



Standard Test Methods for Coated Fabrics¹

This standard is issued under the fixed designation D 751; 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, but are not limited to, rubber-coated fabrics, that is, tarpaulins, rainwear, and similar products.

1.2 The scope of each of these test methods appears in the section in which the test method is described.

1.3 The test methods appear in the following sections:

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1.4 The values stated in SI units are to be regarded as the standard. The values given 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.*

¹ These test methods are under the jurisdiction of ASTM Committee D11 on Rubber and are the direct responsibility of Subcommittee D11.37 on Coated Fabrics and Rubber Thread.

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2. Referenced Documents

2.1 *ASTM Standards:*²

- D 573 Test Method for Rubber—Deterioration in an Air Oven
- D 1349 Practice for Rubber—Standard Temperatures for Testing
- D 1424 Test Method for Tearing Strength of Fabrics by Falling-Pendulum Type (Elmendorf) Apparatus
- D 2136 Test Method for Coated Fabrics—Low-Temperature Bend Test
- D 2137 Test Methods for Rubber Property—Brittleness Point of Flexible Polymers and Coated Fabrics
- D 4483 Practice for Evaluating Precision for Test Method Standards in the Rubber and Carbon Black Manufacturing Industries

3. Significance and Use

3.1 Coated fabrics and rubber products made from coated fabrics are important items of commerce, and adequate test methods must be available to ensure the quality of these products. These test methods provide for this testing capability.

4. Standard Conditions

4.1 *Test Conditions*—Coated fabrics shall be tested in an environment satisfying the conditions as defined in 4.2 or 4.3 unless otherwise specified, or as per agreement between supplier and purchaser. When it is known that the coated fabric is to be used in a tropical environment, the atmosphere described in 4.3 shall be specified.

4.2 *Temperate Atmosphere*—The standard condition for testing coated fabrics shall be that reached by the fabric when in moisture equilibrium with a standard atmosphere having a relative humidity of 50 ± 5 % at 23 ± 2°C (73 ± 4°F).

4.3 *Tropical Atmosphere*—The standard condition for testing coated fabrics shall be that reached by the fabric when in moisture equilibrium with a standard atmosphere having a relative humidity of 65 ± 5 % at 27 ± 2°C (80 ± 2°F).

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.

4.4 *Moisture Equilibrium*—It shall be considered that moisture equilibrium is reached when after free exposure to air in motion, there is no progressive increase in mass. Moisture equilibrium shall be approached from the dry side (not moisture-free). Certain coatings may greatly retard moisture penetration into the fabric; therefore, fabrics coated on both sides may require 24 h or more to reach equilibrium.

5. Time Lapse Between Vulcanization and Testing

5.1 For all test purposes, the minimum time between vulcanization and testing should be 16 h.

5.2 For nonproduct tests, the maximum time between vulcanization and testing should be four weeks, and for evaluations intended to be comparable, the tests, as far as possible, should be carried out after the same time interval.

5.3 For product tests, where possible, the time between vulcanization and testing should not exceed three months. In other cases, tests should be made within two months of the date of receipt by the customer.

NOTE 1—Section 5 is not applicable for coated fabrics not requiring vulcanization.

6. Precision and Bias

6.1 *Precision*—These precision statements have been prepared in accordance with Practice D 4483. Please refer to Practice D 4483 for terminology and other testing and statistical concepts (see Annex A1 for precision tables).

6.2 The precision results give an estimate of the precision of these test methods with the materials (rubbers) used in the particular interlaboratory program as described in Annex A1. The precision parameters should not be used for acceptance/rejection testing of any group of materials without documentation that they are applicable to those particular materials and the specific testing protocols that include these test methods.

6.3 *Bias*—In test method statistical terminology, bias is the difference between an average test value and the reference or true test property value. Reference values do not exist for these test methods since the value or level of the test property is exclusively defined by the test method. Bias, therefore, cannot be determined.

DIMENSIONS AND MASS

7. Length

7.1 *General Method*—Lay the coated fabric out smooth, without tension, on a horizontal surface and measure the length parallel to the selvage; or, measure successive portions, each at least 5 m (5 yd) in length, under the same conditions.

7.2 *Drum Method*—Run the coated fabric over a measuring drum with just enough uniform tension to keep it running flat and true. Determine the length from the dial or counter on the drum and its calibration.

8. Width

8.1 Measure the width with the coated fabric laid out smooth on a horizontal surface but without tension in either direction. Report the average of at least five different measurements uniformly distributed along the full length of a roll or piece as the average width of the roll or piece.

9. Thickness

9.1 *Thickness Gauge*—The gauge used for the measurement of thickness shall be of the deadweight type equipped with a dial graduated to read directly to 0.025 mm (0.001 in.). The presser foot shall be circular with a diameter of 9.52 ± 0.03 mm (0.375 ± 0.001 in.). The presser foot and moving parts connected therewith shall be weighted so as to apply a total force of 1.7 ± 0.03 N (6 ± 0.1 oz) equivalent to a pressure of 23.5 ± 0.5 kPa (3.4 ± 0.07 psi) to the specimen. The presser foot and anvil surfaces shall be plane to within 0.0025 mm (0.0001 in.) and parallel to each other to within 0.0025 mm (0.0001 in.). The gauge shall be calibrated for the actual load exerted by the presser foot by means of any device so arranged as to measure the total vertical force exerted by the presser foot at the several gauge readings or presser foot levels selected for calibration. The presser foot shall be brought to each calibration level from a higher one.

NOTE 2—It is suggested that the calibration may be accomplished by supporting the presser foot on a horizontal strap suspended from a weighing device so arranged that it may be raised or lowered gradually and leveled at any required position.

9.2 *Procedure*—Place the coated fabric upon the anvil of the gauge smooth, but without tension. Lower the presser foot upon the material gradually (without impact), allow it to rest upon it for 10 s, and then observe the reading of the dial. Make similar measurements at not less than five different places uniformly distributed over the surface of the coated fabric exclusive of the area adjacent to either selvage and within one tenth the width of the fabric or within 2.5 m (100 in.) of either end of a roll or piece. Report the average of the five or more measurements as the average thickness.

10. Mass

10.1 *Method Applicable to a Piece, Cut, or Roll*—Weigh the full piece, cut, or roll, on a calibrated scale accurate to 0.25 %, measure the length and width of the coated fabric, and calculate the mass, reporting it in grams per square metre (ounces per square yard) to the nearest 2.8 g (0.1 oz).

10.2 *Method Applicable to a Sample*—Cut a specimen having an area of at least 129 cm² (20 in.²), or a number of specimens not less than 50 mm (2 in.) square and having a total area of at least 129 cm² (20 in.²) from the coated fabric, weigh on a calibrated scale accurate to 0.25 %, and calculate the mass, reporting it in grams per square metre (ounces per square yard). Unless a specimen the full width of the fabric is used, take no specimen nearer the selvage than one tenth the width of the fabric.

NOTE 3—This test method is intended for use when a small sample of coated fabric is sent to the laboratory for test. The result is considered to be applicable to the sample, but not to the piece or lot of goods from which the sample was taken unless the number of samples and method of sampling are specified and agreed upon by those concerned. If this is done, each sample should be tested in accordance with 9.2 and the results averaged to obtain the average mass in grams per square metre (or ounces per square yard).

BREAKING STRENGTH

11. Breaking Strength

11.1 Breaking strength shall be determined by the grab test method, unless the strip test method is specified.

Procedure A—Grab Test Method

12. Testing Machine

12.1 The machine shall consist of three main parts:

- 12.1.1 Straining mechanism,
- 12.1.2 Clamps for holding specimen, and
- 12.1.3 Load and elongation recording mechanism(s).

12.2 *Straining Mechanism*—A machine wherein the specimen is held between the two clamps and strained by a uniform movement of the pulling clamp shall be used. Unless otherwise specified in the material specification, the machine shall be adjusted so that the pulling clamp shall have a uniform speed of 5 ± 0.2 mm/s (12 ± 0.5 in./min).

12.3 *Load and Elongation Recording Mechanism(s)*—Calibrated dial, scale, or chart to indicate applied load and elongation. Unless otherwise specified for load determination, the machine shall be adjusted or set so that the maximum load required to break the specimen will remain indicated on the calibrated dial, scale, chart, autographic recording, or computer interfaced with the testing machine after the test specimen has ruptured.

12.4 *Capacity*—The machine shall be of such capacity that the maximum load required to break the specimen shall be not greater than 85 % or less than 15 % of the rated capacity.

12.5 *Machine Efficiency*—The error of the machine shall not exceed 2 % up to and including a 222-N (50-lbf) force and 1 % over 222 N and 1 % at any reading within its loading range.

13. Clamps for Fabrics

13.1 The clamps for holding a specimen of coated fabric shall have gripping surfaces sufficiently flat and parallel as to prevent the test specimen from slipping or moving between the gripping surfaces when held under the pressure normal to operation. The dimension of all gripping surfaces parallel to the direction of application of the load shall be 25 mm (1 in.); the dimension perpendicular to this direction shall be 1 in. for the face jaw and 50 mm (2 in.) or more for the other. All edges that might cause a cutting action shall be rounded to a radius of not over 0.4 mm (0.0156 in.). The pressure between the gripping surfaces, sufficient to clamp the specimen firmly before the testing load is applied and to prevent slippage during the progress of the test, shall be secured by any suitably constructed mechanical device operating on the member of the clamp. The distance between the clamps at the start of the test shall be 75 mm (3 in.).

NOTE 4—As a practical method of determining the degree of flatness and parallelism of the assembled clamp mechanism, it is recommended that a sheet of thin white paper, between two thin sheets of carbon paper, be placed between the gripping surfaces, and the jaws then brought together with a light pressure.

