An American National Standard

Standard Test Methods for Flexible Resin-Coated Glass Fabrics and Glass Fabric Tapes Used for Electrical Insulation[1]

This standard is issued under the fixed designation D 902; 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.

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 statement are given in 35.1.1 and 58.1.

2. Referenced Documents

2.1 *ASTM Standards:*

D 149 Test Methods for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies[2]

D 150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials[2]

D 295 Test Methods for Varnished Cotton Fabrics Used for Electrical Insulation[2]

D 374 Test Methods for Thickness of Solid Electrical Insulation[2]

D 828 Test Method for Tensile Breaking Strength of Paper and Paperboard[3]

D 1000 Test Methods for Pressure-Sensitive Adhesive Coated Tapes Used for Electrical and Electronic Insulation[2]

D 1711 Terminology Relating to Electrical Insulation[2]

D 1830 Test Method for Thermal Endurance of Flexible Sheet Materials Used for Electrical Insulation by the Curved Electrode Method[2]

D 3487 Specification for Mineral Insulating Oil Used in Electrical Apparatus[4]

D 5032 Practice for Maintaining Constant Relative Humidity by Means of Aqueous Glycerin Solutions[5]

D 5423 Specification for Forced-Convection Laboratory Ovens for Evaluation of Electrical Insulation[5]

E 104 Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions[5]

2.2 *IEEE Standard:*

IEEE No. 1 General Principles for Temperature Limits in the Rating of Electrical Equipment[6]

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[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.

Current edition approved Sept. 10, 2000. Published December 2000. Originally published as D 902 – 46. Last previous edition D 902 – 95.

[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 ± 2 % relative humidity at a temperature of 23 ± 1°C (73.4 ± 1.8°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 ± 2 % relative humidity at a temperature of 23 ± 1°C (73.4 ± 1.8°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 $\pm$ 0.001 in. (6.35$\pm$ 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 $\pm$ 2 psi or 172 $\pm$ 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, ¼ in. (6.35 mm) in diameter with edges rounded to a radius of 1⁄32 in. (0.79 mm) and mounted in a test assembly which permits clamping the specimen between pressure gaskets to eliminate voltage flashover 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.

35.3.2 In the case of tests made by the slow-rate-of-rise method, use a starting voltage which is the same as in the step-by-step method and increase the voltage uniformly at the rate of 12.5 V/s for materials whose nominal thickness is 8 mils or less, and at the rate of 25 V/s for materials whose nominal thickness is greater than 8 mils.

36. Procedure

36.1 Measure the thickness of the test specimens or of a separate set of test specimens in accordance with Sections 16-20.

36.2 Make ten punctures equally spaced along 36 lineal in. when utilizing the short-time method. Make five punctures equally spaced along 36 lineal in. when utilizing the step-by-step or slow-rate-of-rise method.

37. Report

37.1 Report the following:

37.1.1 Method used to determine the dielectric breakdown voltage,

37.1.2 Average, maximum, and minimum dielectric breakdown voltage for each method,

37.1.3 Average thickness as determined in 19.1,

37.1.4 Average dielectric strength in volts per mil obtained by dividing the average breakdown voltage in 37.1.2 by the average thickness in 37.1.3, and

37.1.5 Conditioning.

38. Precision and Bias

38.1 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.

38.2 This test method has no bias because the value for dielectric breakdown voltage is determined solely in terms of this test method itself.

EFFECT OF ELEVATED TEMPERATURE

39. Terminology

39.1 *Definitions of Terms Specific to This Standard:*

39.1.1 *the effect of elevated temperature* (on resin-coated glass cloth or tape), *n*—impairment of physical and electrical properties when the material is subjected to specified oven temperature for a prescribed period of time in free air.

40. Significance and Use

40.1 The effect of elevated temperature on resin-coated glass fabrics or tapes gives some indication of the ability of the cloths or tapes to withstand the service temperature to which they may be subjected without producing crazing or cracking of the resin film.

41. Apparatus

41.1 *Conditioning Oven*—An electrically-heated forced-air circulating oven adjusted to provide for air velocity across the test specimens complying with the requirements of Specification D 5423.

41.2 *Fixture*—A suitable fixture for mounting the specimen vertically so the specimens are at least 4 in. (101.6 mm) from the walls at any point, to permit adequate circulation in all parts of the oven without permitting the specimens to touch each other during the baking period. The fixture is readily removable from the oven for mounting the specimens.

41.3 *Mandrels*—Mandrels, made of drill rod or equivalent, having diameters as specified in Section 43, for bending the baked and unbaked specimens.

