



Designation: D2903 – 21

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

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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 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, temperatures are described in degrees Celsius only.

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
- D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
 - 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
 - D8355 Test Methods for Flammability of Electrical Insulating Materials Used for Sleeving or Tubing

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.

2.2 *Military Standards:*³

- 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:*⁴

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

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 issues, refer to Terminology E176.

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

³ Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, <http://quicksearch.dla.mil>.

⁴ Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Washington, DC 20401-0001, <http://www.access.gpo.gov>.

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

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.

6.3 Conditioning:

6.3.1 Unless otherwise specified, all testing for this standard, except flammability, shall be conducted at 23 ± 5 °C (73 ± 9 °F) and a relative humidity of 50 ± 10 % RH. Flammability testing shall be conducted in still air at a temperature of 15 to 35 °C (59 to 95 °C) and a relative humidity of <75 %. All samples shall be preconditioned at 23 ± 5 °C (73 ± 9 °F) and a relative humidity of 50 ± 10 % RH. for a minimum of 30 minutes prior to test.

7. Chemical Property Requirements

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

7.2 Every lot of material manufactured requires testing for flammability, but testing for all the other chemical property requirements shall be conducted less frequently or at 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 testing for all other requirements shall be conducted less frequently or at 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 have the potential to 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.

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)

11.2 Inspect a quantity of the end item selected at random from each lot in accordance with Practice D3636 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 purchaser is entitled to reject the lot of material. A notice of nonconformance of material based on tests made according to this specification shall be reported to the manufacturer promptly and in writing.

12.3 It is acceptable to replace or rework rejected tubing to correct the nonconformances and then resubmit 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 D2671 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.

17. Keywords

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

TABLE 2 Chemical Requirements

Property	Requirement	
	Type I	Type II
Corrosion		
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
Solvent resistance:		
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 ^A		
Followed by tests for:		
Tensile strength, min, psi (MPa)	900 (6.2)	1000 (6.9)
Ultimate elongation, min, %	150	200
Weight increase, %	25	25
Flammability (Test Methods D8355, Test Method A):		
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

^A Perform in gasoline at room temperature (24 °C) only.

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 D412, 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, ^A	10 ¹⁰	10 ¹¹
Specific gravity, max	1.5	1.5
Stress modulus (at 200 % strain), max, psi (MPa)	2500 (17.2)	2500 (17.2)
Shelf life ^B	meet Table 4 requirements	meet Table 4 requirements

^A Condition the specimens for 24 h before making the volume resistivity measurement.

^B The tubing shall meet Table 4 requirements under the following conditions: one month at 40 °C (104 °F), four months at 30 °C (86 °F), and twelve months at 21 °C (70 °F).