



Standard Test Methods for Flexible Resin-Coated Glass Fabrics and Glass Fabric Tapes Used for Electrical Insulation¹

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This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 These test methods cover procedures for the testing of resin-coated glass fabrics and glass fabric tapes (Note 1) to be used as electrical insulation.

NOTE 1—Methods of testing varnished cloths and tapes are given in Methods D 295.

1.2 The warp threads in fabrics are the threads that are parallel with the length dimension as manufactured.

1.3 The procedures appear as follows:

Procedure	Section	ASTM Test Method Reference
Breaking Strength	22-28	D 828
Conditioning	6-8	...
Dielectric Breakdown Voltage and Dielectric Strength	29-38	D 149, D 295
Dissipation Factor and Relative Permittivity	52-60	D 150, E 104, D 5032
Effect of Elevated Temperature	39-45	D 1830
Resistance to Oil	46-51	D 3487
Sampling	3-5	...
Thermal Endurance	68	D 1830
Thickness	16-21	D 374
Thread Count	12-15	...
Weight	9-11	...
Weight Loss at Elevated Temperature	61-67	D 5423

1.4 The values stated in inch-pound units are to be regarded as the standard. The values in parentheses are for information only.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Specific warning statements are given in 35.1.1 and 58.1.*

2. Referenced Documents

2.1 ASTM Standards:

¹ These methods are under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materials, and are the direct responsibility of Subcommittee D09.07 on Flexible and Rigid Insulating Materials.

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D 149 Test Methods for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies²

D 150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials²

D 295 Test Methods for Varnished Cotton Fabrics Used for Electrical Insulation²

D 374 Test Methods for Thickness of Solid Electrical Insulation²

D 828 Test Method for Tensile Breaking Strength of Paper and Paperboard³

D 1000 Test Methods for Pressure-Sensitive Adhesive Coated Tapes Used for Electrical and Electronic Insulation²

D 1711 Terminology Relating to Electrical Insulation²

D 1830 Test Method for Thermal Endurance of Flexible Sheet Materials Used for Electrical Insulation by the Curved Electrode Method²

D 3487 Specification for Mineral Insulating Oil Used in Electrical Apparatus⁴

D 5032 Practice for Maintaining Constant Relative Humidity by Means of Aqueous Glycerin Solutions⁵

D 5423 Specification for Forced-Convection Laboratory Ovens for Evaluation of Electrical Insulation⁵

E 104 Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions⁵

2.2 IEEE Standard:

IEEE No. 1 General Principles for Temperature Limits in the Rating of Electrical Equipment⁶

² Annual Book of ASTM Standards, Vol 10.01.

³ Annual Book of ASTM Standards, Vol 15.09.

⁴ Annual Book of ASTM Standards, Vol 10.03.

⁵ Annual Book of ASTM Standards, Vol 10.02.

⁶ Available from Institute of Electrical and Electronics Engineers, 345 E. 47th St., New York, NY 10017.

SAMPLING

3. Selecting Sample Rolls

3.1 Sample shipments of resin-coated glass fabrics and glass fabric tapes as specified in 3.2 and 3.3. Select the rolls or pads in such a manner as to be representative of the shipment.

3.2 *Fabric*—Select one roll from each ten rolls or fraction thereof in a shipment of full-width fabric.

3.3 *Tape*—Select rolls of tape from each shipment in accordance with the following schedule:

Number of Rolls in Shipment	Minimum Number of Sample Rolls
Over 10 000	1 per thousand
5 001 to 10 000	10
2 001 to 5 000	5
101 to 2 000	2
100 or less	1

4. Selecting Samples

4.1 Cut off and discard not less than two turns of fabric or six turns of tape from each roll or pad selected for sampling before the samples are selected.

4.2 From shipments such as sheets of fabric or strips of tape, take samples representative of the shipment in accordance with 4.1.

5. Selecting Test Specimens

5.1 Prepare the test specimens from samples as selected in Section 4 and as provided for in the individual test methods.

CONDITIONING

6. Terminology

6.1 *Definitions of Terms Specific to This Standard:*

6.1.1 *conditioning* (of resin-coated glass fabrics or glass fabric tapes), *n*—the process of exposing test specimens of the material to a specified temperature, or to an atmosphere of specified relative humidity and temperature, for a specified period of time.

