



Standard Specification for Crosslinked Polyolefin Heat-Shrinkable Tubing for Electrical Insulation¹

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1. Scope*

1.1 This specification covers flexible and semirigid cross-linked polyolefin heat-shrinkable tubing used for electrical insulating purposes. It is supplied in an expanded form and will shrink to its extruded diameter when heated.

NOTE 1—This standard is similar to but not identical to IEC 60684-3-209, -211 and -212.

1.2 The values stated in inch-pound units are to be regarded as the standard except temperature, which shall be stated in degrees Celsius. Values in parentheses are for information only.

2. Referenced Documents

2.1 ASTM Standards:²

- D910 Specification for Aviation Gasolines
- D1711 Terminology Relating to Electrical Insulation
- D2671 Test Methods for Heat-Shrinkable Tubing for Electrical Use
- D3636 Practice for Sampling and Judging Quality of Solid Electrical Insulating Materials
- E176 Terminology of Fire Standards

2.2 Military Standards:³

- MIL-STD-104 Limits for Electrical Insulation Color
- MIL-H-5606 Hydraulic Fluid, Petroleum Base, Aircraft, Missile, and Ordnance
- MIL-T-5624 Turbine Fuel, Aviation, Grades JP4 and JP5
- MIL-L-7808 Lubricating Oil, Aircraft, Turbine Engine, Synthetic Base
- MIL-L-23699 Lubricating Oil, Aircraft, Turbine Engines, Synthetic Base
- MIL-A-8243 Anti-Icing and De-Icing Defrosting Fluid

¹ This specification is under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.07 on Flexible and Rigid Insulating Materials.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

2.3 Federal Standards:

SS-S-550 Sodium Chloride, Technical, for Water-Softening Units⁴

2.4 IEC Standards:

- 60684-3-209 Flexible insulating sleeving, Part 3, Sheet 209: Heat-shrinkable sleeving, general purpose, flame retarded polyolefin, shrink ratio 2:1⁵
- 60684-3-211 Flexible insulating sleeving, Part 3, Sheet 211: Heat-shrinkable sleeving, general purpose, semi-rigid polyolefin, shrink ratio 2:1⁵
- 60684-3-212 Flexible insulating sleeving, Part 3, Sheet 212: Heat-shrinkable polyolefin sleeving, general purpose, flame retarded, shrink ratio 2:1⁵

3. Terminology

3.1 Definitions:

3.1.1 For definitions pertaining to electrical insulation, refer to Terminology D1711.

3.1.2 For definitions pertaining to fire standards, refer to Terminology E176.

4. Classification

4.1 *Type I*—Flexible, flame-retardant, opaque polyolefin tubing with a secant modulus at 2 % strain less than 25 000 psi (172 MPa).

4.2 *Type II*—Flexible, non-flame-retardant, clear or opaque polyolefin tubing with a secant modulus at 2 % strain less than 25 000 psi (172 MPa).

4.3 *Type III*—Semi-rigid, flame-retardant, opaque polyolefin tubing with a secant modulus at 2 % strain greater than 25 000 psi (172 MPa).

4.4 *Type IV*—Semi-rigid, non-flame-retardant, clear or opaque polyolefin tubing with a secant modulus at 2 % strain greater than 25 000 psi (172 MPa).

⁴ May be obtained from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

⁵ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

*A Summary of Changes section appears at the end of this standard

5. Ordering Information

5.1 When tubing is ordered to this specification, the purchaser should define the type, size, and color of the required tubing.

6. Materials and Manufacture

6.1 The compound used in the manufacture of heat-shrinkable tubing shall be modified polyolefin resin, and the finished compound shall be free of all foreign matter other than intended formulation additives as appropriate.

6.2 The tubing shall be extruded, cross-linked, and then expanded to the required dimensions.

7. Chemical Property Requirements

7.1 The material shall conform to the chemical requirements specified in **Table 1**.

7.2 Every lot of Type I and Type III material manufactured shall be tested for flammability. Other chemical requirements may be tested less frequently or at a frequency agreed upon by the purchaser and supplier.

8. Physical Property Requirements

8.1 The material shall conform to the color, mechanical, thermal, and electrical requirements of **Table 2**.

8.2 Every lot of material manufactured shall be tested for restricted shrinkage, heat shock, tensile strength, elongation, low-temperature flexibility and color. Other physical property requirements may be tested less frequently or at a frequency agreed upon by purchaser and seller.

9. Dimensional Requirements

9.1 The material shall conform to the dimensional requirements of **Table 3**.

9.2 Tubing with non-standard dimensions may be supplied when agreed upon between purchaser and seller. Tubing with non-standard dimensions shall be considered to comply with this specification if the requirements of **Table 1** and **Table 2** are satisfied and the minimum recovered wall thickness equals or

exceeds that of the identical or next largest nominal size. The wall for sizes greater than 4 in. shall be at least as thick as that of the 4-in. size.

10. Workmanship

10.1 The tubing shall be homogeneous and essentially free of flaws, defects, pinholes, bubbles, seams, cracks, or inclusions.

11. Sampling

11.1 A lot shall consist of all material that is processed at the same time and under the same conditions and submitted for inspection at one time.

11.2 Properties may be tested at any stage in processing when they are unaffected by subsequent processing.

11.3 Select a quantity of the product at random from each lot in accordance with Practice **D3636** and **Table 5**.

11.4 Statistical process control measurements may be used to demonstrate conformance in lieu of the sampling plan noted herein when the demonstrated process capability is greater than the specified AQL.

12. Number of Tests and Retests

12.1 The methods of test define the number of specimens and length required for each test.

12.2 If the results of any test, except for attributes listed in **Table 3**, do not conform to the requirements prescribed in this specification, perform two additional tests on different specimens from the same lot. Nonconformance to **Table 3** requirements on first inspection shall be cause for rejection.

12.3 If either of the two additional tests results in a nonconformance, the lot of material may be rejected at the option of the purchaser. Notice of nonconformance determined by the purchaser based on tests made according to this specification shall be reported to the manufacturer within 60 days from receipt of the material.

12.4 Tubing that has been rejected may be replaced or reworked to correct the nonconformance and resubmitted for

TABLE 1 Chemical Property Requirements

Property	Type I	Type II	Type III	Type IV
Corrosion (as measured by copper removal), 16 h at 150 ± 2 °C (302 ± 4 °F), Procedure A	noncorrosive	noncorrosive	noncorrosive	noncorrosive
Fluid resistance, 24 h at 24 ± 3 °C (75 ± 6 °F): JP-4 Fuel, MIL-T-5624 Lubricating Oil, MIL-L-7808 Lubricating Oil, MIL-L-23699 Hydraulic Fluid, MIL-H-5606 5 % NaCl, SS-S-550 Aviation Gas Grade 100, min octane 130, Specification D910 De-icing Fluid, MIL-A-8243 Followed by tests for:				
Dielectric strength, min, V/mil (kV/mm)	400 (15.75)	400 (15.75)	400 (15.75)	400 (15.75)
Tensile strength, min, psi (MPa)	1000 (6.9)	1000 (6.9)	1600 (11.0)	1600 (11.0)
Flammability, max, s Procedure B	60, <25 % paper indicator burned. No dripping or flowing.	N/A ^A	60, <25 % paper indicator burned. No dripping or flowing.	N/A
Water absorption, 24 h at 23 ± 2 °C (73 ± 4 °F) max, %		0.2	0.5	0.2

^A N/A = not applicable.