41.4 *Electrical Apparatus*—Dielectric strength-test apparatus as described in Sections 31 and 34.

42. Test Specimens

42.1 From each sample selected in accordance with Section 4, cut ten specimens in the machine direction. Make the width of the specimens 1 in. (25.4 mm), except for narrow tapes which shall be tested in full width. Make the lengthwise dimension of sufficient magnitude to permit attaching both ends of each specimen in suitable clips of the specimen-holding fixture.

43. Procedure

43.1 With half of the test specimens in position, place the specimen-holding fixtures in the oven which has been previously brought to the required baking temperature. For silicone resin-coated fabrics intended for IEEE Class 180 or Class 200 applications as defined in IEEE No. 1, maintain the temperature at 250 ± 3°C (482 ± 5.4°F), or as otherwise agreed upon by the purchaser and seller. For resin-coated fabrics intended for IEEE Class 155 applications as defined in IEEE No. 1 maintain the temperature at 180 ± 3°C (356 ± 5.4°F), or as otherwise agreed upon.

NOTE 5—Thermal endurance of these fabrics may be determined by Test Method D 1830.

43.1.1 Bake the specimens referred to in 43.1 for 168 h at the temperature previously indicated.

43.1.2 Remove the baked specimens from the mounting fixture, care being taken not to damage the resin surfaces. Cool specimens to room temperature in the Standard Laboratory Atmosphere for not less than 1 h.

43.1.3 For cloths and tapes 10 mils (0.03 mm) or less in thickness, bend the specimens 180° around a mandrel 0.125 in. (3.175 mm) in diameter.

43.1.4 Bend specimens greater than 10 mils (0.03 mm) in thickness 180° around a mandrel 18 times the specimen thickness. Mount the test mandrel horizontally in a rigid holding fixture such as a vice or clamp. Position the center of the specimen above and in contact with the mandrel's center such that the specimen's long dimension is at right angles to the mandrel. With the specimen in contact with the mandrel, press the ends of the specimen down over the mandrel to form the 180° bend in not more than 3 s.

43.1.5 Make five short-time dielectric breakdown voltage tests, using the ¼-in. (6.351-mm) diameter pressure-gasketed electrodes described in Section 34, on each of the baked specimens. Position the electrodes on those areas which were bent 180° around the prescribed diameter mandrel.

43.1.6 Test the other set of specimens which have not been baked previously, but have been bent in accordance with 43.1.3 or 43.1.4, for dielectric breakdown in accordance with 43.1.5.

44. Report

44.1 Report the following information:

44.1.1 Maximum, minimum, and average values of dielectric breakdown voltage, in volts, for the unbaked bent specimens (43.1.6),

44.1.2 Percentage change in dielectric breakdown voltage, due to baking, calculated by dividing the average dielectric breakdown voltage obtained from the baked specimens (43.1.5), by the average dielectric breakdown voltage obtained from the unbaked bent specimens (43.1.6),

44.1.3 Average thickness of the sample as determined in 19.1,

44.1.4 Oven temperature,

44.1.5 Mandrel diameter, and

44.1.6 Appearance of resin films (color, conditions, etc.).

45. Precision and Bias

45.1 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.

45.2 This test method has no bias because the value for effect of elevated temperature is determined solely in terms of this test method itself.

RESISTANCE TO OIL (OLEORESINOUS VARNISH-COATED GLASS FABRIC OR TAPE ONLY)

46. Terminology

46.1 *Definitions of Terms Specific to This Standard:*

46.1.1 *oil-resistance* (of oleoresinous varnish-coated glass fabric or tape), *n*—the property of the varnish film to withstand the attack of mineral oil without excessive impairment of its physical characteristics when the varnish-coated cloth or tape is immersed in a specified oil for a prescribed period of time at a given temperature.

47. Significance and Use

47.1 The oil-resistance of oleoresinous varnish-coated glass fabric or tape determines the suitability of the insulation for use in oil-immersed apparatus, such as oil-filled transformers and switches, and in electric cables and cable splices.

47.2 When immersed in transformer oil, black varnish films usually soften and swell slightly, but they should not blister, wrinkle, nor separate from the fabric. Yellow varnish films are much more oil resistant than black films, and softer and swell very little, if any.

NOTE 6—This method is applicable only to coated glass fabric and tapes of the oleoresinous varnished type since other types of coatings (polyester, silicone resin, etc.) that are intended for higher temperature operation are not generally used in mineral oil-filled transformers or circuit breakers because of the temperature limitations of the oil. Silicone resin-coated glass fabric or tape generally is not highly resistant to mineral oils.