7. Significance and Use

7.1 The electrical properties of resin-coated glass fabrics are affected by their temperature and moisture content. For this reason it is necessary to control these properties for a specified time immediately prior to testing in order to attain reasonably good reproducibility of test values. The time of exposure to the conditioning atmosphere must be long enough to permit the test specimen to reach a relatively stable value. Usually the moisture content of these materials has little effect on the mechanical properties.

8. Conditioning

8.1 Unless otherwise specified in the individual test methods, condition test specimens as described in 8.1.1, 8.1.2, or 8.1.3. In matters of dispute, consider 8.1.2 the referee method. Use the method described in 8.1.3 only if specifically agreed upon by the producer and consumer.

8.1.1 Condition the test specimen for 48 h in the Standard Laboratory Atmosphere ($50 \pm 2\%$ relative humidity at a temperature of $23 \pm 1^\circ\text{C}$ ($73.4 \pm 1.8^\circ\text{F}$)), and conduct the tests in the Standard Laboratory Atmosphere.

8.1.2 Condition the test specimen for 48 h in the Standard Laboratory Atmosphere ($50 \pm 2\%$ relative humidity at a temperature of $23 \pm 1^\circ\text{C}$ ($73.4 \pm 1.8^\circ\text{F}$)), and conduct the tests immediately upon removal of the test specimen from the conditioning room or chamber.

8.1.3 Do not condition the test specimens if it is desired to test the material in the condition as received by the purchaser, but allow the packages containing the rolls of cloth or tape from which the specimens are to be taken to reach approximately test-room temperature before the packages are opened and the specimens cut. Remove the specimens to be tested from the roll as required and test immediately, unless otherwise specified.

WEIGHT

9. Terminology

9.1 *Definitions of Terms Specific to This Standard:*

9.2 *weight* (of resin-coated glass cloth and glass cloth tapes), *n*—the weight per unit area as determined in accordance with this method. It is usually expressed in pounds per square yard for a specified nominal thickness.

10. Significance and Use

10.1 The ratio of resin weight to glass cloth weight, within and between shipments, can be determined from the weight of resin-coated glass cloth and glass cloth tape and the weight of the cloth base. This ratio is a factor in determining the electrical characteristics of the material. Weight values are useful for estimating weight in designing electrical equipment containing a constituent part of resin-coated cloth or tape.

11. Procedure

11.1 Determine the weight per unit area using the method given in Test Methods D 295.

THREAD COUNT

12. Terminology

12.1 *Definitions of Terms Specific to This Standard:*

12.1.1 *thread count*, *n*—The thread count of resin-coated glass cloth refers to the count of the number of threads present in the base glass cloth per linear inch (centimetre) of length or width, respectively.

13. Significance and Use

13.1 Thread count, together with the weight and the width of the glass cloth, is accepted as the common means for designating and identifying cloth constructions.

13.2 Certain of the physical and electrical properties of woven fabrics are dependent on thread count. That is, assuming the same size of yarn, an increase in thread count increases the weight, breaking strength, and density of the cloth. Also, the dielectric strength and power factor of the resin-coated fabric may be changed by altering the number of threads per inch of the cloth.

14. Procedure

14.1 Determine the thread count in threads per inch or per centimetre separately on both the warp and filling.

15. Report

15.1 The results of the warp or filling count shall be reported as threads per inch (centimetre).

NOTE 2—Before counting black resin-coated materials, it will be necessary to remove the resin film with a knife blade or other suitable instrument. As an alternative method, liquid resin removers may be used for this purpose, provided specimens are dried before the thread count is taken.

THICKNESS

16. Terminology

16.1 *Definition:*

16.1.1 *thickness* (of an electrical insulating material), *n*—the perpendicular distance between the two surfaces of interest, determined in accordance with a standard method.

17. Significance and Use

17.1 This test is of value in determining whether the material meets specified tolerances for thickness. In addition, thickness values are essential because of the importance of space factor in designing electrical equipment.

