Designation: D3150 – 11

Standard Specification for Crosslinked and Noncrosslinked Poly(Vinyl Chloride) Heat-Shrinkable Tubing for Electrical Insulation[1]

This standard is issued under the fixed designation D3150; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification applies to flexible, crosslinked and noncrosslinked poly(vinyl chloride) heat-shrinkable tubing 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 but not identical to IEC 60684–3–201.

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

1.2.1 In some cases (including the title), temperatures are described in degrees Celsius only.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

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 JP-4 and JP-5

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

2.3 *Federal Standards:*

SS-S-550 Sodium Chloride, Technical, for Water-Softening Units[4]

2.4 *IEC Standards:*

60684–3–201 Flexible insulating sleeving, Part 3, Sheet 201: Heat shrinkable sleeving, general purpose, flexible, cross-linked PVC, shrink ratio 2:1[5]

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, noncrosslinked poly(vinyl chloride) tubing capable of being shrunk at 135°C (275°F) in 15 min.

4.2 *Type II*—Flexible, crosslinked poly(vinyl chloride) tubing capable of being shrunk at 175°C (347°F) in 15 min.

5. Ordering Information

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

6. Materials and Manufacture

6.1 The polymers used in the manufacture of heat-shrinkable tubing shall be modified poly(vinyl chloride) 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, crosslinked (Type II only), and then expanded to the required dimensions.

7. Chemical and Physical Property Requirements

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

[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.

[4] Available 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, http://www.ansi.org.

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

TABLE 1 Chemical and Physical Property Requirements

Property	Requirements	
	Type I	Type II
Restricted shrinkage, Procedure A:		
Type I—30 min, 135 ± 2°C (275 ± 4°F)	no cracks	
Type II—30 min, 175 ± 2°C (374 ± 4°F)		no cracks
2000-V proof voltage	no failures	no failures
Longitudinal change, max, %	0, – 25	+ 1, – 10
Dielectric strength, V/mil (kV/mm)	400 (15.75)	400 (15.75)
Color	MIL-STD-104	MIL-STD-104
Color stability, 24 h at 130 ± 2°C (266 ± 4°F)	MIL-STD-104	MIL-STD-104
Water absorption, 24 h at 25 ± 2°C (77 ± 4°F), max, %	1.0	1.0
Specific gravity, max	1.40	1.40
Volume resistivity, min, ohm·cm	10^{11}	10^{11}
Flammability, max, s, Procedure A	15	15
Heat shock:		
Type I—4 h at 180 ± 2°C (236 ± 4°F)	no dripping, flowing, or cracking	
Type II—4 h at 200 ± 2°C (392 ± 4°F)		no dripping, flowing, or cracking
Low-temperature flexibility, Procedure B, all sizes 1 h at – 10°C (14°F) on as-received specimens	no cracking	no cracking
Tensile strength, min, psi (MPa)	2000 (13.8)	2000 (13.8)
Elongation, min, %	200	200
Heat resistance, 168 h at 136 ± 2°C (277 ± 4°F), followed by tests for:		
Elongation, min, %	150	130
Elongation, % of original, min	65	65
Fluid resistance, 24 h at 25 ± 2°C (77 ± 4°F):		
Hydraulic Fluid, MIL-H-5606		
JP-4 Fuel, MIL-T-5624		
Lubricating Oil, MIL-L-7808		
Lubricating Oil, MIL-L-23699		
De-icing Fluid, MIL-A-8243		
5 % NaCl, SS-S-550		
Followed by tests for:		
Dielectric strength, V/mil (kV/mm)	280 (11.0)	280 (11.0)
Tensile strength, min, psi (MPa)	1800 (12.4)	2000 (13.8)
Copper corrosion, Procedure B:		
168 h at 136°C (277°F)	no blackening or pitting of copper	no blackening or pitting of copper
Copper dust humidity test, Procedure C	no corrosion or discoloration of copper dust	no corrosion or discoloration of copper dust
Shelf life		
The required shelf life is 2 weeks at 40 ± 2°C (104 ± 4°F). The supplier must advise and caution the customer if special storage and handling precautions must be observed to maintain required product dimensions and characteristics.		

