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AMERICAN SOCIETY FOR TESTING AND MATERIALS
100 Barr Harbor Dr., West Conshohocken, PA 19428
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# Standard Specification for Poly(Vinyl Chloride) Insulation for Wire and Cable, 90°C Operation[1]

This standard is issued under the fixed designation D 6096; 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 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 The values stated in inch-pound units are the standard, except in cases where SI units are more appropriate. The values in parentheses are for information only.

1.5 This specification covers an insulating material. In some tests, it is necessary to produce an insulated conductor in order to test the insulation properties. However, in these instances, only the properties of the insulation are being tested, not the completed conductor.

## 2. Referenced Documents

2.1 *ASTM Standards:*

D 1711 Terminology Relating to Electrical Insulation[2]

D 2633 Methods of Testing Thermoplastic Insulations and Jackets for Wire and Cable[3]

## 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.

## 4. Physical Properties

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

**TABLE 1 Physical Requirements for Insulation**

| | |
|---|---|
| Physical requirements: | |
| Tensile strength, min, psi (MPa) | 2000 (13.8) |
| Elongation at rupture, min, % | 150 |
| Heat aging requirements: | |
| After air oven test at 121 + 1°C for 168 h: | |
| Tensile strength, min, percent of unaged value: | 70 |
| Elongation at rupture, min, percent of unaged value: | 65 |
| Heat shock, 121 ± 1°C | no cracks |
| Heat distortion, 121± 1°C, max, percent decrease | 25 |
| Vertical flame test, maximum burning time after 15-s applications: | passes |
| Oil resistance: | |
| After oil immersion at 70 ± 1°C for 4 h: | |
| Tensile strength, min, percent of unaged value | 85 |
| Elongation, min, percent of unaged value | 85 |
| Cold bend test, +30± 1°C for 1 h | no cracks |

4.2 For Sizes AWG 6 (13.3 mm$^2$) and larger where buffed die-cut specimens are used, the minimum elongation and tensile strength, as a percentage of unaged values, shall be at least the following:

| | |
|---|---|
| Elongation after air oven test | 45 % |
| Tensile strength after oil immersion | 80 % |
| Elongation after oil immersion | 60 % |

## 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.

5.3 *Insulation Resistance*:

5.3.1 Insulated conductors in Sizes AWG 14 (1.63 mm$^2$) and larger shall have an insulation resistance of at least that corresponding to a constant of 2000 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 1 of 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 2. Unless otherwise specified, omit this test if the ac withstand voltage test described in 5.2 is performed.

[1] This specification is under the jurisdiction of ASTM Committee D-9 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.18 on Solid Insulations, Nonmetallic Shieldings and Coverings for Electrical and Telecommunication Wires and Cables.

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[2] *Annual Book of ASTM Standards*, Vol 10.01.

[3] *Annual Book of ASTM Standards*, Vol 10.02.

**TABLE 2 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 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 and for all submarine cables, add 15 mil (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 the insulation.

NOTE 4—Do not use single conductor cables in Size AWG 9 (6.63 $mm^2$) and smaller for direct earth burial.

| 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 |

5.5 *Accelerated Water Absorption*—The insulation shall meet the requirements of Table 3 when tested in accordance with the procedure in 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 Methods D 2633 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 2. The minimum thickness shall be at least 90 % of the thickness prescribed in Table 2.

**TABLE 3 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 |

## 7. Sampling

7.1 Sample the insulation in accordance with Methods D 2633.

## 8. Test Methods

8.1 Test the insulation in accordance with Methods D 2633.

## 9. Keywords

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