17.2 Determination of dielectric strength, usually expressed in volts per mil, also necessitates thickness measurements.

18. Test Specimens

18.1 In the case of fabrics, cut a specimen 1 in. (25.4 mm) wide across the entire width.

18.2 In the case of tapes, remove the specimens from samples selected in accordance with Section 3. Prepare specimens 36 in. (914 mm) long.

19. Procedure

19.1 Unless otherwise specified, measure the thickness in accordance with Method C of Test Methods D 374 with the following modifications:

19.1.1 In making thickness measurements, use only one layer of the material.

19.1.2 In the case of fabrics, take ten measurements equally spaced across the width of the specimen. The thickness of the cloth is the average of the ten measurements.

19.1.3 In the case of tapes, unless otherwise specified, take ten measurements equally spaced along the length of each specimen. The thickness of the tape is the average of the ten measurements.

19.1.4 The diameter of the pressure foot is 0.250 ± 0.001 in. (6.35 ± 0.03 mm) and the diameter of the anvil is at least 2 in. (50 mm). The pressure on the pressure foot (dead weight) is 25 ± 2 psi or 172 ± 14 kPa.

19.1.5 Methods A and C of Test Methods D 374 shall not be considered interchangeable.

19.2 Method B of Test Methods D 374 may be used upon specific agreement between the producer and consumer.

20. Report

20.1 Report the average, maximum, and minimum thicknesses, in inches, reported to the nearest 0.0001 in. (0.0025 mm).

21. Precision and Bias

21.1 This test method has been in use for many years, but no information has been presented to ASTM upon which to base a statement of precision. No activity has been planned to develop such information.

21.2 This test method has no bias because the value for thickness is determined solely in terms of this test method itself.

BREAKING STRENGTH

22. Terminology

22.1 *Definitions of Terms Specific to This Standard:*

22.2 *breaking strength* (of resin-coated glass cloths and glass cloth tapes), *n*—the force per unit width required to break the cloth or tapes when tested under certain prescribed conditions.

23. Significance and Use

23.1 The breaking strength of finished cloth and tape is of importance as a measure of its ability to withstand reasonable pulling without failure while being applied in service.

24. Apparatus

24.1 Use a power-driven testing machine of the dead-weight pendulum type as described in Test Method D 828, or the constant-rate-of-elongation type as described in Test Methods D 1000. The machine shall be graduated to read 1 lb or 1 kg or less per scale division for testing specimens breaking up to 50 lb (22.7 kg) or over, and to 0.5 lb or 0.5 kg or less for testing specimens breaking under 50 lb (22.7 kg).

25. Test Specimens

25.1 From full-width fabric samples or from sample rolls of tapes over 1 in. (25.4 mm) in width cut specimens 1 in. in width (Note 3) and not less than 12 in. (305 mm) in length. For tape having a nominal width of 1 in. or under, prepare specimens of the original width and not less than 12 in. in length.

NOTE 3—In the case of specimens 1 in. in width and having ultimate breaking loads above the capacity of the machine, it is permissible to reduce the width of the specimen to 0.5 in. (12.7 mm).

25.2 In the case of fabrics, cut five specimens with the sides parallel to the warp threads and five with the sides parallel to the filling threads (Note 4), from samples selected in accordance with Section 4.

NOTE 4—Frequently the fill threads of glass fabrics used to manufacture resin-coated glass fabrics do not run in a straight line and are not perpendicular to the warp threads. Breaking strength from specimens cut perpendicular to the warp thread may, therefore, be highly variable.

25.3 In the case of tapes, cut five specimens from each roll selected in accordance with 3.3.

26. Procedure

26.1 Maintain the clearance distance between jaws at 6 in. (153 mm).

26.2 Keep the rate of travel of the movable jaw constant and preferably 12 in. (305 mm)/minute, but it may be within the limits of 11 and 12 in. (280 and 330 mm)/minute, provided it is constant.

26.3 Reject all readings obtained when the specimen breaks at or in the jaws.

27. Report

27.1 The breaking strength of a roll of fabric or tape is the average of the breaking strengths of all the specimens tested from the roll. Report the average, maximum, and minimum breaking strengths in pounds per inch width (or newtons per metre), together with the width and nominal thickness.