14. Test Specimens

14.1 Specimens 102 mm (4 in.) in width and not less than 152 mm (6 in.) in length shall be cut from the coated fabric for test. Two sets of five specimens each will be required, one set for longitudinal breaking strength having the longer dimension parallel to the lengthwise direction of the goods, and the other set for transverse breaking strength, having the longer dimension parallel to the crosswise direction of the goods. No two specimens shall contain the same threads of the fabric in the direction to be tested. Unless otherwise specified, specimens shall be taken no nearer the selvage than one tenth the width of the coated fabric.

15. Procedure

15.1 Place the specimen symmetrically in the clamps of the machine (see Fig. 1) with the longer dimension parallel to and the shorter dimension at right angles to the direction of application of the force. Report the average of the results of the five individual tests in each direction as the longitudinal breaking strength and the transverse breaking strength of the fabric, respectively. If a specimen slips in the clamps, breaks in the clamps, breaks at the edges of the clamps, or if for any reason attributable to faulty operation, the result falls markedly below the average for the set of specimens, discard the result, take another specimen, and include the result of this break in the average.

Procedure B—Cut Strip Test Method

16. Procedure

16.1 Make the breaking strength test by the cut strip method in accordance with the directions for the grab method (Sections 12-15), with the exception that the specimens shall be cut 25 mm (1 in.) in width (or other width when specified). The 25 mm (1 in.) wide specimen shall be cut to obtain 25 mm (1 in.) of yarn.

ELONGATION

17. Procedure

17.1 Unless otherwise specified, obtain the elongation of a coated fabric at any stated force when the breaking strength (Sections 11-15) is determined and for the same specimens by the mechanism provided for such purpose. The elongation shall be the average of the results obtained for five specimens, and it shall be expressed as the percentage increase in length. Since the initial length and, therefore, the measured elongation depend upon the load applied in placing the specimen in the

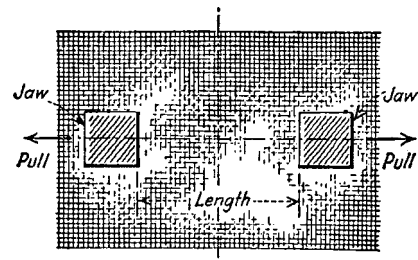


FIG. 1 Illustration of Grab Test

clamps of the machine, place an initial load of 1.7 N (6 ozf), or other initial load specified for the particular material in question, on the specimen before gripping the specimen in the lower clamp of the machine.

BURSTING STRENGTH

18. Testing Machine

18.1 The machine used for determining bursting strength shall be either of the following types:

18.2 *Tension Testing Machine with Ring Clamp*—The tension testing machine described in Section 12 shall be equipped with a bursting attachment of such design that the specimen held securely by a ring-clamp mechanism 44.4 ± 0.05 mm (1.750 ± 0.002 in.) in internal diameter with the center of the specimen pressed against a polished steel ball of 25.40 ± 0.050 mm (1.000 ± 0.002 in.) in diameter until a burst is produced. The direction of motion of the ring clamp shall be at right angles to the initial plane of the specimen. The machine shall be at such capacity that the maximum load required shall be not greater than 85 % or less than 15 % of the rated capacity.

18.3 *Diaphragm Bursting Tester*—Requirements for a diaphragm bursting tester are outlined in 18.3.1, 18.3.2, and 18.3.3; however, any machine that operates on the same principle and has coaxial apertures of 31.5 ± 0.05 mm (1.24 ± 0.02 in.) in diameter in the clamping surfaces is a valid machine for this test.

18.3.1 The testing machine to be used may be either mechanically or manually operated. It shall permit the clamping of the material to be tested between two circular clamps not less than 75 mm (3 in.) in diameter having coaxial apertures of their centers 31.5 ± 0.05 mm (1.24 ± 0.02 in.) in diameter. The surfaces of the clamps between which the specimen is to be placed shall be concentrically grooved. The grooves shall be spaced not less than 0.78 mm (0.031 in.) apart and of a depth not less than 0.15 mm (0.006 in.). The grooves shall not start closer than 3.2 mm (0.125 in.) from the edge of the aperture. The surfaces of the clamps shall be metallic and any edge that might cause a cutting action shall be rounded to a radius of not over 0.4 mm (0.0156 in.). The lower clamp shall be integral with the chamber in which a screw shall operate to force a liquid pressure medium at a uniform rate of 1.64 ± 0.07 cm³/s (6.00 ± 0.25 in.³/min) against a rubber diaphragm fitted to expand through the aperture exerting its force against the coated fabric set between the two clamps. (In the manually operated machine, this shall correspond to approximately 2 r/s of a hand wheel turning the displacement screw.)

18.3.2 In the mechanically operated machine, means shall be provided for stopping, at the instant of the rupture of the specimen, any further application of the loading pressure, and for holding unchanged the contents of the pressure chamber until the gross bursting pressure and tare diaphragm pressure indicated on the gauge have been recorded. The machine shall be fitted with a Bourdon tube gauge, maximum-reading type, having a dial 114 mm (4.5 in.) in diameter, and the scale divided to read in 2-N (0.5-lbf) units, with a range of from 0 to 444 N (0 to 100 lbf). Accuracy shall be within ± 2 N (± 0.4 lbf). When the gauge is calibrated, it shall be mounted in the same relative position as on the bursting tester. If calibrated

with a deadweight tester, the weights shall be spun slowly to ensure free action of the piston.

NOTE 5—A higher capacity gauge may be used provided it meets the accuracy requirements.

18.3.3 Provision shall be made for applying to the specimen, before clamping, a slight initial tension, which shall be uniform in all directions.

19. Test Specimens

19.1 At least ten specimens shall be cut, the smallest dimension of which shall be at least 12.7 mm (0.5 in.) greater than the outside diameter of the ring-clamp mechanism of the testing machine.

20. Procedure

20.1 Mount the test specimen in the ring clamp perpendicular to the ball and move the clamp or ball at a rate of 5.00 mm/s ± 0.2 mm/s (12 in./min ± 0.5 in./min) until rupture occurs. Record the pounds pressure as the bursting strength of the specimen.

20.2 When the diaphragm tester is used, mount the specimen between the ring clamp and the base surface with a uniform tension. Apply the pressure at a constant rate as prescribed in 18.3.1 until rupture occurs. Record the pounds pressure and then release the upper clamp completely, allowing the tare of the diaphragm to register on the pressure gauge. Report the bursting strength of the material as the gross pressure minus the tare of the diaphragm.

21. Calculation

21.1 The average bursting strength of the material shall be the average of the results of five tests and reported in pascals or pounds per square inch.

PUNCTURE RESISTANCE

22. Testing Machine

22.1 The apparatus used for determining puncture resistance shall be the tension testing machine with ring clamp described in 18.2, except that the polished steel ball shall be replaced by a piercing instrument shaped like a flared, flat-tip screwdriver, having a width of 7.92 ± 2.5 mm (0.312 ± 0.1 in.) and a thickness of 0.8 ± 0.1 mm (0.031 ± 0.004 in.) at the extreme tip. The piercing tip edges shall be rounded to a 0.25-mm (0.01-in.) radius. The piercing instrument shall be oriented to intercept the warp and fill threads of the mounted specimen at an angle of approximately 45°.

23. Test Specimens

23.1 Five circular specimens shall be cut, each having a diameter at least 12.7 mm (0.5 in.) greater than the outside diameter of the ring-clamp mechanism of the testing machine.

24. Procedure

24.1 Mount each specimen, centering it in the ring clamp. Allow the piercing device to descend at a rate of 5.0 mm/s ± 0.2 mm/s (12 in./min ± 0.5 in./min) until puncture of the

coated fabric occurs. Record the force required to completely penetrate the specimen.

25. Calculation

25.1 The average puncture resistance of the material shall be the arithmetic mean of the results of five tests and reported in newtons or pounds force.

TEARING RESISTANCE

26. Scope

26.1 The tearing strength of the coated fabrics shall be determined by either the pendulum method or the tongue tear method. The tongue tear test method cannot be used for fabric whose yarns bunch up before tearing.

Procedure A—Pendulum Test Method

27. Procedure

27.1 Determine the tear strength by the pendulum method in accordance with Test Method [D 1424](#).

Procedure B—Tongue Tear Test Method

28. Testing Machine

28.1 The testing machine used for this test shall conform to the requirements of the machine used in the grab test method for breaking strength (see Section [12](#)) with the following modifications: The face of the jaws shall measure 25 by 50 mm (1 by 2 in.) or more with the long dimension perpendicular to the direction of application of the load. All machine attachments for determining maximum loads shall be disengaged during this test. Unless otherwise specified in the material specification, the machine shall be adjusted so that the pulling clamp shall have a uniform speed of 0.85 ± 0.04 mm/s (2 ± 0.1 in./min) or 5.00 ± 0.2 mm/s (12 ± 0.5 in./min).

29. Test Specimen

29.1 The specimen shall be a rectangle of 76- by 203-mm (3- by 8-in.) cloth. Five specimens from each of the warp and filling directions shall be tested. The short distance shall be parallel to the warp yarns for the warp tests and parallel to the filling yarns for the filling tests. No two specimens for warp tests shall contain the same warp yarns, nor shall any two specimens for the filling tests contain the same filling yarns. A 76-mm (3 in.) cut shall be made at the center of and perpendicular to a short side of the specimen forming the tongues or cut strips.

NOTE 6—On specimens in which the yarns pull out of the coated fabric and do not tear, a larger specimen may be used. A 203 by 203 mm (8 by 8 in.) specimen has been used to overcome this issue.

