

# Federal Aviation Agency

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AIRPORTS

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**SUBJECT :** SPECIFICATION FOR L-824 UNDERGROUND ELECTRICAL CABLES FOR AIRPORT LIGHTING CIRCUITS

1. **PURPOSE.** This circular describes the subject specification requirements and is published by the Federal Aviation Agency for the guidance of the public. The use of this specification is required for project activity under the Federal-aid Airport Program.
2. **CANCELLATION.** This advisory circular cancels and replaces FAA Specification L-824, "Underground Electrical Cables for Airport Lighting Circuits," dated May 15, 1960. The substantive change in this advisory circular is the deletion of requirements for 3000 volt, Type A cable. This change was occasioned by a revision of the requirements of the applicable American Society for Testing and Materials (ASTM) specifications.
3. **DESCRIPTION OF PUBLICATION.** The specification requirements presented are for #12 to #4 AWG, rubber or synthetic rubber insulated underground electrical cables with a neoprene sheath for direct earth burial, or installation in ducts or conduit. Requirements for metallic shielding are included which may be optionally specified by the user.
4. **APPLICABLE SPECIFICATIONS.** The following ASTM specifications, as referred to hereinafter, of the issues in effect on the date of application for qualification (paragraph 9) are applicable to this specification. In case of conflict between this specification and the applicable specifications, this specification shall govern.
  - a. **ASTM Specifications.** Copies of ASTM specifications may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania, at published price.
    - (1) B8 - Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
    - (2) B33 - Tinned Soft or Annealed Copper Wire for Electrical Purposes.

- (3) B189 - Lead-Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes.
  - (4) D15 - Sample Preparation for Physical Testing of Rubber Products.
  - (5) D353 - Natural Rubber Performance Insulation for Wire and Cable, 60 C Operation.
  - (6) D412 - Tension Testing of Vulcanized Rubber.
  - (7) D470 - Testing Rubber and Thermoplastic Insulated Wire and Cable.
  - (8) D572 - Accelerated Aging of Vulcanized Rubber by the Oxygen-Pressure Method.
  - (9) D573 - Accelerated Aging of Vulcanized Rubber by the Oven Method.
  - (10) D574 - Ozone-Resisting Insulation for Wire and Cable.
  - (11) D752 - Heavy-Duty Black Neoprene Sheath for Wire and Cable.
  - (12) D755 - Synthetic Rubber Insulation for Wire and Cable, 60 C Operation.
  - (13) D1350 - Construction of Rubber Insulated Wire and Cable.
  - (14) D1352 - Ozone-Resisting Butyl Rubber Insulation for Wire and Cable.
5. MATERIAL AND WORKMANSHIP. The cable shall be a first-grade commercial product, free from defects in material and workmanship which might affect either life or performance. Materials shall be as specified herein.
6. TYPES.
- a. Type A. Single and multiple conductor cable with 600 volt "Performance" type insulation and an overall neoprene sheath.
  - b. Type B. Single and multiple conductor cable with 3000 volt or 5000 volt "Ozone Resistant" insulation and an overall neoprene sheath.

7. DETAIL REQUIREMENTS.

a. Conductors.

- (1) Stranded Conductors. All AWG sizes covered by this specification shall be stranded. Conductors shall be stranded in accordance with ASTM Specification B8. For Type "A", 600 volt cable, the stranding shall be Class "B" (7 wires). For Type "B", 3000 volt and 5000 volt cable, the stranding shall be Class "C" (19 wires).
- (2) Strand Shielding. Internal (strand) shielding will be permissible for all AWG sizes covered by this specification. The use of strand shielding shall not permit reduction of the requirements for stranding as specified above. Strand shielding, if used, shall conform with good industry practice in quality and workmanship.
- (3) Material. Electrical conductors shall be soft drawn or annealed copper having an electrical resistivity not higher than that permitted by the values prescribed in ASTM Specification B33 or ASTM Specification B189, whichever is applicable.
- (4) Coating. Conductors shall be continuously coated with pure tin, lead, or a lead alloy. The coated wire shall meet the requirements of ASTM Specification B33 or B189, whichever is applicable. The individual wires of a stranded conductor shall be separately coated.

b. Insulation. Single conductors or the individual conductors of multiple conductor cable shall be insulated for their entire length with a properly vulcanized synthetic rubber or natural rubber compound. The insulation shall be of circular cross section, applied concentrically about the conductor, and shall fit the conductor tightly. The insulating compound shall be free from pores, splinters, and other defects visible to the unaided eye.

