



Standard Specification for Fluoropolymer Resin Heat-Shrinkable Tubing for Electrical Insulation¹

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1. Scope*

1.1 This specification applies to flexible heat-shrinkable extruded tubing made from tetrafluoroethylene resin, copolymer of tetrafluoroethylene and hexafluoropropylene, and from perfluoroalkoxy resin for use as electrical insulation. This specification excludes crosslinked poly(vinylidene fluoride) and poly(vinylidene fluoride) copolymer which are covered under Specification [D3144](#).

NOTE 1—This standard is similar but not identical to IEC 60684-3-240.

1.2 The values stated in inch-pound units are to be regarded as standard, except temperature, which shall be stated in degrees Celsius. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

- [C618](#) Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
- [D638](#) Test Method for Tensile Properties of Plastics
- [D1711](#) Terminology Relating to Electrical Insulation
- [D2116](#) Specification for FEP Resin Molding and Extrusion Materials
- [D2671](#) Test Methods for Heat-Shrinkable Tubing for Electrical Use

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 Electrical 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.

- [D3144](#) Specification for Crosslinked Poly(Vinylidene Fluoride) Heat-Shrinkable Tubing for Electrical Insulation
- [D3307](#) Specification for Perfluoroalkoxy (PFA) Resin Molding and Extrusion Materials
- [D3636](#) Practice for Sampling and Judging Quality of Solid Electrical Insulating Materials
- [D4895](#) Specification for Polytetrafluoroethylene (PTFE) Resin Produced From Dispersion
- [E176](#) Terminology of Fire Standards

2.2 IEC Standards:³

- [IEC 60684-3-240](#) Flexible insulating sleeving - Part 3: Specifications for individual types of sleeving - Sheets 240 to 243: Heat-shrinkable PTFE sleeving

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*—Tubing made from tetrafluoroethylene polymer (TFE) and capable of being heat shrunk at a temperature of 327 °C (621 °F).
- 4.2 *Type II*—Tubing made from a copolymer of tetrafluoroethylene and hexafluoropropylene (FEP) and capable of being heat shrunk at a temperature of 150 °C (302 °F).
- 4.3 *Type III*—Tubing made from perfluoroalkoxy resin (PFA) and capable of being heat shrunk at a temperature of 175 °C (347 °F).

5. Ordering Information

- 5.1 When ordering to this specification, the purchaser must state the size, and type of the required tubing.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

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

6. Materials and Manufacture

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

6.2 Type I tubing is normally made by paste extrusion. Type II and Type III tubings are normally made by melt extrusion. All types are expanded by mechanical means.

7. Chemical and Physical Property Requirements

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

7.2 Every lot of material manufactured should be tested for dimensional requirements and restricted shrinkage. Other requirements shall be permitted to be tested less frequently or with a frequency agreed upon between seller and purchaser.

8. Dimensional Requirements

8.1 Type I material shall conform to the requirements specified in **Table 3**.

8.2 Type II and Type III materials shall conform to the requirements specified in **Table 4**.

8.3 Tubing with non-standard dimensions shall be permitted to 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**

TABLE 2 Mandrel Sizes for Low-temperature Flexibility Testing

Nominal Tubing Inside Diameter (Max After Unrestricted Shrinkage)		Mandrel Diameter	
in.	(mm)	in.	(mm)
0.015 to 0.125	(0.38 to 3.2)	0.3125 ± 0.002	(7.95 ± 0.06)
0.126 to 0.250	(3.3 to 6.3)	0.375 ± 0.003	(8.06 ± 0.07)
0.251 to 1.000	(6.4 to 26)	0.437 ± 0.004	(11.10 ± 0.10)
1.001 to 2.000	(27 to 50)	0.875 ± 0.005	(16.13 ± 0.13)
2.001 to 3.000	(51 to 75)	1.000 ± 0.005	(25.40 ± 0.13)
3.001 to 4.000	(76 to 101)	1.125 ± 0.005	(28.58 ± 0.13)

are satisfied and the minimum recovered wall thickness equals or exceeds that of the identical or next largest as supplied size. The wall for sizes greater than the largest specified size shall be at least as thick as that of the largest specified size.

9. Workmanship

9.1 The heat-shrinkable tubing shall be homogeneous and free from flaws and defects and from foreign matter that have the potential to compromise its performance.

9.2 Type I tubing shall be furnished in clear (transparent milk white to tan) or in a color as agreed between purchaser and seller.

9.3 Type II tubing shall be furnished in clear (water white to transparent light blue) or in a color as agreed between purchaser and seller.

TABLE 1 Chemical and Physical Property Requirements

Property	Requirement		
	Type I	Type II	Type III
Restricted shrinkage, ^A procedure B, 2000 V, 10 min	no cracking	no cracking	no cracking
Specific gravity	2.13 to 2.18	2.12 to 2.20	2.13 to 2.20
Longitudinal change, max, %	+20	±15	±15
Tensile modulus at 200 % elongation, min, psi (MPa) Test Method D638 2 in./min (50 mm/min)	2000 (13.8)	1500 (10.3)	2500 (17.3)
Volume resistivity, ^B Ω-cm, at standard laboratory atmosphere, min	10 ¹⁶	10 ¹⁶	10 ¹⁶
Dielectric breakdown voltage, min kV:			
Wall thickness:			
0.004 to 0.006 in.	8	8	8
0.007 to 0.008 in.	10	10	10
0.009 in.	11.5	11.5	11.5
0.010 to 0.011 in.	12.5	12.5	12.5
0.012 to 0.014 in.	14.6	14.6	14.6
0.015 in.	15	15	15
0.016 to 0.019 in.	16.3	16.3	16.3
0.020 in. and larger	17	17	17
Heat resistance for 96 h followed by tests for tensile modulus at 200 % elongation, min, psi (MPa)			
Type I—350 ± 4 °C (662 ± 7 °F)	2000 (13.8)		
Type II—250 ± 3 °C (482 ± 6 °F)		1500 (10.3)	
Type III—275 ± 4 °C (527 ± 7 °F)			2500 (17.3)
Low-temperature flexibility, -55 ± 2 °C (-67 ± °F)	no cracking	no cracking	no cracking
Melting point:			
Specification D4895	327 ± 10 °C (621 ± 20 °F)		
Specification D2116		270 ± 20 °C (518 ± 40 °F)	
Specification D3307 endotherm peak, min			300 ± 2 °C (572 ± 7 °F)
Specification D3307			305 ± 3 °C (581 ± 5 °F)

^A For over-expanded sleeving, use a mandrel equal to the enclosable diameters $(D + d)/2$.

^B See Specification **C618**.