48. Test Specimens

48.1 Cut one specimen 12 in. (305 mm) in length and not exceeding 1.5 in. (38 mm) in width from each sample selected in accordance with Section 4, and used for thickness measurements before and after oil immersion.

49. Procedure

49.1 Determine the thickness of the specimen by the method described in Section 19, except make only three measurements, one at the center and one 3 in. (76.2 mm) each side of the center.

49.2 Immerse specimens for 15 min in oil at a temperature of 100 ± 3°C (212 ± 5.4°F). The oil shall conform to Type I of Specification D 3487. Other liquids may be used, as agreed upon between the purchaser and seller.

49.3 At the end of the period of immersion remove the specimen from the oil, cool for at least 30 min to room temperature, and then remove any excess oil by placing the specimen between blotters without any sliding.

49.4 Examine the varnish film for disintegration in the oil and flaking either in the oil or on the blotter. Disintegration in the oil may be detected by examination of the used oil for turbidity. Consider the oil turbid if a sample of used oil filtered through filter paper is distinctly less transparent than an unfiltered sample of the unused oil when the two samples, in identical containers, are held in front of a diffused light. Do not consider flaking along the cut edges of tapes as disintegration of the varnish film.

49.5 Determine the thickness of the specimen again by the method described in Section 19, except make only three measurements, one at the center and one 3 in. each side of the center. Make these measurements any time within a period of 4 h after removal from the oil.

50. Report

50.1 Report the following information:

50.1.1 Type of oil used,

50.1.2 Temperature of the oil,

50.1.3 Average thickness of the specimen before oil immersion (49.1),

50.1.4 Average thickness of the specimen after oil immersion (49.5), and

50.1.5 Results of the physical examination of the film and oil (49.4).

51. Precision and Bias

51.1 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.

51.2 This test method has no bias because the value for oil resistance is determined solely in terms of this test method itself.

DISSIPATION FACTOR AND RELATIVE PERMITTIVITY

52. Terminology

52.1 *Definition:*

52.1.1 For definitions of dissipation factor and relative permittivity refer to Terminology D 1711.

53. Significance and Use

53.1 The dissipation-factor test on resin-coated fabrics and tapes is a nondestructive test. It is helpful in determining indications of product uniformity, moisture absorption, and changes in composition. The dissipation factor and permittivity determine the dielectric-loss characteristic of the material, which is of extreme importance when it is used as high-voltage insulation.

53.2 The dissipation-factor test may be used for a specification acceptance test, factory control, or in connection with referee testing.

53.3 Permittivity is significant in that it has a direct bearing on both the capacitance and the dielectric power loss of the material.

54. Electrodes

54.1 Use flat, rigid, guarded electrodes, not over 10 in.^{2} (65 cm^2) in area, of such size as to give the bridge sufficient sensitivity to detect readily a change in dissipation factor of 0.0005. The electrode pressure on the specimen shall be not less than 10 nor more than 20 psi (69 to 138 kPa).

NOTE 7—Guarded foil electrodes, as described in Test Methods D 150 may be used. Apply the foil electrodes after conditioning and immediately before test.

55. Test Specimens

55.1 Prepare each specimen of such size that it shall extend to at least the outer edge of the guard electrode. Test at least three specimens from each sample selected in accordance with Section 3.

56. Conditioning

56.1 Condition the test specimens by one of the following methods:

56.1.1 Condition the test specimens for 48 h in the Standard Laboratory Atmosphere (50 ± 2 % relative humidity at a temperature of 23 ± 1°C (73.4 ± 1.8°F)), and conduct the tests in the Standard Laboratory Atmosphere.

56.1.2 Condition the test specimens for 96 h at 23 ± 1°C (73.4 ± 1.8°F) and 96.5 % relative humidity (see Practice D 5032 or E 104) and conduct the tests in the Standard Laboratory Atmosphere.

57. Voltage Stress

57.1 Unless otherwise specified, make tests at 60 Hz. The voltage gradient shall be 30 ± 5 V/mil (1.2 ± 0.2 kV/mm).

58. Procedure

58.1 **Warning**—See 35.1.1.

58.2 Test the conditioned specimens in single thickness. The method of measurement shall conform to that described in Test Methods D 150. Determine the average thickness of each specimen from five measurements made in accordance with 19.1 of these methods.