- (1) Type A. The conductor(s) shall be insulated with "Performance" type insulation conforming to ASTM Specification D353 for natural rubber or D755 for synthetic rubber. The insulation thickness shall be as specified in Table 1 for wire of the proper size and voltage rating.

- (2) Type B. The conductor(s) shall be insulated with "Ozone Resistant" type insulation conforming to ASTM Specification D574 or D1352. The insulation thickness shall be as specified in Table 1 for wire of the proper size and voltage rating.

TABLE 1

<u>Rated Circuit Voltage</u>	<u>Size of Conductor, AWG</u>	<u>Thickness of Insulation 64ths of an Inch</u>
600 Volts or Less	12 - 10	3
	8 - 6 - 4	4
2001 - 3000	8	7
	6 - 4	8
4001 - 5000	8 - 6 - 4	10

c. Insulation Covering.

- (1) Single Conductor Cables. No fillers, braid, tape, or other covering between insulation and sheath shall be supplied on single conductor unshielded cables. The sheath shall adhere directly to the insulation in unshielded cables.
- (2) Multiple Conductor Cables. Each insulated conductor of a multiple conductor cable shall have a tape, braid, wrap, or a suitable rubber-like covering, such as a layer of neoprene compound, over the insulation. All tapes, braids, wraps, and coverings shall be of a suitable type and construction in accordance with established industry standards.
- (3) Shielding. Only when specifically indicated in the "invitation to bid" and/or in the "purchase order," a metallic shielding tape of copper, bronze, or aluminum alloy with a nominal thickness of 0.003 inch shall be applied over the insulation and under the neoprene sheath for lightning and termite protection. The shielding tape shall be applied with a sufficient overlap to provide 100% coverage. Suitable tapes shall be applied under and over the metallic shielding tape.

- d. Identification Markers. The tape, braid, or wrap, described in paragraph 7c(2), may serve as an identification covering for the conductors of multiple conductor cables and shall be color coded in accordance with the National Electrical Manufacturers Association

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(NEMA) color code for control cables. In the case of rubber-like covering applied over the insulation on individual conductors, the identification may be obtained by the use of colored compounds, colored coatings, stripes, or bands applied to the surface of the sheathing material.

e. Cabling.

- (1) Cable Lay. Two-conductor cable may be flat twin parallel construction. Multiconductor cable shall be laid up round with a suitable lay.
- (2) Fillers. Multiconductor cables shall have the interstices between insulated conductors filled with a suitable material such as rubber, jute, or cotton. Fibrous fillers may be either untreated or treated. A twine binder, cotton braid, or tape may be used to hold the conductors together.

- f. Sheath. The unshielded and shielded cable shall be jacketed with a layer of nonhygroscopic vulcanized neoprene compound conforming to ASTM Specification D752. The sheath shall be tightly and concentrically formed around the core and shall be free from pores, splinters, and other defects visible to the unaided eye. For single conductor cables, the average thickness shall not be less than that listed in Table 2. For multiple conductor cables, the average thickness shall not be less than that listed in Table 3. The minimum thickness at any point shall not be less than 90% of the specified thickness. For flat twin cable, use the major core diameter under sheath to determine sheath thickness.

TABLE 2

Thickness of Sheath for Single Conductor Cable

Size of Conductor AWG	Nonshielded Sheath Thickness, $\frac{64}{1000}$ ths of an Inch		
	600 Volts or Less	2001-3000 Volts	4001-5000 Volts
12 - 10	3		
8	3	3	4
6 - 4	3	4	4

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TABLE 2 (Continued)Metallic Shielded (All Voltages)

<u>Diameter of Cable Under Sheath in Inches</u>	<u>Thickness of Sheath in 64ths of an Inch</u>
.425 or less	3
.426 - .700	4
.701 - 1.050	5
1.051 - 1.500	6
1.501 - 2.000	7