7.2 Every lot of material shall be tested for dimensional requirements, restricted shrinkage, tensile strength, elongation, longitudinal change, and dielectric breakdown. Other requirements shall be tested at a frequency agreed upon between the supplier and the purchaser.

8. Dimensional Requirements

8.1 Type I material shall conform to the applicable requirements listed in Table 2 or Table 3.

8.2 Type II material shall conform to the requirements listed in Table 3.

8.3 Tubing with non-standard dimensions shall be supplied only 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 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.

TABLE 2 Type I Dimensions

As Supplied		After Unrestricted Shrinkage	
Nominal Size, in.	Inside Diameter, min, in. (mm)	Inside Diameter, max, in. (mm)	Wall Thickness, in. (mm)
1/16	0.063 (1.60)	0.037 (0.94)	0.014 ± 0.003 (0.35 ± 0.08)
3/32	0.093 (2.34)	0.055 (1.41)	0.014 ± 0.003 (0.35 ± 0.08)
1/8	0.125 (3.18)	0.075 (1.91)	0.014 ± 0.003 (0.35 ± 0.08)
3/16	0.187 (4.75)	0.110 (2.80)	0.018 ± 0.003 (0.45 ± 0.08)
1/4	0.250 (6.35)	0.150 (3.81)	0.022 ± 0.004 (0.56 ± 0.12)
3/8	0.375 (9.5)	0.225 (5.71)	0.022 ± 0.004 (0.56 ± 0.12)
1/2	0.500 (12.7)	0.300 (7.61)	0.022 ± 0.004 (0.56 ± 0.12)
3/4	0.750 (19.7)	0.450 (11.4)	0.022 ± 0.004 (0.56 ± 0.12)
1	1.000 (25.4)	0.600 (15.25)	0.022 ± 0.004 (0.56 ± 0.12)
1½	1.500 (38.1)	0.900 (22.9)	0.034 ± 0.005 (0.86 ± 0.13)
2	2.000 (50.1)	1.200 (30.5)	0.034 ± 0.005 (0.86 ± 0.13)
3	3.000 (76.4)	1.800 (45.8)	0.034 ± 0.005 (0.86 ± 0.13)
4	4.000 (101.6)	2.400 (61.0)	0.034 ± 0.005 (0.86 ± 0.13)
5	5.000 (127.0)	3.000 (76.3)	0.034 ± 0.005 (0.86 ± 0.13)
6	6.000 (152.5)	3.600 (91.5)	0.034 ± 0.005 (0.86 ± 0.13)

9. Workmanship

9.1 The tubing shall be homogeneous and free of flaws, defects, pinholes, bubbles, seams, cracks, or inclusions that have the potential to detrimentally affect its suitability for the service intended.

TABLE 3 Type I and II Dimensions

As Supplied		After Unrestricted Shrinkage	
Nominal Size, in.	Inside Diameter, min, in. (mm)	Inside Diameter, max, in. (mm)	Wall Thickness, in. (mm)
3/64	0.046 (1.16)	0.023 (0.59)	0.020 ± 0.003 (0.51 ± 0.08)
1/16	0.063 (1.60)	0.031 (0.76)	0.020 ± 0.003 (0.51 ± 0.08)
3/32	0.093 (2.34)	0.046 (1.16)	0.020 ± 0.003 (0.51 ± 0.08)
1/8	0.125 (3.18)	0.062 (1.60)	0.025 ± 0.003 (0.63 ± 0.08)
3/16	0.187 (4.75)	0.093 (2.34)	0.025 ± 0.003 (0.63 ± 0.08)
1/4	0.250 (6.35)	0.125 (3.18)	0.025 ± 0.003 (0.63 ± 0.08)
3/8	0.375 (9.50)	0.187 (4.75)	0.030 ± 0.005 (0.76 ± 0.13)
1/2	0.500 (12.7)	0.250 (6.35)	0.030 ± 0.005 (0.76 ± 0.13)
3/4	0.750 (19.1)	0.375 (9.50)	0.035 ± 0.005 (0.89 ± 0.13)
1	1.000 (25.4)	0.500 (12.7)	0.040 ± 0.005 (1.02 ± 0.13)
1 1/2	1.500 (38.1)	0.750 (19.1)	0.045 ± 0.006 (1.15 ± 0.15)
2	2.000 (50.1)	1.000 (25.4)	0.050 ± 0.007 (1.27 ± 0.18)

