



# Standard Specification for Poly(Vinyl Chloride) Insulation for Wire and Cable, 60°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.

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.

1.23 ~~Whenever two sets of values stated in inch-pound units are presented, in different units, the standard, except values in cases where SI units the first set are more appropriate. The values standard, while those in parentheses are for information only.~~

1.34 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>

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee ~~D-9~~ 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 Telecommunications Wires and Cables.

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**3. Terminology**

3.1 *Definitions:*

3.1.1 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 a time as specified in Table 1.

**4. Physical Properties**

4.1 The insulation shall conform to the requirements for physical properties prescribed in Table 1.

**5. Thickness of Insulation**

5.1 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.

**6. Workmanship, Finish, and Appearance**

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

6.2 *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 5.

**7. Electrical Requirements**

7.1 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.

7.2 *AC Voltage Test*—Test the insulated conductor at the ac withstand voltage as specified in Table 2. This test may be omitted if the dc withstand voltage test described in 7.4 5.4 is performed.

7.3 *Insulation Resistance:*

7.3.1 Insulated conductors in sizes AWG 26 (0.13 mm<sup>2</sup>) 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).

<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**

Physical properties requirements:	
<u>Unaged Requirements:</u>	
Tensile strength, min, psi (MPa)	1500 (10.3)
Elongation at rupture, min, %	100
<u>Air Oven Aging Requirements:</u>	
<u>Aged Requirements:</u>	
After air oven test at 100 ± 1°C for 168 h:	
Tubular Specimens—up to size AWG 6 (13.3 mm <sup>2</sup> )	
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	45
Tensile strength, min, % of unaged value	65
Elongation, 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, max burning time after	passes
Vertical flame test, after	passes
five 15-s applications	
<u>Oil resistance test:</u>	
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,% of unaged value	85
Elongation, min, % of unaged value	85
Buffed die-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

**TABLE 2 Conductor Sizes, Insulation Thicknesses, 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 long vertical risers, these minimum conductor sizes may not be strong enough.

NOTE 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, with the following exceptions: 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.

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 and not by the apparent thickness of insulation.

NOTE 4—Do not use single conductor cables in size AWG 9 (6.63 mm<sup>2</sup>) and smaller for direct earth burial.

Rated Circuit Voltage, Phase-to-Phase, V	Power and Control Cable:		AC Test Voltage, kV
	Conductor Size, AWG or cmil (mm <sup>2</sup> )	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

75.3.2 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 Methods D 2633.

75.4 *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. This test may be omitted if the ac withstand voltage which is three times the ac test voltage specified in Table 2. This test may be omitted if the ac withstand voltage test described in 7.2 5.2 is performed.

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

75.6 *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 Methods D 2633.

**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

## 9. Test Methods

9.1 Test the insulation in accordance with Methods D 2633.

## 10. Keywords

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

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