TABLE 3Thickness of Sheath for Multiple Conductor Cable  
All Voltages

<u>Diameter Under Sheath Inches</u>	<u>Thickness of Sheath 64ths of an Inch</u>
0.425 or less	5
0.426 - 0.700	6
0.701 - 1.050	7
1.051 - 1.500	8
1.501 - 2.000	9
2.001 - 3.000	10

g. Cable Surface Marking. All cable produced under this specification shall be identified by imprinted marking or printed surface marking with ink continuously spaced. Such markings shall not materially affect the smoothness of the cable sheath. The cable identification for either method shall give the following information:

- (1) Manufacturer's name or trademark.
- (2) Conductor size.
- (3) Voltage rating.

- (4) Identification: FAA L-824.
- (5) Type (specification designation A or B).
- (6) Additional information may be included if the manufacturer so desires.

8. SAMPLES AND TESTS.

- a. Samples. Samples of insulated conductors and completed cable shall be supplied in such lengths and quantities as required for the tests performed at the testing laboratory.
- b. Testing. The cable and its constituent parts shall be subjected to the electrical and physical tests described below and the applicable detail requirements under paragraph 7.

(1) Electrical Tests.

(a) AC High Voltage Tests.

- 1 The test procedure for the AC high voltage test on completed nonshielded or shielded single conductor cables after application of sheath, and on individual insulated conductors of a multiconductor cable before cabling shall conform to ASTM Specification D470, and test voltages shall be those listed in ASTM Specification D1350.
- 2 The test procedure for the AC high voltage test on completed nonshielded or shielded multiconductor cables shall conform to ASTM Specification D470, and test voltages shall be those listed in ASTM Specification D1350.

- (b) DC High Voltage Tests. In addition to the high voltage AC tests described above in paragraphs 1 and 2, a DC high voltage test shall be performed on all 3000 volts and 5000 volt cable after the insulation resistance test. The procedure shall conform to ASTM Specification D470, except that the test voltage shall be 3.0 times the AC test voltage for Type "B" insulated cables. The length of time of the DC voltage application shall be 15 minutes.

(c) Insulation Resistance Tests.

1 The test procedure for the insulation resistance test on completed nonshielded or shielded single conductor cables after application of sheath, and on individual insulated conductors of a multiconductor cable before cabling shall conform to ASTM Specification D470. The values of insulation resistance, computed for measured average conductor diameter and insulation thickness, shall not be less than those listed in ASTM Specifications D353, D574, D755, or D1352, whichever is applicable.

2 The test procedure for the insulation resistance test on completed nonshielded or shielded multiconductor cables shall conform to ASTM Specification D470. The values of insulation resistance, computed for measured average conductor diameter and insulation thickness, shall not be less than those listed in ASTM Specifications D353, D574, D755, or D1352, whichever is applicable.

(d) Copper Resistance Measurements on Conductors of Completed Cable. The resistivity shall not exceed the maximum permissible values listed in ASTM Specification B33.

(2) Physical Tests.

(a) Conductor Coating Test. Tests of the coatings on conductors shall be made before insulating or stranding. Tests shall be conducted in accordance with, and shall conform to, ASTM Specification B33 or E189, whichever is applicable.

(b) Insulation Thickness Tests. The average thickness of the insulation shall be not less than that given in Table 1. The minimum thickness shall be not less than 95% of the prescribed thickness for insulations less than 1/64 inch in thickness and not less than 90% of the prescribed thickness for insulation of 1/64 inch and greater. Table 1 applies to single conductor cable and to the individual conductors of multiple conductor cable. The average thickness of the insulation shall be determined by the difference method as prescribed in ASTM Specification D470. Thickness measurements may be made with any type of micrometer reading to .001 inch.



- (c) Sheath Thickness Test. The thickness of the sheath shall be measured after removal from the cable with any type of micrometer reading to .001 inch, except that where the insulation and sheath are inseparable, a measuring microscope may be used. The sheath thickness shall meet the requirements of paragraph 7f, Table 2 or 3, whichever is applicable.
- (d) Bend Test. A sample of completed cable shall be held at a temperature of  $-18^{\circ}$  C. ( $0^{\circ}$  F.) for approximately one hour and then bent around a mandrel in accordance with Table 4. The winding shall be done at an approximate uniform rate of six turns per minute and shall be performed while the cable is at test temperature. On completion of the bending, the sheath shall have no cracks or breaks visible to the unaided eye.