30. Procedure

30.1 The machine, when used for a given specimen, shall be of such capacity that the maximum force required to tear the specimen is not greater than 85 or less than 15 % of the rated capacity.

30.2 Center the specimen in the machine with one tongue or cut strip in each clamp. The specimen shall be mounted so the face of one tongue and the back of the other are facing the

operator. Start the machine and observe by the means provided the force necessary to tear the cloth a distance of 76 to 102 mm (3 to 4 in.).

30.3 If a specimen slips between the jaws, breaks or tears in a direction other than that of the original cut, or if, for any reason attributable to faulty technique, an individual measurement falls markedly below the average test result for the sample unit, discard and test another specimen.

31. Report

31.1 The tearing strength of the test specimen shall be the average of the five highest peak loads of resistance (not including the initial peak) registered during the separation of the tear. The tearing strength of the sample unit shall be the average of the results obtained from the five specimens tested in each of the warp and filling directions and shall be reported separately to the nearest 0.4 N (0.1 lbf).

TRAPEZOIDAL TEAR

32. Testing Machine

32.1 The testing machine used for this test shall conform to the requirements of the machine used in the tongue tear test method (see Section [28](#) Procedure B) with the following exceptions: The distance between the clamps at the start of the test should be 25 ± 1 mm (1 ± 0.05 in.). The face of the jaws shall measure 25 by 50 mm (1 by 2 in.). Unless otherwise specified in the material specification, the machine shall be adjusted so that the pulling clamp shall have a uniform speed of 5.00 ± 0.2 mm/s (12 ± 0.5 in./min). Set the machine such that the maximum force occurs between 15 and 85 % of full-scale force.

33. Test Specimen

33.1 Cut rectangular specimens 76 by 152 mm (3 by 6 in.). The long distance shall be parallel to the warp yarns for the warp tests, and parallel to the filling yarns for the filling tests. No two specimens shall contain the same warp yarns in a warp test or the same filling yarns in a fill test. Mark each specimen with an isosceles trapezoid template 25 by 102 mm (1 by 4 in.), centering the 25 mm (1 in.) on the cut rectangle specimen. Make a cut 15.9 mm (0.625 in.) long at the center of the 25 mm (1 in.) edge. (See [Fig. 2](#) below.)

34. Procedure

34.1 Secure the test specimen in the machine, clamping along the sides of the trapezoid which contains the 15.9 mm (0.625 in.) cut. Position the specimen so the cut is halfway between the clamps. Hold the short edge taut and let the remaining fabric lie in folds. Start the machine and record the tearing force by a graphic method. Continue to tear the specimen until it has torn completely across the sample. If breakage occurs at the jaw area, discard values and retest using padded jaws. Some materials will start to tear showing several maximum and minimum points prior to a 25 % increase or more in value. The material typically does not tear beyond this point. The test results are to be taken prior to this increase.

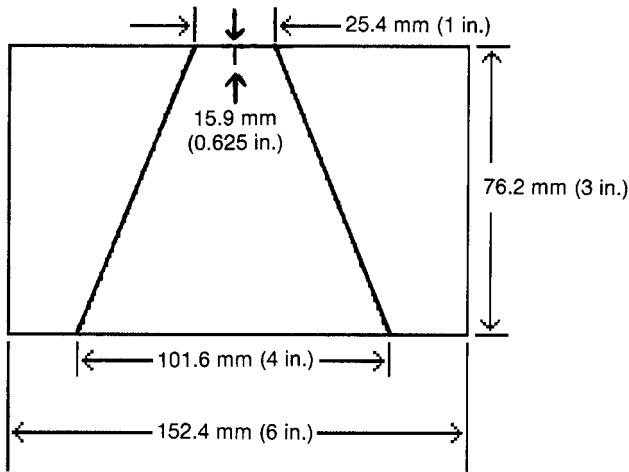


FIG. 2 Trapezoidal Tear Test Specimen

35. Report

35.1 The results of the trapezoidal tear test shall be reported as in the tongue tear test method (see Section 31 Procedure B).

HYDROSTATIC RESISTANCE

36. Hydrostatic Resistance

36.1 The hydrostatic resistance of a coated fabric shall be determined by Procedure A which uses a Mullen-type hydrostatic tester or, when specified, by Procedure B which uses the hydrostatic pressure of a rising column of water (Suter test).

Procedure A—Pressure Application by Mullen-Type Hydrostatic Tester

37. Testing Machine

37.1 Requirements for the testing machine are outlined in 37.2; however, any machine that operates on the same principle and has coaxial apertures of 31.8 ± 0.5 mm (1.24 ± 0.02 in.) in diameter in the clamping surfaces is a valid machine.

37.2 The testing machine to be used may be either mechanically or manually operated. It shall permit the clamping of the material to be tested between two circular clamps about 76 mm (3 in.) in diameter having coaxial apertures of their centers 31.8 ± 0.5 mm (1.24 ± 0.02 in.) in diameter. The surfaces of the clamps between which the specimen is to be placed shall be concentrically grooved. The grooves shall be spaced 0.8 mm (0.031 in.) apart and of a depth not less than 0.15 mm (0.006 in.). The grooves shall not start closer than 3.18 mm (0.125 in.) from the edge of the aperture. The lower clamping surface shall have a recession concentric to the aperture capable of accepting an O-ring having a cross-sectional diameter of 4.7 ± 0.1 mm (0.187 ± 0.004 in.). The machine shall have means of applying hydraulic pressure to the underside of the clamped specimen until the specimen fails. The pressure shall be generated by means of a piston forcing water into the pressure chamber of the apparatus at the rate of 1.4 ± 0.1 cm³/s (5.2 ± 0.3 in.³/min). The machine shall be fitted with a Bourdon gauge, maximum-reading type, with the scale divided to read 2-N (0.5-lbf) units. Accuracy shall be within 2 N (0.5 lbf) on readings from 0 to 444 N (0 to 100 lbf) and to 1.0 % on

any reading over 444 N. When the gauge is calibrated, it shall be mounted in the same relative position as on the bursting tester.

NOTE 7—Any machine that operates on the above principle and maintains the specified displacement rate of 85 mL/min, and in addition possesses an opening in the upper clamping surface of 31.8 ± 0.25 mm (1.24 ± 0.01 in.), is a valid machine for this test.

38. Test Specimens

38.1 The test specimen cut from the coated fabric shall be of such size that the smallest dimension is at least 12.7 mm (0.5 in.) greater than the outside diameter of the ring-clamp mechanism of the testing machine.

39. Procedure

39.1 Before clamping the specimen into the testing machine, bring the water level up flush with the top of the rubber gasket so that no air pocket may exist between the water surface and the coated fabric being tested. Unless otherwise specified in the case of materials coated on one side only, place the coated side next to the water level. In the case of double-coated fabrics or double-texture fabrics, either surface may be used unless the side to be put facing downward against the water level is definitely specified. The temperature of the water shall be the same as the atmospheric temperature of the testing room. Conduct the test in accordance with one of the following two procedures.

39.1.1 *Procedure 1*—Increase the pressure steadily at the rate of displacement indicated in 18.3.1 and take a dial reading at the first appearance of water through the coated fabric being tested. Make ten different determinations and take the average as the hydrostatic resistance of the coated fabric. Discard an isolated high or low result that is not repeated in duplicate when a consistent average has been obtained without the abnormal reading and substitute a retest.

39.1.2 *Procedure 2*—Apply a specified pressure held constant within 14 kPa (2 psi) against the test specimen for a period of 5 min. Any appearance of water through the coated fabric that can be detected during that period will indicate failure to meet the test. Test at least five specimens from any sample of material.

NOTE 8—Any material that fails to give a value of at least 35 kPa (5 psi) as measured by either procedure of testing shall be regarded as having too low a hydrostatic resistance to be measured by this test method, and the alternate Procedure B of using the hydrostatic pressure of a rising column of water shall be tried.

40. Report

40.1 Report the following information:

40.1.1 Statement of the test method and procedure used.

40.1.2 With Procedure 1, all observed and recorded data together with the average value of the hydrostatic resistance in N (lbf).

40.1.3 With Procedure 2, statement of the number of specimens tested, the specified pressure applied, and the number of specimens that withstood the pressure.

Procedure B—Pressure Application by a Rising Column of Water

41. Testing Machine

41.1 The machine shall consist of a clamp for holding the specimen and a means of providing a column of water whose level can be raised. Fig. 3 shows a suitable apparatus.

41.2 The clamp shall consist of a lower ring about 171 mm (6.75 in.) in outside diameter by 114 mm (4.5 in.) in inside diameter held in a fixed position and provided with a channel 9.5 mm (0.375 in.) in width into which a rubber gasket seats

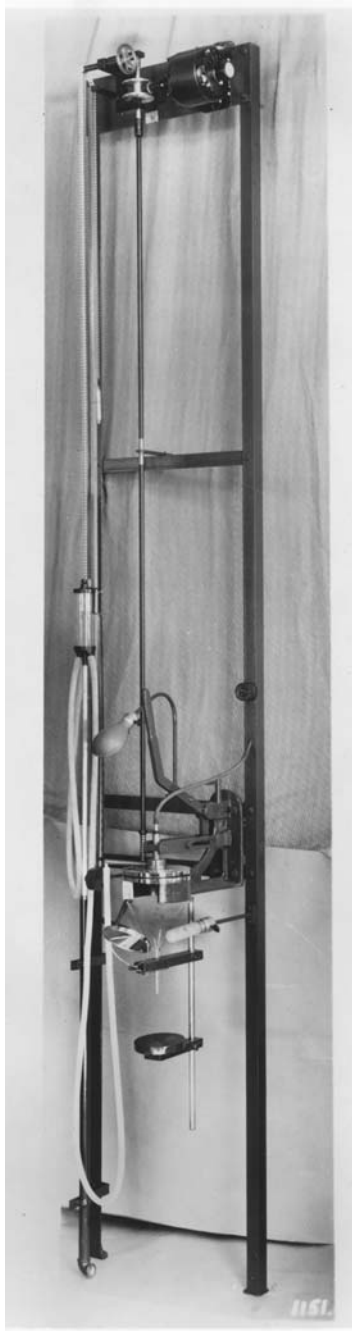


FIG. 3 Machine for Measuring Hydrostatic Resistance of a Coated Fabric by Using the Pressure of a Rising Column of Water

and also a movable upper plate which shall be about 170 mm (6.70 in.) in outside diameter and shall carry the rubber gasket. A water chamber on top of the upper plate shall have a water opening into the clamp and a vent pipe. A suitable mechanism shall be provided to close the clamp with the specimen of fabric between the ring and plate.

