



Designation: D2219 – 21

Standard Specification for Poly(Vinyl Chloride) Insulation for Wire and Cable, 60 °C Operation¹

This standard is issued under the fixed designation D2219; 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 covers a thermoplastic insulation of poly(vinyl chloride) or the copolymer of vinyl chloride and vinyl acetate.

1.2 This insulation is recommended for use at conductor temperatures not in excess of 60 °C in wet or dry locations at a maximum voltage rating of 600 V for power and control circuits.

1.3 In many instances, the insulation material cannot be tested unless it has been formed around a conductor or cable. Therefore, tests are done on insulated wire or cable in this specification solely to determine the relevant property of the insulation material and not to test the conductor or completed cable.

1.4 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.

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

1.5 *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](#)

[D2633 Test Methods for Thermoplastic Insulations and](#)

[Jackets for Wire and Cable](#)

[D8354 Test Method for Flammability of Electrical Insulating Materials Used for Sleeving or Tubing](#)

[G153 Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials](#)

[G155 Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials](#)

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this specification, refer to Terminology [D1711](#).

4. Physical Properties

4.1 The insulation shall conform to the requirements for physical properties prescribed in [Table 1](#). In terms of this specification, the act of aging is the response of materials to their exposure to air or oil at a temperature and a time as specified in [Table 1](#). The vertical flame test shall be conducted in accordance with Test Method [D8354](#).

5. Electrical Requirements

5.1 Perform the ac voltage, insulation resistance, and dc voltage tests in that order when any of these tests are required. The sequence for other testing is not specified.

5.2 *AC Voltage Test*—Test the insulated conductor at the ac withstand voltage as specified in [Table 2](#). Unless otherwise specified, omit this test if the dc withstand voltage test described in [5.4](#) is performed.

5.2.1 For cables or conditions of service where mechanical stresses govern, such as in vertical risers, it is possible that the minimum conductor sizes in [Table 2](#) are not strong enough.

5.2.2 The thicknesses given in [Table 2](#) apply to aerial cables and to single conductors installed in conduits above ground and to the individual conductors of all multiple-conductor cables having a common jacket metallic sheath or protective covering over the assembly, except as shown in [5.2.2.1](#).

5.2.2.1 For single-conductor cables for installation in underground ducts or direct earth burial, add 15 mils (0.38 mm) to the insulation thicknesses given in [Table 2](#) when such cables do not have a thermoplastic jacket or metallic sheath over the assembly.

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 Jan. 1, 2021. Published February 2021. Originally approved in 1963. Last previous edition approved in 2017 as D2219 – 17. DOI: 10.1520/D2219-21.

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.

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

TABLE 1 Physical Properties Requirements

Unaged Requirements:		
Tensile strength, min, psi (MPa)		1500 (10.3)
Elongation at rupture, min, %		100
Aged Requirements:		
After Air Oven Test at 100 ± 1 °C for 168 h:		
Tubular Specimens—Up to size AWG 6 (13.3 mm ²)		
Tensile strength, min, % of unaged value		65
Elongation, min, % of unaged value		65
Buffed Die-cut Specimens—sizes AWG 6 and larger		
Tensile strength, min, % of unaged value		65
Elongation, min, % of unaged value		45
Heat Shock, 121 ± 1 °C		no cracks
Heat Distortion, 121 ± 1 °C, max, %		50
Vertical Flame test, after		passes
Five 15-s applications in accordance with Test Method D8354		
Oil Resistance Test:		
After Oil Immersion at 70 ± 1 °C for 4 h:		
Tubular Specimens—Up to size AWG 6 (13.3 mm ²)		
Tensile strength, min, % of unaged value		85
Elongation, min, % of unaged value		85
Buffed Sie-cut Specimens—Sizes AWG 6 and larger		
Tensile strength, min, % of unaged value		80
Elongation, min, % of unaged value		60
Cold Bend Test, -10 ± 1 °C for 1 h		no cracks

5.2.3 Where the thickness of the insulation is increased for mechanical reasons or for special service conditions, determine the test voltage in Table 2 by the size of the conductor and the rated voltage.

5.3 Insulation Resistance:

5.3.1 Insulated conductors in sizes AWG 26 (0.13 mm²) and larger shall have an insulation resistance of at least that corresponding to a constant of 500 MΩ-1000 ft at 60 °F (15.6 °C).

TABLE 2 Conductor Sizes, Insulation Thicknesses, and Test Voltages for Poly(Vinyl Chloride)-insulated Control and Power Cables

Rated Circuit Voltage, Phase-to-Phase, V	Power and Control Cable:		AC Test Voltage, kV
	Conductor Size, AWG or cmil (mm ²)	Insulation Thickness, mils (mm)	
0 to 300	26 to 16 (0.13 to 1.31)	15 (0.38)	1.0
0 to 600	18 to 16 (0.82 to 1.31)	30 (0.76)	1.5
	14 to 9 (2.08 to 6.63)	45 (1.14)	3.0
	8 to 2 (8.37 to 33.6)	60 (1.52)	3.5
	1 to 0000 (42.4 to 10.7)	80 (2.03)	4.0
	225 000 to 500 000 (140 to 253)	95 (2.41)	5.0
	501 000 to 1 000 000 (254 to 507)	110 (2.79)	6.0
	Over 1 000 000 (507)	125 (3.18)	7.0

5.3.2 If the temperature at the time measurement was made differs from 60 °F (15.6 °C), correct the insulation resistance to 60 °F by multiplying the measured value by the proper

correction factor from Table 1, Temperature Correction Factors for Insulation Resistance at 60 °F, of Test Methods D2633.

5.4 DC Voltage Test—Upon completion of the insulation resistance test, test each non-shielded insulated conductor for 5 min at a dc withstand voltage which is three times the ac test voltage specified in Table 2. Unless otherwise specified, omit this test if the ac withstand voltage test described in 5.2 is performed.

5.5 Accelerated Water Absorption—The insulation shall meet the requirements in Table 3.

5.6 Dielectric Strength Retention— The insulation shall be capable of meeting a dielectric strength retention of at least 50 % of the original dielectric strength when tested at a temperature of 50 ± 1 °C.

6. Thickness of Insulation

6.1 The average thickness of the insulation shall be at least that prescribed in Table 2. The minimum thickness shall be at least 90 % of the thickness prescribed in Table 2.

7. Workmanship, Finish, and Appearance

7.1 Apply the insulation directly to the surface of the conductor or conductor covering and obtain a tight fit to that surface.

7.2 Repairs and Joints—When making repairs or joints in the insulation, do the work in such a manner that the repaired part of the joint, and all parts affected by the process, meet the same electrical tests as the remainder of the insulation and maintain the limitations on the thickness specified in Section 6.

8. Sampling

8.1 Sample the insulation in accordance with Test Methods D2633.

9. Test Methods

9.1 Test the insulation in accordance with Test Methods D2633.

10. Keywords

10.1 60 °C poly (vinyl chloride) insulation; ac voltage test; accelerated water absorption; dc voltage test; insulation resistance; poly (vinyl chloride) insulation; thickness

TABLE 3 Accelerated Water Absorption Requirements

Electrical Method 60 Hz at 50 ± 1 °C:	
Permittivity after 24 h, max	10.0
Increase in Capacitance, max, %:	
1 to 14 days	10.0
7 to 14 days	5.0