TABLE 4

Size of Mandrel for Bending Test

<u>Cable Diameter (Inches)</u>	<u>Number of Turns Around Mandrel</u>	<u>Size of Mandrel (Cable Diameters)</u>
Less than 1	2½	5
1.001 - 1.500	2	6
1.501 or over	1½	8

- (e) Oxygen-Pressure Test. Samples of insulation and sheath compounds shall be subjected to an aging test in oxygen for the specified number of hours and temperatures required by the applicable specification. After aging, the samples shall meet the applicable requirements of ASTM Specifications D353, D574, D752, or D755.
- (f) Air-Oven Test. Samples of insulation and sheath compounds shall be subjected to an aging test in air for the specified number of hours and temperatures required by the applicable specification. After aging, the samples shall meet the applicable requirements of ASTM Specifications D353, D574, D752, or D1352.

- (g) Air Pressure Heat Test. Samples of insulation compound shall be subjected to an aging test in the pressure chamber for the specified number of hours and temperatures required by the applicable specification. After aging, the samples shall meet the applicable requirements of ASTM Specification D1352.
- (h) Oil Immersion Test. Samples of the sheath shall be immersed in oil and tested as described in ASTM Specification D752.
- (i) Ozone Resistance Test. Samples of the Type "B" cable shall be tested for ozone resistance as described in ASTM Specification D470 and shall meet the requirements of ASTM Specification D574 or D1352, whichever is applicable.
- (j) Water Absorption Test. All insulated cable prior to application of any covering shall meet the applicable requirements of ASTM Specifications D353, D574, D755, or D1352 (Electrical Method) for water absorption.

## 9. QUALIFICATION.

- a. The manufacturer shall furnish a sample, or samples, to a disinterested testing laboratory to be tested as described in paragraph 8 to obtain certification regarding the ability to manufacture cable meeting the requirements of this specification. The disinterested testing laboratory shall be a laboratory acceptable to the Federal Aviation Agency, Airports Service, Washington, D. C. 20553. The manufacturer shall furnish two copies of the testing laboratory's reports to the Airports Service for review and approval consideration. Upon approval of test reports which show satisfactory certification of compliance, the Airports Service will list the name of the qualified manufacturer and a description of their cable in Advisory Circular No. 150/5345-1, "Approved Airport Lighting Equipment." The cost of the testing shall be borne by the manufacturer offering the material for qualification.
- b. Manufacturers need qualify only for such types, voltages, or sizes of cables as they propose to furnish. If a manufacturer proposes to furnish all types, all voltages, and AWG sizes covered by this specification, the procedure listed below must be followed:
  - (1) For unshielded cable, separate qualification samples of single and multiple (3 or 4 conductors) cable in the 600 volt category for Type "A" cable shall be furnished for testing.

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- (2) For unshielded cable, separate qualification samples of single and multiple (3 or 4 conductors) cable in both the 3000 volt and the 5000 volt category for Type "B" cable shall be furnished for testing.
  - (3) If separate qualification samples of single and multiple (3 or 4 conductors) shielded cable in the 600 volt, 3000 volt, and 5000 volt category for Type "A" or "B" are submitted for the initial test, approval will also be granted for nonshielded cables in the same classification without the manufacturer submitting nonshielded samples for test.
- c. Qualification of one AWG size conductor will be acceptable as proof of compliance for all other AWG sizes of conductors having the same type insulation and the same voltage rating. Adequate lengths of samples, plainly marked as to type, voltage, size, and number of conductors, shall be forwarded to the testing laboratory.
  - d. At any time after approval has been granted under the above conditions, a certified copy of factory test reports on the latest production run of any type of cable produced under this specification shall be made available by the manufacturer upon written request by the Federal Aviation Agency, Airports Service, Washington, D. C. 20553.

#### 10. HOW TO GET THIS PUBLICATION.

- a. Order copies of this publication from:

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- c. There is no charge for this publication.

  
Cole Morrow, Director  
Airports Service