41.3 The water leveler shall be provided with a water inlet, water outlet, and overflow pipe. It shall be connected to the clamp by means of a rubber hose. The overflow pipe provides a means of maintaining a constant level of water. A suitable mechanism for raising the water leveler uniformly at the required rate and lowering it again shall be provided. A chain and sprocket device driven by a motor and controlled by a suitable disk clutch has been found satisfactory.

41.4 A steel scale for measuring the height of the water column shall be attached to the water leveler in such a way that the zero is in the same horizontal plane as the constant water level at all times. A reference pointer in fixed position at the level of the face of the lower ring of the clamp shall be provided for measuring the distance of travel of the water leveler above the face of the clamp. The scale shall be graduated in millimetres (or sixteenths of an inch).

41.5 A mirror shall be provided under the clamp to observe any leaks in the fabric being tested.

42. Test Specimens

42.1 The test specimen of the coated fabric shall be at least 203 mm (8 in.) square. The specimen may include a seam if desired since the rubber gasket provides a means of obtaining a tight seal in the clamp. At least five specimens from any sample of material shall be tested.

43. Procedure

43.1 Conduct the test according to one of the following two procedures:

43.1.1 *Procedure 1*—Lay the specimen smoothly on the face of the lower ring of the clamp and lower and fasten the upper plate in place. This shall form a watertight compartment. When the specimen is coated on only one side, place the coated side next to the water column, unless otherwise specified. With the leveler at the zero position, turn the water on and keep it running at such a rate as to overflow continuously. Raise the column at a rate of 10 mm/s (24 in./min) until the first drop of water appears through the coated fabric. Read on the scale the height of the water column above the level of the specimen.

43.1.2 *Procedure 2*—An alternative procedure is placing the specimen in the clamp and raising the water column to a predetermined height and recording the time required for the first drop of water to penetrate the coated fabric.

44. Report

44.1 Report the following information:

44.1.1 Statement of the test method and procedure used and the number of specimens tested.

44.1.2 With Procedure 1, the height of the column of water to the nearest 1.6 mm (0.0625 in.), at which the first drop appeared on the underside of each of the coated fabric specimens, also the average value for all specimens.

44.1.3 With Procedure 2, the preset height of the column of water and the time elapsed before the first drop of water appeared on the underside of each specimen of the coated fabric, also the average value for all specimens.

ADHESION OF COATING TO FABRIC

45. Testing Machine

45.1 A testing machine as described in Section 12 shall be used, except that the speed of the pulling clamp shall be *either* 0.85 ± 0.04 mm/s (2.0 ± 0.1 in./min) or 5.00 ± 0.2 mm/s (12 ± 0.5 in./min). The faces of the clamps shall measure 25 by 76 mm (1 by 3 in.), with the short dimensions parallel to the direction of application of the load. The distance between the clamps at the start shall be 25 mm (1 in.).

46. Test Specimens

46.1 *Peel Adhesion*—Two sets of three specimens each 25 mm (1 in.) in width and 203 mm (8 in.) in length shall be cut from the coated fabric. Two sets of two specimens each will be required, one set for adhesion in the longitudinal direction having the longer dimension parallel to the lengthwise direction of the fabric and the other set for adhesion in the transverse direction having the longer dimension parallel to the crosswise direction of the fabric. These specimens shall be prepared for test as follows:

46.1.1 When the strength of the coating film exceeds the adhesive bond to the fabric, as with thick films, each specimen shall be prepared for testing by carefully cutting the coating through to the fabric with a diagonal cut starting 50 mm (2 in.) from the top of the specimen. The edge of a knife shall be worked under the point formed by the cut and the edge of the fabric and the coating of strip shall be separated from the backing for a distance sufficient to hold the specimen in the clamps. Both sides of the specimen are to be tested if the fabric is coated on both sides.

46.1.2 Reinforced coating adhesion specimens shall be prepared in the case of thin films or in cases in which the coating is not sufficiently strong to be stripped from the fabric as described in 46.1.1. Two specimens of the coated fabric 50 by 203 mm (2 by 8 in.) shall be bonded together face to face. If both sides are coated, one side is to be bonded to the other side unless otherwise specified. Die cut a 25- by 203-mm (1- by 8-in.) specimen from the center of the larger sample. Separate one end of the specimen a distance sufficient to hold the specimen in the clamps.

NOTE 9—In case the fabric is too weak to be tested in a 25-mm (1-in.) width, the specimen may be cut 75 mm (3 in.) in width and the strip for evaluation cut 50 mm (2 in.) in width. The results shall then be recorded as newtons per 25 mm (pounds-force per 1 in.) strip, and the width of the specimen noted in the report.

47. Procedure

47.1 Clamp the peel separated portions of the 25-mm (1-in.) strip in the lower jaw of the testing machine and the other end of the specimen in the upper jaw so that the movement of the jaw will separate the coating from the backing or fabric. The rate of travel of the jaw shall be one of the two speeds specified in 45.1. The distance of separation of the coating shall be a minimum of 76 mm (3 in.).

47.2 Clamp the separated portions of the adhesion specimen in upper and lower jaws of the test machine. The rate of travel of the moving jaw shall be one of the two speeds specified in 45.1. The distance of separation of the plies shall be a minimum of 76 mm (3 in.). If the coating does not pull down to the backing or fabric, then the test machine will be stopped, and the coating on the ply in the jaw shall be carefully cut to the fabric. Then the machine shall be restarted.

48. Report

48.1 Report the following information:

48.1.1 The type of testing machine and the rate of travel of the moving jaw, and

48.1.2 The average test value for at least three specimens cut in the longitudinal direction and three specimens cut in the transverse direction. The average of the five high peaks, not including the initial peak, per specimen shall be used to determine the force in newtons/25 mm (or pounds-force/1 in.) for reporting the adhesion of the coating or plies. The average of the five low peaks may also be reported if it is desired to also report the range of peel adhesion.

STRENGTH OF COATING

49. Strength of Coating

49.1 This test method covers the determination of the strength and elasticity of a fabric coating by hydrostatic resistance measurement after controlled mechanical preconditioning.

50. Test Apparatus

50.1 *Mechanical Pretensioning*—The testing machine shall conform to the requirements cited for the grab procedure for breaking strength (see Section 12), with the following modifications: The face of the clamps shall measure 25 by 50 mm (1 by 2 in.) with the long dimension perpendicular to the direction of application of the load. All machine attachments for determining maximum load shall be disengaged during the test. The test load applied to test specimens during testing shall be capable of being maintained within a one-pound load tolerance for the required duration.

50.2 *Hydrostatic Resistance*—The testing machine shall conform to the requirements cited for this determination (Procedure A or B, in Sections 36-44).

51. Test Specimen

51.1 The coated fabric test specimen shall be a 152-mm (6-in.) square with diagonal dimensions oriented parallel to the warp and fill threads. At least five specimens from each material shall be tested.

52. Procedure

52.1 *Specimen Pretensioning*—Set the distance between clamps of the testing machine (see 50.1) at 102 mm (4 in.). Center the test specimen in the clamps with the edges parallel to clamp edges. Separate the clamps at a rate of 5.00 ± 0.2 mm/s (12 ± 0.5 in./min) until a load of 133.5 ± 4.5 N (30 ± 1 lbf) has been applied to the specimen. Hold the load for 30 s and then release, allowing the specimen to relax. Release the

specimen from the clamps and repeat the procedure with the load applied in the direction perpendicular to that of the first loading.

52.2 *Hydrostatic Resistance*—Determine the hydrostatic resistance of the pretensioned specimens in accordance with one of the procedures cited in Sections 36-44.

53. Report

53.1 Report the following information:

53.1.1 Statement of the test method and procedure used.

53.2 All observed and recorded data as indicated for applicable hydrostatic resistance Procedure A or B (Section 36 or 40).

TACK-TEAR RESISTANCE

54. Scope

54.1 This test method covers the measurement of the resistance of a coated fabric to tearing under conditions simulating an installation that has been tacked in place. It is

intended primarily for testing vinyl plastic coated fabrics for furniture or automotive applications.