59. Report

59.1 Report the following information:

59.1.1 Frequency in hertz,

59.1.2 Voltage stress in volts per mil,

59.1.3 Type and size of electrodes,

59.1.4 Description of the bridge,

59.1.5 Average thickness of each specimen,

59.1.6 Conditioning used for test specimens,

59.1.7 Measured capacitance and dissipation factor in each specimen, and

59.1.8 Calculated permittivity and loss factor of each specimen.

60. Precision and Bias

60.1 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.

60.2 This test method has no bias because the value for capacitance and dissipation factor is determined solely in terms of this test method itself.

WEIGHT LOSS AT ELEVATED TEMPERATURES

61. Significance and Use

61.1 Loss in weight of coated glass fabrics at elevated temperatures is related to the deteriorating effects of oxygen, heat, and moisture (either singly or in combination) on the resin coating or saturant. Weight loss data provide information related to the thermal endurance of the coated fabric, are useful in evaluating control of the resin-curing process, and assist in determining the engineering application of the coated fabric, particularly in the design of insulation for hermetically sealed electrical equipment.

62. Apparatus

62.1 *Analytical Balance*, sensitive to 0.1 mg.

62.2 *Aging Oven*—An electrically heated chamber meeting the requirements of Specification D 5423, Type II.

63. Test Specimens

63.1 In the case of wide fabrics, cut samples in the form of a tape 1 in. (25.4 mm) wide across the full width of the goods. Obtain specimens 5 in. (127 mm) long from each end of the tape after trimming and discarding 3 in. (75 mm) from each end.

63.2 In the case of tapes, cut specimens 1 in. wide and 5 in. long, not closer together than 36 in. (1 m) in the tape roll.

64. Conditioning

64.1 Condition specimens for 2 h at 105°C (220°F), remove from the aging oven, and allow to cool to room temperature in a desiccator containing anhydrous calcium chloride or similar desiccant.

65. Procedure

65.1 Weigh two conditioned specimens accurately to the nearest 0.2 mg. Freely suspend the specimens in an oven at a selected temperature. Periodically remove both specimens, allow to cool to room temperature under desiccation, and weigh immediately. Compute the average loss in weight in percent based on the average weight of the unaged conditioned specimens.

NOTE 8—Since the rate of diffusion of volatile matter through the resin film can be affected by the presence of a layer of stagnant volatilized products at the surface of the specimen, it is important that the ovens used not be overloaded. A general guide is to keep the ratio of oven volume to specimen surface area to at least 50 ft^3/ft^2 (1520 cm^3/cm^2) of surface area, for ovens having ventilation rates of 100 to 200 air changes per hour.

NOTE 9—Place not more than one type of resin coated fabric in a single oven chamber unless it has been established that there is no likelihood of interaction to influence the weight loss of either material.

65.2 Plot the average weight loss in percent as the ordinate in rectangular coordinates against the aging time in hours as the abscissa in logarithmic coordinates. Determine from this plot the aging time in hours corresponding to a 25 % loss in weight.

NOTE 10—End points other than 25 % may be employed, for example, 50 % or some percentage of the net volatile content of the coating. In the latter case, the actual composition of the resin may have to be determined, as well as the actual weight of the substrate.

NOTE 11—For research purposes, this method may be refined to provide weight loss data at several elevated and accelerated temperatures, and by means of an Arrhenius-type plot to study the mechanism of degradation by evaluation of the volatilization rate as a function of temperature.

66. Report

66.1 Report the following information:

66.1.1 Description of the material (resin type, base fabric, total thickness, etc.),

66.1.2 Aging temperatures used,

66.1.3 Plot of weight loss in percent versus time in hours 65.2,

66.1.4 Weight loss end point, if other than 25 %, and

66.1.5 Average time at each temperature to reach a 25 % weight loss (or other end point).

67. Precision and Bias

67.1 The measurement of this property is influenced by temperature, air velocity across the specimens, percentage of recirculated air in the aging atmosphere, and often the nature and amount of substances in the aging atmosphere other than the products of decomposition of the coating.

67.2 Work among several laboratories on different resin-coated fabrics indicates that weight loss data at a variety of temperatures obtained using this method are reproducible to within an average deviation from the mean of about 15 %.

67.3 This test method has no bias because the value for weight loss is determined solely in terms of this test method itself.

THERMAL ENDURANCE

68. Procedure

68.1 Determine the thermal endurance in accordance with Test Method D 1830.

69. Keywords

69.1 breaking strength; coated glass fabric; dielectric breakdown voltage; dissipation factor; heat aging; permittivity; thermal endurance; thread count