27.2 In the case of fabrics, report the breaking strengths of the warp threads and the filling threads separately.

28. Precision and Bias

28.1 This test method has been in use for many years, but no information has been presented to ASTM upon which to base a statement of precision. No activity has been planned to develop such information.

28.2 This test method has no bias because the value for breaking strength is determined solely in terms of this test method itself.

DIELECTRIC BREAKDOWN VOLTAGE AND DIELECTRIC STRENGTH

29. Terminology

29.1 *Definition:*

29.1.1 For definitions of dielectric breakdown voltage and dielectric strength refer to Terminology D 1711.

30. Significance and Use

30.1 Dielectric strength of resin-coated glass fabric or tape insulating material is of significance for the following reasons:

30.1.1 Insulating materials are subjected to electrical stresses in service for long periods of time. Although these service stresses are usually a small fraction of the breakdown stresses determined by dielectric strength tests, it has been found that, for any given material, the service stresses which it can withstand during its life bear some relation to the breakdown stresses obtained in the dielectric strength test. This test, therefore, gives some indication of the ability of the fabrics or tapes to withstand the service stresses to which they are subjected.

30.1.2 The dielectric strength test indicates the presence of defects in the fabric or resin, in that part of the surface explored.

30.2 Three test methods of test for dielectric strength are given, the "short-time," the "step-by-step," and the "slow-rate-of-rise" tests. Choice of the test method should be based on whether or not the effect of time under stress is considered an important factor, and the available time which can be allowed for each test.

31. Apparatus

31.1 Use the apparatus described in Test Method D 149 except as described in Section 34 of these test methods.

32. Test Specimens

32.1 In the case of fabrics, cut the specimens across the full width of each sample selected in accordance with Section 4, and cut in the form of a piece of tape at least 1 in. (25.4 mm) in width. When the specimen is less than 36 in. (914.4 mm), cut as many specimens as are needed to obtain an equivalent 36 lineal in.

32.2 In the case of tapes, remove the specimens from the sample selected in accordance with Section 3. Prepare specimens 36 in. long.

33. Conditioning

33.1 Condition specimens in accordance with Section 8.

34. Electrodes

34.1 Use cylindrical electrodes, $\frac{1}{4}$ in. (6.35 mm) in diameter with edges rounded to a radius of $\frac{1}{32}$ in. (0.79 mm) and mounted in a test assembly which permits clamping the specimen between pressure gaskets to eliminate voltage flash-over as described in the Appendix to Test Method D 295, to measure the dielectric breakdown voltage.

35. Dielectric Breakdown Voltage

35.1 Determine the dielectric breakdown voltage in accordance with Test Method D 149, except as otherwise specified in this method.

35.1.1 **Warning** —*Lethal voltages may be present during this test. It is essential that the test apparatus, and all associated equipment that may be electrically connected to it, be properly designed and installed for safe operation. Solidly ground all electrically conductive parts that any person might come into contact with during the test. Provide means for use, at the completion of any test, to ground any parts which: were at high voltage during the test; may have acquired an induced charge during the test; may retain a charge even after disconnection of the voltage source. Thoroughly instruct all operators in the proper way to conduct tests safely. When making high voltage tests, particularly in compressed gas or in oil, the energy released at breakdown may be sufficient to result in fire, explosion, or rupture of the test chamber. Design test equipment, test chambers and test specimens so as to minimize the possibility of such occurrences, and to eliminate the possibility of personal injury.*

35.2 For fairly rapid determinations, make tests by the short-time method described in Test Method D 149, voltage being increased at the rate of 0.5 kV/s.

35.3 For determinations somewhat more dependent on the duration of stress, make tests by the step-by-step or its alternate, the slow-rate-of-rise method.

35.3.1 In the case of tests made by the step-by-step method, make each step of 20-s duration, and increase the voltage by an increment of 250 V for materials whose nominal thickness is 8 mils (0.2 mm) or less, and by an increment of 500 V for materials whose nominal thickness is greater than 8 mils. Use a starting voltage which is equal to 50 % of the breakdown voltage obtained in the short-time test and adjusted to the nearest even 250 or 500 V depending on the increment of increase.