



# Standard Specification for Crosslinked Chlorinated Polyolefin Heat-Shrinkable Tubing for Electrical Insulation<sup>1</sup>

This standard is issued under the fixed designation D 2903; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This specification covers flexible crosslinked chlorinated polyolefin heat-shrinkable tubing used for electrical insulating purposes. It is supplied in an expanded form and will shrink to the specified diameter when heated.

NOTE 1—This standard does not have a similar or equivalent IEC standard.

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

## 2. Referenced Documents

### 2.1 ASTM Standards:

D 412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension<sup>2</sup>

D 1711 Terminology Relating to Electrical Insulation<sup>3</sup>

D 2671 Test Methods for Heat-Shrinkable Tubing for Electrical Use<sup>4</sup>

D 3636 Practice for Sampling and Judging Quality of Solid Electrical Insulating Materials<sup>4</sup>

E 176 Terminology of Fire Standards<sup>5</sup>

### 2.2 Military Standards:<sup>6</sup>

MIL-H-5606 Hydraulic Fluid Petroleum Base, Aircraft, Missile and Ordnance

MIL-T-5624 Turbine Fuel, Aviation, Grades JP4 and JP5

MIL-L-7808 Lubrication Oil, Aircraft, Turbine Engine, Synthetic Base

MIL-L-23699 Lubrication Oil, Aircraft, Turbine Engines, Synthetic Base

MIL-A-8243 Anti-Icing and De-Icing Defrosting Fluid  
MIL-G-5572 Fuel, Aviation, Grades 100 and 130

### 2.3 Federal Standards:

SS-S-550 Sodium Chloride, Technical, for Water Softening Units<sup>6</sup>

## 3. Terminology

### 3.1 Definitions:

3.1.1 For definitions pertaining to electrical insulation, refer to Terminology D 1711.

3.1.2 For definitions pertaining to fire issues, refer to Terminology E 176.

### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *chlorinated polyolefin, n*—a polymer or polymer blend based on chlorinated polyolefin(s), chlorinated olefin copolymer(s) or chlorinated polybutadiene polymer(s).

## 4. Classification

4.1 *Type I*—Normal operating temperature.

4.2 *Type II*—Extended operating temperature.

## 5. Ordering Information

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

## 6. Materials and Manufacture

6.1 The compound used in the manufacture of this heat-shrinkable tubing shall be based on chlorinated polyolefin as defined in Section 3, Terminology. The finished compound shall be free of foreign matter other than antioxidants, flame retardants, processing aids, crosslinking agents, pigments or other additives as appropriate.

6.2 The tubing shall be extruded, crosslinked and then expanded to the required dimensions.

## 7. Chemical Property Requirements

7.1 The material shall conform to the chemical requirements specified in Tables 1 and 2.

<sup>1</sup> 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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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 09.01.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 10.01.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 10.02.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 04.07.

<sup>6</sup> Available from Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA 19120.

**TABLE 1 Sampling Table for Lot Acceptance Tests**

Property	Requirement	Inspection Level	AQL	Sampling Unit of Sleeving, ft (m)
Inside diameter as supplied	Table 4	S-3	1.0	4 (1.2)
Inside diameter after unrestricted shrinkage	Table 4	S-3	1.0	4 (1.2)
Wall thickness after shrinkage	Table 4	S-3	1.0	4 (1.2)
Longitudinal change	Table 4	S-2	1.0	4 (1.2)
Straight length size, min	16.1 herein	S-3	1.0	single straight length
Workmanship	10.1 herein	I	4.0	4 (1.2)