55. Apparatus

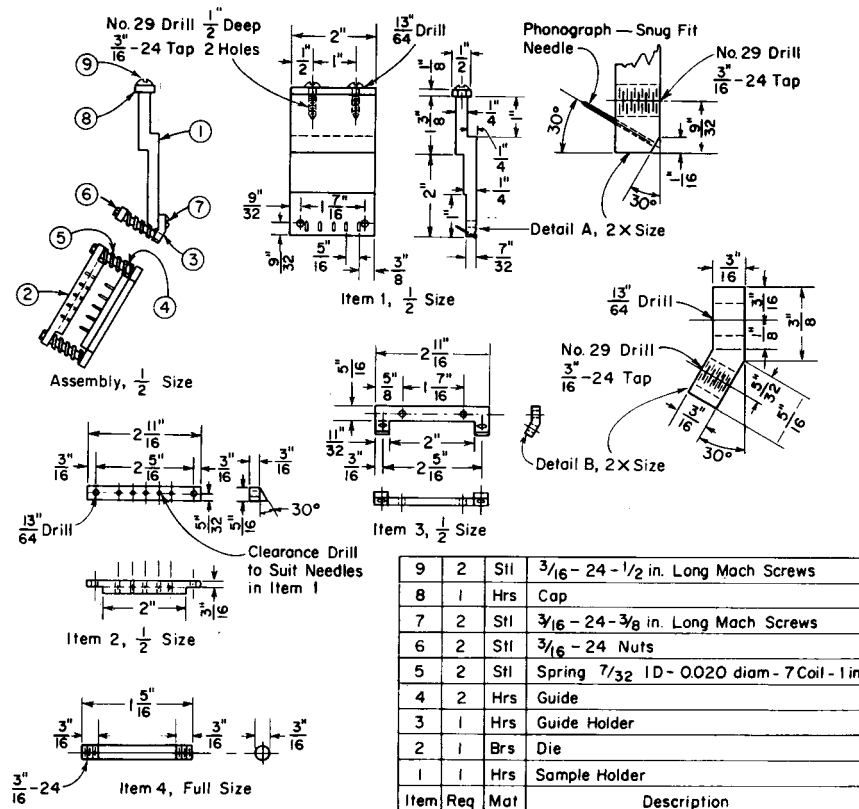
55.1 The apparatus shall consist of the device illustrated in Fig. 4 and a testing machine conforming to the requirements of Section 12.

56. Test Specimens

56.1 The specimens shall be 50 mm (2 in.) in width and 152 mm (6 in.) in length. Two sets of five specimens each are required, one set for warp tack-tear strength having the longer dimension parallel to the filling yarns, and the other set for filling tack-tear strength having the longer dimension parallel to the warp yarn.

57. Procedure

57.1 Clamp the device shown in Fig. 4 in the upper jaw of the testing machine and adjust the machine to compensate for



in.	mm	in.	mm
1/16	1.59	3/8	9.525
1/8	3.175	1/2	12.700
5/32	3.969	5/8	15.875
3/16	4.762	1	25.400
13/64	5.159	1 1/16	33.338
7/32	5.556	1 3/8	34.925
1/4	6.350	1 7/16	36.512
9/32	7.144	2	50.800
5/16	7.938	2 5/16	58.735
11/32	8.731	2 1/16	68.262

FIG. 4 Tack-Tear Tester for Coated Fabrics

its weight. Impinge the specimen on the needles, taking care that the line of needles is parallel to the threads to be tested and exactly 12.7 mm (0.5 in.) from the top edge of the specimen. Clamp the specimen in the lower clamp. Operate the machine as for a tension test with the distance from the bottom of the needles to the top of the lower clamp 76 mm (3 in.) and the rate of jaw separation 5.00 ± 0.2 mm/s (12 ± 0.5 in./min) with no load. The faces of the bottom clamp shall measure 25 by 76 mm (1 by 3 in.) or more. If the machine is of the pendulum type, disengage the pawls on the pendulum from the ratchet. Record the average force necessary to tear the fabric, preferably with an autographic recording device.

58. Report

58.1 Report the medium of the results of the five individual tests on the warp as the warp tack-tear strength, and the median of the five individual tests on the filling as the filling tack-tear strength.

LOW-TEMPERATURE BEND TEST

59. Procedure

59.1 Determine the resistance of the material to low-temperature bending in accordance with Test Method D 2136.

LOW-TEMPERATURE IMPACT TEST

60. Procedure

60.1 Determine the resistance of the material to low-temperature impact in accordance with Test Methods D 2137.

LOW-TEMPERATURE CRACK RESISTANCE

61. Scope

61.1 The test method covers the determination of resistance of coated fabrics to cracking when exposed to low temperature, and the subsequent ability to maintain hydrostatic resistance.

62. Apparatus

62.1 *Low Temperature Chamber*—Apparatus as cited for low-temperature bend and impact tests (Sections 55 and 56).

62.2 *Roller*—Steel roller, approximately 140 mm (5½ in.) in diameter and 51 mm (2 in.) wide, weighing 4.5 kg (10 lb), with a suitable handle guide.

62.3 *Gloves*—Arctic gloves, preferably with sleeve attachments, capable of retaining flexibility at sub-zero temperatures.

62.4 *Hydrostatic Resistance*—Apparatus as cited for Procedure B (Sections 41-44).

63. Test Specimen

63.1 The test specimen shall be a 203-mm (8-in.) square of coated fabric with edges oriented parallel to the warp and fill directions. Unless otherwise specified, at least three specimens from each lot of material shall be tested.

64. Procedure

64.1 *Low Temperature Crack Procedure*—Expose the specimens in the low-temperature chamber at the required temperature for the required conditioning time. While still in the chamber, crease each specimen 180° in the center in the warp

and fill directions respectively by folding slightly while lying on a flat smooth surface and running the center of the steel roller over the fold a single time. Open the specimen between the two creasing operations. The pressure on the specimen shall be the weight of the roller. The temperature of the roller shall be of the same as that of the specimen. Handle the specimen with gloves, and take care that its temperature remains uniform throughout the test. Fold the specimen in both the warp and fill directions, that the coating in the case of unbalanced double-coated cloth shall be on the outside of the fold. In the case of a true balanced double coating, either side may be toward the outside of the fold. Remove the specimen from the chamber and visually examine for signs of coating cracking or flaking.

64.2 *Hydrostatic Resistance*—Determine the hydrostatic resistance of the specimens exposed as previously detailed in accordance with Procedure B, Sections 41-44, after allowing at least 2 h for return to standard laboratory conditions.

65. Report

65.1 Report the following information:

65.1.1 Results of test expressed as “passed” or “failed,” that is, whether specimens exhibited visible coating cracks or water leakage during hydrostatic resistance testing, or evidenced a significant change in hydrostatic resistance when compared to the initial value.

65.1.2 Number of specimens tested.

65.1.3 Temperature at which the specimens were tested.

65.1.4 Length of the exposure period.

65.1.5 Identification, date of manufacture, and date of test.

SEAM STRENGTH

66. Scope

66.1 The strength of coated fabric seams (lapped, lapped and bonded, and sewn seams) shall be tested by the modified grab test method.

67. Significance

67.1 This test method is intended to determine the seam strength for comparison with the strength of the coated fabric.

68. Testing Machine

68.1 The testing machine used for this test shall conform to the requirements of the machine used in the grab test method for breaking strength (see Section 12) with the following modification: The face of the jaws shall measure 25 by 76 mm (1 by 3 in.) or more with the long dimension perpendicular to the direction of application of the load. The machine shall be adjusted to pull the clamps at a uniform rate of 5.00 ± 0.2 mm/s (12 ± 0.5 in./min).

69. Test Specimen

69.1 The specimen shall be a rectangle 50 by 203 mm (2 by 8 in.) with the seam horizontally across the center, perpendicular to the long direction. Unless otherwise specified in the material or product specification, three individual specimens shall be tested and the average of the three test results shall be recorded.

70. Procedure

70.1 The machine shall be of such capacity that the maximum force required to tear the seam of the specimen is not greater than 85 % or less than 15 % of the rated capacity.

70.2 Place the specimen symmetrically in the jaws of the testing machine with the seam centered between and parallel to the jaws and the shorter dimension at right angles to the direction of application of the force. Start the machine and observe by means of an autographic recording device the force or load necessary to slip the seam or rupture the fabric.

70.3 If a specimen slips between the jaws, breaks or tears in a direction other than parallel to the seam, or, if for any reason attributable to faulty technique an individual measurement falls 20 % below the median test results for the sample unit, discard and test another specimen.

71. Calculation and Report

71.1 The seam strength of the test specimen shall be reported as the average of all the individual results in N/25 mm (lbf/1 in.) to the nearest 0.4 N/25 mm (0.1 lbf/1 in.). The report shall include whether failure occurred in the seam or in the fabric.

ACCELERATED HEAT AGING OF FABRICS COATED WITH RUBBER OR PLASTICS BY THE OVEN METHOD

72. Scope

72.1 This test method is used to estimate the relative heat deterioration resistance of fabrics coated with rubber or plastics. No exact correlation between this accelerated test and the natural life of coated fabrics is given or implied since the rate of deterioration during the normal life of coated fabrics varies widely, depending on the condition of exposure to heat, light, and air and on the composition of the coated fabric. This accelerated test is comparative only and must be evaluated against the performance of coated fabrics, of which both the natural and accelerated aging characteristics are known.

73. Nature of Test

73.1 This aging test of coated fabrics consists of subjecting test specimens having previously determined physical properties to controlled deteriorating influences for known periods, after which the physical properties are again measured and compared with corresponding properties of unaged specimens. The test involves exposure of the specimens to an elevated temperature in air at atmospheric pressure. The test is designated as an oven-aging test. It does not include exposure to light.

73.2 The selection of the aging time and temperature will depend on the purpose of the test and the type of coated fabric. This selection indicates whether an accelerated aging or a simulated service (heat) test is being used.

73.3 The physical properties used to measure the deterioration of coated fabrics, in addition to visual and manual inspections, are breaking strength, burst strength, tear strength, or other desired physical properties. Except as otherwise

specified, the determination of these properties before and after aging shall be carried out in accordance with these test methods.

74. Apparatus

74.1 Except as otherwise specified, the apparatus shall conform to the apparatus section of Test Method D 573.

75. Test Specimens

75.1 Prepare specimens as described in these test methods. Use at least three specimens to determine both the original and aged physical properties.

