



# Standard Specification for Poly(Vinyl Chloride) Insulation for Wire and Cable, 90°C Operation<sup>1</sup>

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## 1. Scope

1.1 This specification covers a thermoplastic insulation of poly (vinyl chloride) or the copolymer of vinyl chloride and vinyl acetate. This insulation is recommended for use at conductor temperatures not in excess of 90°C.

1.2 Depending on the thickness of the insulation, the maximum voltage used, and whether the location is wet or dry, this insulation may be used for 300 V (dry) and 600 V (wet or dry) power and control circuits.

1.3 This insulation may have low-temperature installation limitations. Consult the manufacturer for specific recommendations for installation.

1.4 Whenever two sets of values are presented, in different units, the values in the first set are the standard, while those in parentheses are for information only.

1.5 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.

## 2. Referenced Documents

### 2.1 ASTM Standards:

D 1711 Terminology Relating to Electrical Insulation<sup>2</sup>

D 2633 Test Methods for Thermoplastic Insulations and Jackets for Wire and Cable<sup>3</sup>

## 3. Terminology

3.1 *Definitions:* For definitions of terms used in this specification, refer to Terminology D 1711.

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

3.2.1 *aging (act of), n*—exposure of materials to air or oil at a temperature and for an interval of time as required in Table 1.

<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 D09.18 on Solid Insulations, Non-Metallic Shieldings and Coverings for Electrical and Telecommunication Wires and Cables.

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 10.01.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 10.02.

**TABLE 1 Physical Properties Requirements for Insulation**

Unaged requirements:	
Tensile strength, min, psi (MPa)	2000 (13.8)
Elongation at rupture, min, %	150
Aged requirements:	
After air oven test at 136 ± 1°C for 168 h:	
Tubular Specimens - up to size AWG 6 (13.3 mm <sup>2</sup> )	
Tensile strength, min, percent of unaged value:	70
Elongation at rupture, min, percent of unaged value:	65
Buffed die-cut Specimens - sizes AWG 6 and larger	
Tensile strength, min, percent of unaged value:	70
Elongation at rupture, min, percent of unaged value:	45
Heat shock, 121 ± 1°C	no cracks
Heat distortion, 121 ± 1°C, max, percent decrease	25
Vertical flame test, after five 15-s applications:	passes
Oil resistance:	
After oil immersion at 70 ± 1°C for 4 h:	
Tubular Specimens - up to size AWG 6 (13.3 mm <sup>2</sup> )	
Tensile strength, min, percent of unaged value	85
Elongation, min, percent of unaged value	85
Buffed die-cut Specimens - sizes AWG 6 and larger	
Tensile strength, min, percent of unaged value	80
Elongation, min, percent of unaged value	60
Cold bend test, -30 ± 1°C for 1 h	no cracks

## 4. Physical Properties

4.1 The insulation shall conform to the requirements for physical properties prescribed in Table 1. (See Table 2 for optional oil resistance requirements.)

## 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 3. Unless otherwise specified, omit this test if the dc withstand voltage test described in 5.4 is performed.

### 5.3 Insulation Resistance:

5.3.1 Insulated conductors in Sizes AWG 14 (2.08 mm<sup>2</sup>) and larger shall have an insulation resistance of at least that corresponding to a constant of 2000 MΩ-1000 ft at 60°F (15.6°C).

**TABLE 2 Optional Oil Resistance Requirements**

Oil Resistant Rating		
60°C (140°F)	After oil immersion at 100 ± 1°C for 96 h:	
	Tensile strength, min, percent of unaged value	50
	Elongation, min, percent of unaged value	50
75°C (167°F)	After oil immersion at 75 ± 10°C for 60 days:	
	Tensile strength, min, percent of unaged value	65
	Elongation, min, percent of unaged value	65

**TABLE 3 Conductor Sizes, Insulation Thickness, and Test Voltages for Poly(Vinyl Chloride)-Insulated Control and Power Cables**

NOTE 1—For cables or conditions of service where mechanical stresses govern, such as in submarine cables or long vertical risers, these minimum conductor sizes may not be strong enough.

NOTE 2—The thicknesses given in Table 3 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, with the following exceptions: For single-conductor cables for installation in underground ducts or direct earth burial and for all submarine cables, add 15 mil (0.38 mm) to the insulation thicknesses given in Table 3, when such cables do not have a thermoplastic jacket or metallic sheath over the assembly.

NOTE 3—Where the thickness of the insulation is increased for mechanical reasons or for special service conditions, determine the test voltage by the size of the conductor and the rated voltage.

Control and Power Cable			
Rated Circuit Voltage Phase-to-Phase, V	Conductor Size, AWG or kcmil (mm <sup>2</sup> )	Insulation Thickness, mil (mm)	AC Test Voltage, kV
0 to 300	26 to 16 (0.13 to 1.31)	15 (0.38)	1.0
	26 to 16 (0.13 to 1.31)	30 (0.76)	1.5
0 to 600	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 107)	80 (2.03)	4.0
	225 to 500 (140 to 253)	95 (2.41)	5.0
	501 to 1000 (254 to 507)	110 (2.79)	6.0
	Over 1000 (507)	125 (3.18)	7.0

5.3.2 If the temperature at the time the 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 number 1 of Test Methods D 2633.

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 that is three times the ac test voltage specified in Table 3. 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 of Table 4 when tested in accordance with the procedure in Test Methods D 2633. Conduct the test at 60 Hz with the water temperature at 90 ± 1°C.

5.6 *Dielectric Strength Retention*—The insulation shall be capable of meeting a dielectric strength retention of at least 60 % of the original dielectric strength when tested in accordance with Test Methods D 2633 at a temperature of 90 ± 1°C.

**TABLE 4 Accelerated Water Absorption Requirements**

Electrical Method:	
Permittivity after 1 day, max	10.0
Increase in capacitance, max, %	
From 1 to 14 days	4.0
From 7 to 14 days	2.0

## 6. Thickness of Insulation

6.1 The average thickness of the insulation shall be at least that prescribed in Table 3. The minimum thickness shall be at least 90 % of the thickness prescribed in Table 3.

## 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 D 2633.

## 9. Test Methods

9.1 Test the insulation in accordance with Test Methods D 2633.

## 10. Keywords

10.1 accelerated water absorption; ac voltage test; dc voltage test; insulation resistance; poly(vinyl chloride) insulation; 90°C poly(vinyl chloride) insulation; thickness

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