**TABLE 2 Chemical Requirements**

Property	Requirement	
	Type I	Type II
<b>Corrosion</b>		
Method A (copper mirror) 16 h at 150 ± 2°C (302 ± 4°F)	no corrosion	no corrosion
Method B (copper contact) 168 h at 121 ± 2°C (250 ± 4°F)	no pitting or blackening	no pitting or blackening
Followed by test for:		
Ultimate elongation, min, %		150
<b>Solvent resistance:</b>		
Type I—Immerse 24 h at 24 ± 3°C (75 ± 5.4°F)		
Type II—Immerse 24 h at 50 ± 2°C (122 ± 4°F)		
MIL-T-5624—Grade JP-4 fuel		
MIL-L-7808—Lubricating oil		
MIL-H-5606—Hydraulic fluid		
SS-S-550—Sodium chloride, 5 % solution		
MIL-A-8243—Anti-icing fluid		
MIL-L-23699—Lubricating oil		
MIL-G-5572—Aviation gasoline 100/130 <sup>A</sup>		
Followed by tests for:		
Tensile strength, min, psi (MPa)	900 (6.2)	1000 (6.9)
Ultimate elongation, min, %	150	200
Weight increase, %	25	25
<b>Flammability (Procedure A):</b>		
Time of burning, max, s	15	15
Burning distance, max, in.	3	3
Water absorption—24 h at 24 ± 3°C (75 ± 5.4°F) by lot, max, %	1.0	1.0

<sup>A</sup> Perform in gasoline at room temperature (24°C) only.

7.2 Every lot of material manufactured requires testing for flammability, but the other chemical property requirements may be tested less frequently or with a frequency agreed upon by the purchaser and seller.

## 8. Other Property Requirements

8.1 The material shall conform to the mechanical, thermal, and electrical requirements of Table 3.

8.2 Every lot of material manufactured shall be tested for heat shock, tensile strength, and elongation, but other requirements may be tested less frequently or with a frequency agreed upon by the purchaser and seller.

## 9. Dimensional Requirements

9.1 Both Type I and Type II tubing shall conform to the dimensional requirements of Tables 4 and 5.

## 10. Workmanship

10.1 Chlorinated polyolefin heat-shrinkable tubing shall be homogeneous and free from flaws and defects and from foreign matter that may compromise its performance.

## 11. Sampling

11.1 A lot is defined as that material which is processed at the same time and under essentially the same conditions in accordance with this specification and submitted for inspection at one time.

11.2 Inspect a quantity of the end item selected at random from each lot in accordance with Practice D 3636 and Table 1.

## 12. Tests and Retests

12.1 If the results of any test do not conform to the requirements prescribed in this specification, make two additional tests on different specimens from the same lot.

12.2 If the results of either of the two additional tests do not conform to the requirements, the lot of material may be rejected at the option of the purchaser. A notice of nonconformance of material based on tests made according to this specification should be reported to the manufacturer promptly and in writing.

12.3 Rejected tubing may be replaced or reworked to correct the nonconformances and resubmitted for inspection. Before resubmitting, furnish to the inspector full particulars concerning previous rejection and action taken to correct the nonconformances.

## 13. Test Methods

13.1 Use the test methods described in Test Methods D 2671 unless stated otherwise in Table 2 or Table 3.

13.2 To recover heat-shrinkable tubing in this specification, use a time of 10 min and a temperature of 175 ± 1°C (347 ± 2°F).

## 14. Inspection

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

## 15. Certification

15.1 When agreed upon in writing by the purchaser and a seller, a certification consists of the lot number and a copy of the manufacturer's test report or a statement by the seller, accompanied by a copy of the test results, that the material was sampled, tested and inspected in accordance with the provisions of the specification. An authorized agent of the seller and manufacturer shall sign each certification.

15.2 When original identity cannot be established, certification can only be based on the sampling procedure as defined in Section 11.

## 16. Packaging, Marking, and Shipping

16.1 Supply the tubing on spools in lengths of 10 ft (3 m) minimum for all sizes unless otherwise specified.

16.2 Package the tubing in conformance with standard commercial practice unless otherwise specified. Box each size separately.

16.3 Distinctly identify each container of tubing by a tag or label. Show the name of the manufacturer, the expanded and recovered dimensions of the tubing, the length, quantity and other appropriate information.