75.2 The material used for identifying the test specimens should not injure the test specimens or become destroyed during aging.

76. Procedure for Accelerated Aging

76.1 Place the specimens in the oven after it has been preheated to the operating temperature. The test specimens shall be free from strain, freely exposed on all sides, and not exposed to light.

76.2 The operating temperature may be any elevated standard temperature as shown in Practice D 1349.

76.3 Start the aging interval at the time the specimens are placed in the oven and continue aging for a measured time interval. The selection of suitable intervals will depend on the rate of deterioration of the particular coated fabric being tested. Intervals frequently used are one, two, three, seven, or some multiple of seven days.

76.4 At the termination of the aging period, remove the specimens from the oven, cool to room temperature, and condition in accordance with these test methods.

77. Physical Tests of Aged Specimens

77.1 Testing shall be done in accordance with these test methods.

78. Calculation

78.1 In determining the physical properties after aging, the final value shall be the average of results from three specimens.

78.2 Express the results of the aging tests as a percent of the change, c , in each physical property (breaking strength, tear strength, or burst strength), calculated as follows:

$$c = A - O/O \times 100 \quad (1)$$

where:

O = original value and

A = value after aging.

79. Report

79.1 Report the following information:

79.1.1 The results calculated in accordance with Section 78.

79.1.2 All observed and recorded data on which the calculations are based.

79.1.3 The type of aging tests.

79.1.4 The aging interval.

79.1.5 The aging temperature.

79.1.6 The number of specimens exposed for each property under test.

DEAD LOAD SEAM STRENGTH

80. Testing Equipment

80.1 *Clamps*—The clamps for holding the specimens shall have metallic gripping surfaces with minimal serration to prevent the test specimen from slipping or moving between the gripping surfaces when held under the pressure normal to operate. The clamp dimensions shall be greater than 1 in., perpendicular to the application of the load.

80.2 *Tension Testing Machine*—A mechanism wherein the specimen is held between two clamps and placed under constant load for a required period of time.

80.3 Circulating air oven capable of maintaining the specified temperature within $\pm 2^{\circ}\text{F}$.

80.4 Machine efficiency shall not deviate more than $\pm 1\%$ of the load.

81. Test Specimen

81.1 The specimen shall be 25 ± 0.5 mm (1.00 ± 0.02 in.) wide, parallel to the seam, and extend 76 mm (3 in.) in length, perpendicular to the seam, on each side of the seam. No two specimens shall contain the same threads of the fabric in the direction to be tested.

82. Procedure

82.1 Place the specimen in the clamping device so the seam is centered between the clamps. The clamps shall not be further than 1 in. from the seam edge. Apply the designated load under constant tension according to the specification for the required period of time and temperature. (If the specification requires testing at an elevated temperature, the specimen must be subjected to a constant tension at the specified temperature).

82.2 Evaluate the specimen while under tension for jaw slippage, breaks, and tears. Readjust the specimen in the clamps if slippage occurs. Discard specimens with breakage and tears, retest using a new specimen. Some materials may elongate beyond the capacity of the machine. In these cases, if readjusting the specimens in the clamps does not allow for a constant tension, these materials are considered non-testable to this method. Upon completion of the tests, if lifting or separation of the seam has occurred, or the reinforcement material in the seam area has been altered, the test shall be reported as a failure. Three specimens shall be tested for each sample unit.

83. Report

83.1 The dead load seam strength shall be reported as pass or fail, indicating the load, temperature, time duration, and the seam width. Failure of any specimen shall constitute failure of this test.

DETERMINATION OF BLOCKING RESISTANCE OF FABRICS COATED WITH RUBBER OR PLASTICS AT ELEVATED TEMPERATURES

84. Scope

84.1 This test method is intended for determining the resistance of fabrics coated with rubber or plastics to blocking at elevated temperatures. The selection of the conditioning

time and temperature will depend on the types of coating to be evaluated. This selection decides whether an accelerated temperature or simulated (heat) test is to be used.

85. Apparatus

85.1 *Two Glass Plates*, approximately 100 by 100 by 3 mm (4 by 4 by $\frac{1}{8}$ in.).

85.2 *Mass*, 1.8 kg (4.0 lb).

85.3 *Circulating Air Oven*, of such a size that the total volume of the test pieces does not exceed 10 % of the free air space of the oven.

85.4 *Storage*—Provisions shall be made for placing the specimens under test on shelves so they are not within 12.7 mm (0.5 in.) of each other or the sides of the oven.

85.5 *Heat*—The source of heat is optional but shall be located in the air supply of the aging chamber proper.

85.6 *Air Circulation*—Provisions shall be made for circulation of air through the oven and shall have a minimum of three changes per hour.

85.7 *Temperature*—The temperature of the oven shall be thermostatically controlled so that the test pieces are kept within $\pm 1.1^{\circ}\text{C}$ ($\pm 2^{\circ}\text{F}$) of the specified temperature.

85.8 Baffles shall be used as required to prevent overheating and dead spots.

86. Test Specimens

86.1 Test three 203- by 203-mm (8- by 8-in.) specimens from each sample.

87. Procedure

87.1 The specimens shall be folded double, face to face, then back to back, making a 102- by 102-mm (4- by 4-in.) square and placed between two glass plates. The 1.8-kg (4.0-lb) mass shall be placed on the top plate in a position to ensure even pressure.

87.2 Unless other times and temperatures are specified in the material specification, expose the specimen for 6 h at a temperature of $66 \pm 1^{\circ}\text{C}$ ($150 \pm 2^{\circ}\text{F}$).

87.3 At the end of the exposure period, remove the test assembly from the oven and immediately take the specimen from between the plates and allow it to cool for a minimum of 5 min. Then slowly unfold the specimen and at the same time carefully examine it for evidence of adhering or peeling of the coating.

87.4 Evaluate the resistance of the specimen to blocking by the scale given below:

- 1—*No Blocking*. Cloth surfaces separate without any evidence of adhering.
- 2—*Slight Blocking*. Cloth surfaces must be slightly peeled to separate.
- 3—*Blocking*. Cloth surfaces separate with difficulty or coating is removed during separation.

88. Report

88.1 Report the following information:

- 88.1.1 Identification of the specimen.
- 88.1.2 The total load on the specimen.
- 88.1.3 The exposure temperature.
- 88.1.4 The length of exposure.
- 88.1.5 The rating of resistance to blocking.
- 88.1.6 The length of cooling.

DETERMINATION OF CRUSH RESISTANCE OF FABRICS COATED WITH RUBBER OR PLASTICS

89. Scope

89.1 This test method outlines a procedure for determining the crush or cutting resistance for fabrics coated with rubber or plastics. It is applicable, particularly to diaphragm material cut from coated fabrics, to be used for automotive and regulator devices. For this purpose, the coated fabric is subjected to a controlled load application over a specified area until the fabric is crushed or cut by the loading fixture.

89.2 The observation of the coating for possible cutting or penetration is also considered to be part of the test.

90. Test Pieces

90.1 The test pieces shall be at least 50 mm (2.0 in.) wide by 203 mm (8.0 in.) long, and at least three specimens shall be tested from each sample.

91. Apparatus

91.1 The force shall be applied to this specimen by use of the following parts:

91.2 *Base Plate*, having the dimensions shown in Fig. 5.

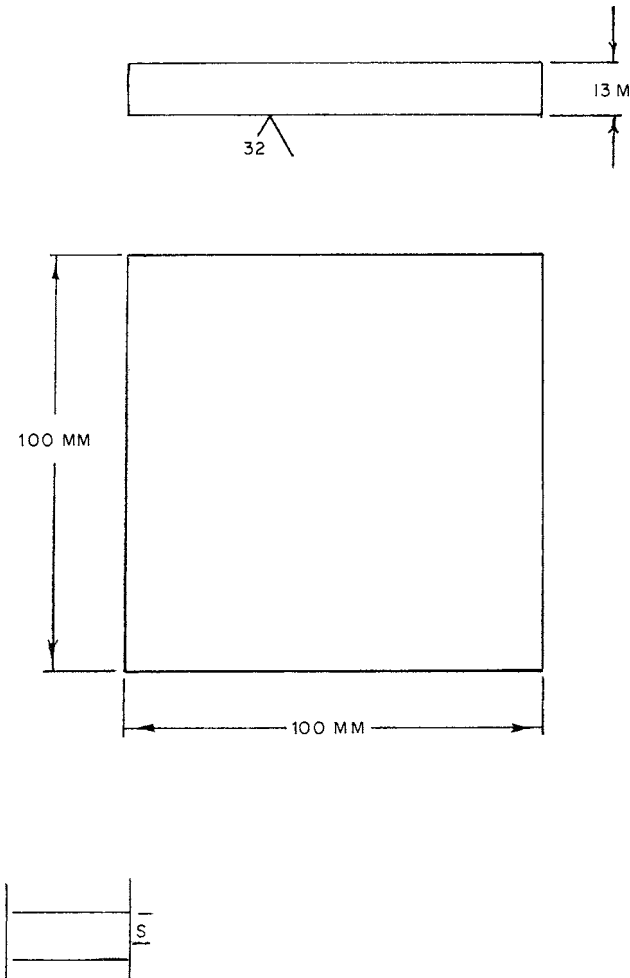


FIG. 5 Crush Test Plate

91.3 *Load Button Assembly*, having the dimensions shown in Fig. 6.

91.4 *Compression Testing Machine*—A compression testing machine having a speed of 0.084 mm/s (0.0033 in./s) may be used. Any other type of machine that will meet these requirements may be used. The load source should have a total capacity of at least 5338 N (1200 lbf).

