



Designation: **D3150—18** **D3150 – 21**

Standard Specification for Crosslinked and Noncrosslinked Poly(Vinyl Chloride) Heat-Shrinkable Tubing for Electrical Insulation¹

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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

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.

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

- [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](#)
- [D8355 Test Methods for Flammability of Electrical Insulating Materials Used for Sleeving or Tubing](#)
- [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](#)

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.

Current edition approved May 1, 2018; Jan. 1, 2021. Published May 2018; February 2021. Originally approved in 1973. Last previous edition approved in 2014 as D3150—14; D3150 – 18. DOI: 10.1520/D3150-18.10.1520/D3150-21.

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.

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

2.3 *Federal Standards: Standard:*⁴

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

2.4 *IEC Standards:*⁵

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

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~~.

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4. Classification

4.1 *Type I*—Flexible, noncrosslinked poly(vinyl chloride) tubing capable of being shrunk at ~~135°C (275°F)~~ 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)~~ 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.

6.3 *Conditioning:*

6.3.1 Unless otherwise specified, all testing, except flammability, shall be conducted at ~~23 ±5°C (73 ±9°F)~~ ± 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 –35°C (59 –95°C)~~ 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)~~ ± 5 °C (73 ± 9 °F) and a relative humidity of ~~50 ±10% ± 10% RH~~ ± 10 % RH. for a minimum of 30 ~~minutes~~ min prior to test.

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 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.

⁴ Available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; Superintendent of Documents, 732 N. Capitol St., NW, Washington, DC 20401-0001, <http://www.access.gpo.gov>.

⁵ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

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 I—30 min, 135 ± 2 °C (275 ± 4 °F) | no cracks | |
| — Type II—30 min, 175 ± 2°C (374 ± 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 |
| 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 |
| 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 |
| 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 |
| Flammability, max, s, Test Methods D8355, Test A | 15 | 15 |
| Heat shock: | | |
| — Type I—4 h at 180 ± 2°C (236 ± 4°F) | no dripping, flowing, or cracking | |
| — 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 |
| — 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 |
| 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: | | |
| 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): | | |
| 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 |
| — 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 | ^A | ^A |
| — 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. | | |
| ^A The required shelf life is two 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. | | |

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

| Nominal Size, in. | As Supplied | | After Unrestricted Shrinkage |
|-------------------|--------------------------------|--------------------------------|------------------------------|
| | 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) |
| 1 1/2 | 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) |

TABLE 3 Type I and II Dimensions

| Nominal Size, in. | As Supplied | | After Unrestricted Shrinkage |
|-------------------|--------------------------------|--------------------------------|------------------------------|
| | 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) |

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.

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 instead 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.