      8. Cables shall not be spliced without special permission from LANL ES I&C responsible engineer. Splicing is allowed if specifically called out on the Drawings.
   5. Connector Installation
      1. Install conductors in terminals, splices, adapters, and connectors in accordance with the manufacturer’s instructions. Have the manufacturer’s installation instructions available at the construction site.
      2. Do not nick inner wire insulation when removing cable outer covering or shielding.
      3. Do not nick conductors when removing insulation.
      4. Do not cut conductor strands to fit into connectors, splices, adapters, or terminals.
   6. Identification
      1. Identify wire and cable under provisions of Section 25 0553, *Identification for BAS Electrical Systems.*
   7. FIELD QUALITY CONTROl
      1. Observe conductors and cables during the installation process.
         1. Reject and replace entire reels, rolls, or boxes containing conductors or cables with material or manufacturing defects.
         2. Reject and replace cable or conductor segments that have been kinked, dented, or otherwise damaged during handling or installation.
      2. Perform the following inspections:
         1. Inspect conductors and cables for:
            1. Freedom from material defect or physical damage,
            2. Correct conductor size, material, and insulation type,
            3. Correct color coding and identification.
         2. Inspect connections for:
            1. Correct connector size and type, according to the Specifications.
      3. Perform the following tests:
         1. After connecting conductors to equipment, verify correct connection of each control circuit conductor through point-to-point testing.
         2. Perform a tug-test on all terminal block connections by lighting pulling on each individual wire. Any wire found to be loose shall be re-terminated and re-tested.
      4. Remove and replace defective, incorrect, or improperly installed conductors and connectors. Re-inspect and re-test replacement conductors and connectors.

END OF SECTION

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Do not delete the following reference information.  
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THE FOLLOWING STATEMENT IS FOR LANL USE ONLY

This project specification is based on LANL Master Specification 25 0519, Rev. 2, dated April 3, 2023.