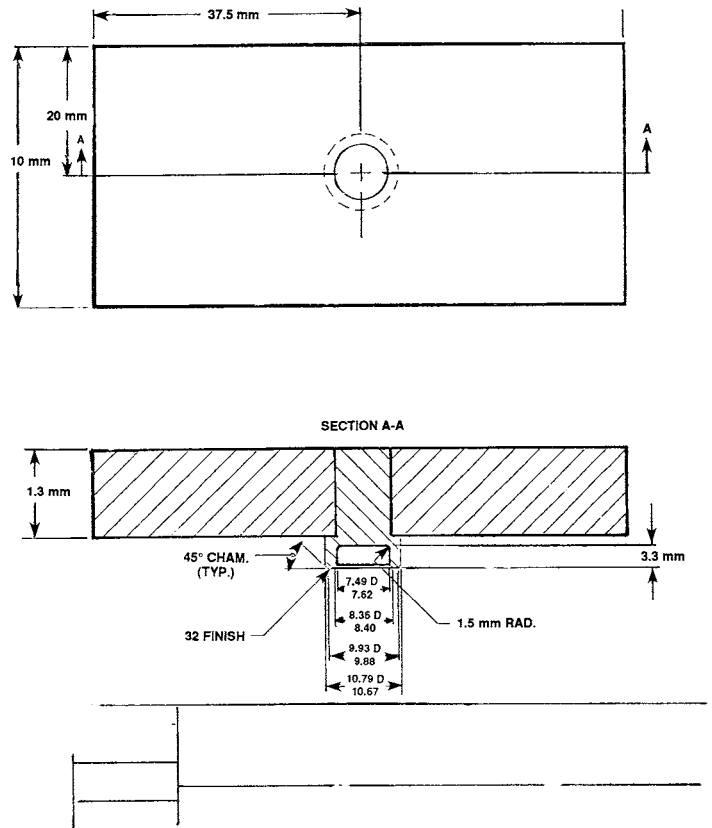
91.5 *Force Recording Mechanisms*—A calibrated dial with a maximum pointer, chart, autographic recording device, or a computer interface to indicate force required to crush or cut fabric. Unless otherwise specified for force determination, the machine shall be adjusted so that the maximum force required to crush or cut the specimen can readily be detected by the maximum pointer or can be read from the recording device.

91.6 *Machine Efficiency*—The error of the machine shall not exceed 2 % up to and including 222 N (50 lbf) and 1 % over 222 N (50 lbf) at any reading within its loading range.

92. Procedure

92.1 Place the base plate in Fig. 5 on the platform of the apparatus that will supply the force, and place the test specimen on the base plate.

92.2 Place the load button in Fig. 6 on the test specimen with the recessed end down and a minimum of 12.7 mm (0.50 in.) from any edge of the specimen. Apply the force to the button at the rate of 0.084 mm/s (0.0033 in./s) until a deflection



- NOTE 1—All dimensions are in millimetres.
- NOTE 2—Break all sharp edges.
- NOTE 3—Button to be press fit in plate.

FIG. 6 Diaphragm Crush Test Button

is noted on the maximum pointer or recording device. Record the force required to crush or cut the fabric. Repeat this procedure at least two additional times on a new area of the specimen a minimum of 12.7 mm (0.5 in.) from the previous test area.

NOTE 10—If the specimen of material to be tested has an unbalanced coating, the side having the thicker coating shall be facing upward.

92.3 Fabric crushing or cutting can readily be detected by stretching the specimen in the damaged area. The fabric will have noticeably less resistance to stretching for the damaged areas when compared with the undamaged areas.

93. Report

93.1 Report the following information:

93.1.1 Identification of the specimens.

93.1.2 The method of test.

93.1.3 The conditioning period.

93.1.4 The number of specimens tested.

93.1.5 The force required to crush or cut specimens.

93.1.6 The condition of the coating after force has been applied.

WICKING OF COATED CLOTH

94. Test Specimen

94.1 The specimen shall be a piece of coated fabric 2.5 cm (1 in.) in width and not less than 203 mm (8 in.) in length. Unless otherwise specified in the material specification, three specimens for the longitudinal wicking having the longer dimension parallel to the lengthwise direction of the goods, and

the transverse wicking having the longer direction parallel to the crosswise direction of the goods, shall be tested from each sample unit. The specimens shall be taken uniformly across the material. No two specimens shall contain the same threads of the fabric in the direction to be tested.

95. Apparatus

95.1 A 1-dm³(L) beaker or equivalent shall be filled to a depth of 5 cm (2 in.) minimum with a 10 % solution of water-soluble dye (contrasting with the color of the base fabric or coating).

96. Procedure

96.1 Hang the specimen so that one end in the length direction is immersed 2.5 cm (1 in.) into the water/dye solution. The 2.5 cm (1 in.) of specimen shall be immersed continuously for 24 h at $21 \pm 1^\circ\text{C}$ ($70 \pm 2^\circ\text{F}$), $50 \pm 5\%$ humidity. Remove the specimen from water/dye solution, blot dry. Use a ruler to mark the specimen in regular intervals above the immersion line perpendicular to the specimen length. Using a razor cut through the coating into the reinforcement material at the marked intervals. Observe for stain of the base cloth in the direction of test using a lighted magnifier.

97. Report

97.1 The length of wicking to the nearest 1.6 mm (0.0625 in.) on each individual specimen, direction of test, and the number of yarns at each interval shall be reported.

98. Keywords

98.1 coated fabrics; physical properties; rubber

ANNEX
(Mandatory Information)
A1. PRECISION TABLES
A1.1 Introduction to Precision Tables

A1.1.1 A Type 1 precision was evaluated by preparing standard test specimens in one laboratory and distributing these specimens to the laboratories participating in the interlaboratory test. A separate test was conducted on each of two test days in each laboratory. The testing was done in 1983.

A1.1.2 A test result as used in the calculations for the precision statements (see Section 6) is the average of the number of specimens required under the corresponding section of Test Methods D 751 for any one day.

A1.1.3 The number of participating laboratories for each of the tests evaluated for precision is indicated at the bottom of each table.

A1.1.4 In the precision tables given in this annex, the symbols in the tables are identified as follows:

- s_r = within laboratory standard deviation.
- r = repeatability (in measurement units).
- (r) = repeatability (in percent).
- S_R = between laboratory standard deviation.
- R = reproducibility (in measurement units).
- (R) = reproducibility (in percent).
- c = Mooney torque units.

A1.1.5 The precision of these test methods may be expressed in the format of the following statements which use what is called the “appropriate value” of r , R , (r), or (R), that is, that value to be used in decisions about test results (obtained with the test method). The *appropriate value* is that value of r or R associated with a mean level in the precision tables for that particular test, closest to the mean level under consideration at any given time, for any given material in routine testing operations.

A1.1.6 *Repeatability*—The repeatability, r , of any of these test methods has been established as the *appropriate value* tabulated in the precision tables. Two single test results, obtained under normal test method procedures, that differ by more than this tabulated r (for any given level) must be considered as derived from different or nonidentical sample populations.

A1.1.7 *Reproducibility*—The reproducibility, R , of any of these test methods has been established as the *appropriate*

value tabulated in the precision tables. Two single test results obtained in two different laboratories, under normal test method procedures, that differ by more than the tabulated R (for any given level) must be considered to have come from different or nonidentical sample populations.

A1.1.8 Repeatability and reproducibility expressed as a percent of the mean level, (r) and (R), have equivalent application statements as above for r and R . For the (r) and (R) statements, the difference in the two single test results is expressed as a percent of the arithmetic mean of the two test results.

A1.1.9 **Table A1.1** and **Table A1.2** give the precision results for grab breaking strength (see Sections 12-15).

A1.1.10 **Table A1.3** and **Table A1.4** give the precision results for cut-strip breaking strength (see Sections 12-16).

A1.1.11 **Table A1.5** give the precision results for diaphragm bursting strength (see Sections 18-21).

A1.1.12 **Table A1.6** and **Table A1.7** give the precision results for pendulum tear, Procedure A (see Section 27).

A1.1.13 **Table A1.8** and **Table A1.9** give precision results for tongue tear, Procedure B (see Sections 28-31).

A1.1.14 **Table A1.10** gives the precision results for hydrostatic resistance, Procedure A (see Sections 36-40).

A1.1.15 **Tables A1.11-A1.14** give precision results for peel adhesion, warp, and fill, Sides 1 and 2 (see Section 46.1.1).

A1.1.16 **Table A1.15** and **Table A1.16** give precision results for reinforced coating peel adhesion, warp, and fill (see Section 46.1.2).

A1.1.17 **Table A1.17** and **Table A1.18** give precision results for percent change in breaking strength after heat aging of cut strip and grab specimens (see Sections 72-79).

A1.1.18 The precision for the low temperature bend test can be obtained by reference to Test Method **D 2136**.

A1.1.19 The precision for the other individual test methods contained in Test Methods D 751 has not yet been evaluated. When this work is done, the results will be given in tabular form at the appropriate location (table number) in this annex.

TABLE A1.1 Type 1 Precision Results—Grab Breaking Strength (Warp)⁴

Material	Mean Level, N	Within Laboratory			Between Laboratory		
		s_r	r	(r)	S_R	R	(R)
A	638.654	32.255	91.28235	14.3	130.956	370.606	58.0
B	1322.465	118.699	335.9190	25.4	214.820	607.941	46.0
C	5205.997	209.659	593.3353	11.4	421.254	1192.148	22.9

⁴The number of laboratories was five.

TABLE A1.2 Type 1 Precision Results—Grab Breaking Strength (Fill)^A

Material	Mean Level, N	Within Laboratory			Between Laboratory		
		s_r	r	(\bar{r})	S_R	R	(\bar{R})
A	561.241	39.351	111.3644	19.8	132.892	376.083	67.0
B	1251.504	145.149	410.7706	32.8	267.719	757.644	60.5
C	5031.819	165.792	469.1913	9.3	279.976	792.331	15.7

^AThe number of laboratories was five.