10. Sampling

10.1 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.

10.2 If properties are unaffected by subsequent processing, they shall be permitted to be tested at any stage in processing.

10.3 Select a quantity of the product at random from each lot in accordance with Practice D3636 and Table 4.

10.4 It is acceptable to use statistical process control measurements to demonstrate conformance in lieu of the sampling plan noted herein when the demonstrated process capability is greater than the specified AQL.

11. Number of Tests and Retests

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

11.2 If the results of any test, except for attributes listed in Table 2 and 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 2 and Table 3 requirements on first inspection shall be cause for rejection.

TABLE 4 Sampling Table for Lot Acceptance Tests

Property	Requirement	Inspection Level	AQL	Sampling Unit, ft (m)
Inside diameter as supplied	Table 2 or Table 3	S-3	1.0	4 (1.2)
Inside diameter after unrestricted recovery	Table 2 or Table 3	S-3	1.0	4 (1.2)
Wall thickness after shrinkage	Table 2 or Table 3	S-3	1.0	4 (1.2)
Longitudinal change	Table 1	S-2	1.0	4 (1.2)
Workmanship	8.1 herein	I	2.5	4 (1.2)

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

11.4 It is acceptable to replace or rework tubing that has been rejected in order to correct the defects and to resubmit it for inspection. Before resubmitting, full particulars concerning previous rejection and action taken to correct the nonconformances shall be furnished to the inspector.

12. Test Methods

12.1 The test methods described in Test Methods D2671 shall be used unless otherwise stated in Table 1.

12.2 To recover (shrink) heat-shrinkable tubing described in this specification, the following shall be used:

Type I—15 min at 135 ± 5°C (275 ± 9°F)

Type II—15 min at 175 ± 6°C (347 ± 10°F)

13. Inspection

13.1 The manufacturer or the purchaser or both shall have available all the facilities to enable the complete testing to this specification.

14. Certification

14.1 When specified in the purchase order or contract, the manufacturer's or supplier's certification shall be furnished to the purchaser stating that samples representing each lot have been manufactured, tested, and inspected in accordance with this specification and the requirements have been met. When specified in the purchase order or contract, a report of the test results shall be furnished.

15. Packaging, Marking, and Shipping

15.1 The tubing shall be supplied in continuous rolls, or in lengths as mutually agreed upon between the manufacturer and the purchaser.

15.2 The tubing shall be packaged in conformance with good commercial practice unless otherwise specified. Individual sizes, types, lengths, and colors shall be bundled and spooled and properly identified, specifying size, type, quantity, color, and material.

15.3 The bundles or spools shall then be placed in corrugated boxes, and shall be taped in a manner that shall be accepted by parcel post or common carrier.

16. Keywords

16.1 crosslinked poly(vinyl chloride) heat-shrinkable tubing; electrical insulation; heat-shrinkable tubing; poly(vinyl chloride); poly(vinyl chloride) heat-shrinkable tubing

SUMMARY OF CHANGES

Committee D09 has identified the location of selected changes to this specification since the last issue, D6096 – 00R06, that may impact the use of this specification. (Approved August 1, 2011.)

(*1*) Revised Units statement.

(*2*) Modified text throughout.