**TABLE 3 Other Property Requirements**

Property	Requirement	
	Type I	Type II
Restricted shrinkage, Procedure A 135 ± 2°C (275 ± 4°F) for 30 min—2000 V	no cracking, no dielectric breakdown	no cracking, no dielectric breakdown
Dielectric strength, V/mil (V/mm): ¼ in. through 1¾ in.	300 (11 800)	300 (11 800)
2 in. and larger	200 (7870)	200 (7870)
Heat shock: Type I at 150 ± 2°C (302 ± 4°F)	no cracking, flowing, or dripping	
Type II at 200 ± 2°C (392 ± 4°F)		no cracking, flowing, or dripping
Low-temperature flexibility: Procedure A for sizes ¼ through ⅝		
Procedure C for sizes ¾ through 4		
Mandrels specified in Table 5		
Type I at –55 ± 2°C (–67 ± 4°F)	no cracks	
Type II at –70 ± 2°C (–94 ± 4°F)		no cracks
Tensile strength, min, psi (MPa): Full sections of tubing for sizes ¼ through ½:	1500 (10.3)	1500 (10.3)
Die D, Test Methods D 412, for all larger sizes		
Speed 20 in./min (500 mm/min)		
Ultimate elongation, min, % (Class 1)	225	225
Simultaneous with tensile strength		
Heat resistance: Type I at 100 ± 2°C (212 ± 4°F) for 96 h		
Type II at 121 ± 2°C (250 ± 4°F) for 168 h		
Followed by tests for:		
Tensile strength, min, psi (MPa):	1200 (8.3)	1200 (8.3)
Elongation, min, %:	150	175
Volume resistivity, min Ω·cm, <sup>A</sup>	10 <sup>10</sup>	10 <sup>11</sup>
Specific gravity, max	1.5	1.5
Stress modulus (at 200 % strain), max, psi (MPa)	2500 (17.2)	2500 (17.2)
Shelf life <sup>B</sup>	meet Table 4 requirements	meet Table 4 requirements

<sup>A</sup> Condition the specimens for 24 h before making the volume resistivity measurement.

<sup>B</sup> The tubing shall meet Table 4 requirements under the following conditions: 1 month at 40°C (104°F), 4 months at 30°C (86°F), and 12 months at 21°C (70°F).

**TABLE 4 Dimensional Requirements (1.75 to 1 Shrink Ratio)**

As Supplied			After Unrestricted Shrinkage		
Nominal Size, in.	Inside Diameter, min, in. (mm)	Eccentricity, max, %	Inside Diameter, max, in. (mm)	Wall Thickness, in. (mm)	Longitudinal Change, max, %
¼	0.250 (6.35)	40	0.143 (3.63)	0.035 ± 0.010 (0.89 ± 0.25)	+ 1, – 10
⅜	0.375 (9.52)	40	0.214 (5.44)	0.040 ± 0.010 (1.02 ± 0.25)	+ 1, – 10
½	0.500 (12.7)	40	0.286 (7.26)	0.048 ± 0.015 (1.22 ± 0.38)	+ 1, – 10
⅝	0.625 (15.9)	40	0.357 (9.07)	0.052 ± 0.015 (1.32 ± 0.38)	+ 1, – 10
¾	0.750 (19.0)	40	0.428 (10.9)	0.057 ± 0.015 (1.45 ± 0.38)	+ 1, – 10
7/8	0.875 (22.2)	40	0.500 (12.7)	0.065 ± 0.015 (1.65 ± 0.38)	+ 1, – 10
1	1.00 (25.4)	40	0.570 (14.5)	0.070 ± 0.020 (1.78 ± 0.51)	+ 1, – 10
1¼	1.25 (31.8)	40	0.714 (18.1)	0.087 ± 0.020 (2.21 ± 0.51)	+ 1, – 10
1½	1.50 (38.1)	40	0.857 (21.8)	0.095 ± 0.020 (2.41 ± 0.51)	+ 1, – 10
1¾	1.75 (44.4)	40	1.000 (25.4)	0.107 ± 0.020 (2.72 ± 0.51)	+ 1, – 10
2	2.00 (50.8)	40	1.140 (29.0)	0.110 ± 0.020 (2.79 ± 0.51)	+ 1, – 10
3	3.00 (76.2)	40	1.710 (43.4)	0.125 ± 0.020 (3.18 ± 0.51)	+ 1, – 10
4	4.00 (101.6)	40	2.280 (57.9)	0.140 ± 0.020 (3.56 ± 0.51)	+ 1, – 10

## 17. Keywords

17.1 crosslinked chlorinated polyolefin heat-shrinkable tubing; electrical insulation; heat-shrinkable tubing

**TABLE 5 Mandrel Sizes for Low-Temperature Flexibility**

Nominal Tubing Size, in.	Mandrel Diameter, in. (mm)
1/4	5/16(8)
3/8 to 1/2	3/8(10)
3/4 to 2	7/16(11)
3 to 4	7/8(22)

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