Designation: D6096 – 21

Standard Specification for Poly(Vinyl Chloride) Insulation for Wire and Cable, 90 °C Operation[1]

This standard is issued under the fixed designation D6096; 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. 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 is acceptable for use in 300 V (dry) and 600 V (wet or dry) power and control circuits.

1.3 This insulation has potential low-temperature installation limitations. Consult the manufacturer for specific recommendations for installation.

1.4 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.

1.5 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.

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

1.6 *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

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this specification, refer to Terminology D1711.

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.

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.)

[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.

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

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^2):	
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 deformation, 121± 1 °C, max, percent decrease	25
Vertical flame test, af	passes
Oil resistance:	
After oil immersion at 70 ± 1 °C for 4 h:	
Tubular Specimens - up to size AWG 6 (13.3 mm^2)	
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

TABLE 2 Optional Resistance Requirements

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

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

Control and Power Cable			
Rated Circuit Voltage Phase-to-Phase, V	Conductor Size, AWG or kcmil (mm^2)	Insulation Thicknesss, mil (mm)	AC Test Voltage, kV
0 to 300	26 to 16 (0.13 to 1.31)	15 (0.38)	1.0
0 to 600	26 to 16 (0.13 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 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. 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.

5.2.1 For cables or conditions of service where mechanical stresses govern, such as in submarine cables or long vertical risers, it is possible that the minimum conductor sizes in Table 3 are not strong enough.

5.2.2 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, excerpt as shown in 5.2.2.1.

5.2.2.1 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.

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 3 by the size of the conductor and the rated voltage.

5.3 *Insulation Resistance:*

5.3.1 Insulated conductors in Sizes AWG 14 (2.08 mm^2) 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).

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 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 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 D2633. 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 D2633 at a temperature of 90 ± 1 °C.

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.

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