TABLE A1.3 Type 1 Precision Results—Cut Strip Breaking Strength (Warp)^A

Material	Mean Level, N	Within Laboratory			Between Laboratory		
		s_r	r	(\bar{r})	S_R	R	(\bar{R})
A	406.416	20.643	58.42070	14.4	47.157	133.455	32.8
B	819.283	60.640	171.6108	20.9	66.446	188.042	23.0
C	3367.448	152.890	432.6783	12.8	314.811	890.916	26.5

^AThe number of laboratories was four.

TABLE A1.4 Type 1 Precision Results—Cut Strip Breaking Strength (Fill)^A

Material	Mean Level, N	Within Laboratory			Between Laboratory		
		s_r	r	(\bar{r})	S_R	R	(\bar{R})
A	327.068	18.708	52.94376	16.2	52.254	147.877	45.2
B	735.420	61.930	175.2621	23.8	83.219	235.508	32.0
C	2986.836	125.150	354.1755	11.9	345.131	976.720	32.7

^AThe number of laboratories was four.

TABLE A1.5 Type 1 Precision Results—Bursting Strength Diaphragm Test^A

Material	Mean Level, MPa	Within Laboratory			Between Laboratory		
		s_r	r	(\bar{r})	S_R	R	(\bar{R})
A	1.51	0.227	0.642	42.5	0.198	0.558	36.9
B	3.37	0.082	0.232	6.9	0.248	0.70	20.8

^AThe number of laboratories was three.

TABLE A1.6 Type 1 Precision Results (Procedure A)—Pendulum Tear (Fill)^A

Material	Mean Level, N	Within Laboratory			Between Laboratory		
		s_r	r	(\bar{r})	S_R	R	(\bar{R})
3	3.02	0.76	2.15	71.2	0.63	1.78	58.9
1	5.79	0.55	1.56	26.9	0.497	1.41	24.3
2	7.42	0.81	2.29	30.9	0.750	2.12	28.7
4	14.98	0.87	2.46	16.4	0.981	2.78	18.5
5	21.2	0.43	1.22	5.7	2.27	6.43	30.3

^AThe number of laboratories was four.

TABLE A1.7 Type 1 Precision Results (Procedure A)—Pendulum Tear (Warp)^A

Material	Mean Level, N	Within Laboratory			Between Laboratory		
		s_r	r	(\bar{r})	S_R	R	(\bar{R})
3	3.47	0.78	2.21	63.6	0.68	1.93	55.6
1	6.76	0.68	1.92	28.5	0.751	2.12	31.4
2	6.84	0.61	1.73	25.2	0.48	1.37	2.00
4	11.4	0.26	0.74	6.5	0.618	1.75	15.3
5	28.0	0.45	1.27	4.5	1.66	4.69	16.8

^AThe number of laboratories was four.

TABLE A1.8 Type 1 Precision Results (Procedure B)—Tongue Tear (Transverse or Fill)^A

Material	Mean Level, N	Within Laboratory			Between Laboratory		
		s_r	r	(\bar{r})	S_R	R	(\bar{R})
5	4.6	0.72	2.04	44.3	2.60	7.36	160.0
1	6.9	0.83	2.35	34.0	1.61	4.56	66.0
3	8.5	0.70	1.98	23.3	1.35	3.83	45.1
2	72.5	6.37	18.0	24.9	13.8	38.9	53.7
4	80.9	5.64	16.0	19.7	22.3	63.0	77.9

^AThe number of laboratories was four.

TABLE A1.9 Type 1 Precision Results (Procedure B)—Tongue Tear (Warp or Longitudinal)^A

Material	Mean Level, N	Within Laboratory			Between Laboratory		
		s_r	r	(\bar{r})	S_R	R	(\bar{R})
5	4.7	0.85	2.41	51.2	2.37	6.70	143.0
1	7.1	1.03	2.92	41.1	1.49	4.22	59.4
3	7.3	0.39	1.10	15.1	1.52	4.29	58.8
4	76.9	2.20	6.23	8.1	19.1	53.9	70.0
2	81.2	3.73	10.6	13.0	11.7	33.1	40.8

^AThe number of laboratories was four.

TABLE A1.10 Type 1 Precision Results (Procedure A)—Hydrostatic Resistance (Procedure A)^A

Material	Mean Level, kPa	Within Laboratory			Between Laboratory		
		s_r	r	(\bar{r})	S_R	R	(\bar{R})
3	2540.0	520.0	1472.0	58.0	979.0	2771.0	109.0
1	2850.0	263.0	744.0	26.1	478.0	1352.0	47.4
2	3170.0	858.0	2428.0	76.6	690.0	1953.0	61.6

^AThe number of laboratories was four.

TABLE A1.11 Type 1 Precision Results—Peel Adhesion (Warp Side 1) (See Section 46.1.1)^A

Material	Mean Level, N	Within Laboratory			Between Laboratory		
		s_r	r	(\bar{r})	S_R	R	(\bar{R})
A	38.964	0.426	1.204927	3.1	1.135	3.213	8.2
B	51.028	1.593	4.509348	8.8	8.064	22.821	44.7
C	58.511	8.257	23.36828	39.9	7.290	20.666	35.3
D	66.446	0.645	1.825647	2.7	2.116	5.988	9.0

^AThe number of laboratories was four.

TABLE A1.12 Type 1 Precision Results—Peel Adhesion (Warp Side 2) (See Section 46.1.1)^A

Material	Mean Level, N	Within Laboratory			Between Laboratory		
		s_r	r	(\bar{r})	S_R	R	(\bar{R})
A	39.738	0.890	2.519393	6.3	1.639	4.637	11.7
B	46.254	3.077	8.708336	18.8	6.064	17.161	37.1
C	67.736	0.903	2.555906	3.8	4.690	13.296	19.6
D	70.058	6.380	18.05565	25.8	8.322	23.553	33.6

^AThe number of laboratories was four.

TABLE A1.13 Type 1 Precision Results—Peel Adhesion (Fill Side 1) (See Section 46.1.1)^A

Material	Mean Level, N	Within Laboratory			Between Laboratory		
		s_r	r	(\bar{r})	S_R	R	(\bar{R})
A	38.835	1.187	3.359190	8.6	1.245	3.523	9.1
B	50.254	2.864	8.105873	16.1	2.987	8.453	16.8
C	54.640	3.871	10.95388	20.0	3.245	9.199	16.8
D	61.091	4.890	13.83840	22.7	4.529	12.816	21.0

^AThe number of laboratories was four.

TABLE A1.14 Type 1 Precision Results—Peel Adhesion (Fill Side 2) (See Section 46.1.1)^A

Material	Mean Level, N	Within Laboratory			Between Laboratory		
		s_r	r	(\bar{r})	S_R	R	(\bar{R})
A	38.190	1.077	3.048830	8.0	2.187	6.189	16.2
B	45.351	1.419	4.016423	8.9	4.825	13.656	30.1
C	59.221	3.632	10.27839	17.4	6.161	17.466	29.5
D	67.349	4.445	12.57870	18.7	4.361	12.341	18.3

^AThe number of laboratories was four.

TABLE A1.15 Type 1 Precision Results—Reinforced Coating Peel Adhesion (Warp) (See Section 46.1.2)^A

Material	Mean Level, N	Within Laboratory			Between Laboratory		
		s_r	r	(\bar{r})	S_R	R	(\bar{R})
A	12.128	1.426	4.034680	33.3	2.471	6.992	57.7
B	30.320	3.735	10.57049	34.9	12.515	35.418	116.8
C	39.674	3.187	9.018696	22.7	4.864	13.790	34.8
D	109.023	5.761	16.30302	15.0	8.773	24.829	22.8

^AThe number of laboratories was five.

TABLE A1.16 Type 1 Precision Results—Reinforced Coating Peel Adhesion (Fill) (See Section 46.1.2)^A

Material	Mean Level, N	Within Laboratory			Between Laboratory		
		s_r	r	(\bar{r})	S_R	R	(\bar{R})
A	12.128	3.935	11.13644	91.8	6.645	18.804	155.0
B	34.449	1.935	5.476941	15.9	1.813	5.130	14.9
C	35.094	4.883	13.82014	39.4	12.580	35.663	101.6
D	66.704	2.090	5.915096	8.9	12.322	34.870	52.3

^AThe number of laboratories was four.

TABLE A1.17 Type 1 Precision Results—Percent Change in Breaking Strength “Cut Strip”

Material	Average Level	Within Laboratory		Between Laboratory	
		s_r	r	S_R	R
<i>Part A: Warp</i>					
1	-10.5	12.8	36.1	15.6	44.2
2	2.9	12.9	36.3	18.6	52.6
3	1.7	4.0	11.3	4.0	11.3
<i>Part B: Fill</i>					
1	-11.6	2.94	8.32	9.07	25.7
2	2.2	10.9	3.07	14.6	41.3
3	3.5	5.21	14.8	9.00	25.4

TABLE A1.18 Type 1 Precision Results—Percent Change in Breaking Strength “Grab”

Material	Average Level	Within Laboratory		Between Laboratory	
		s_r	r	S_R	R
<i>Part A: Warp</i>					
1	-7.9	6.90	19.5	8.14	23.0
2	-3.6	4.90	13.8	4.88	13.8
3	-3.2	3.82	10.8	6.14	17.4
<i>Part B: Fill</i>					
1	-14.7	6.53	18.5	6.53	18.5
2	-3.2	4.38	12.4	9.86	27.9
3	-2.6	9.39	26.6	9.63	27.3

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