



Designation: D3886 – 22

Standard Test Method for Abrasion Resistance of Textile Fabrics (Inflated Diaphragm Apparatus)¹

This standard is issued under the fixed designation D3886; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method² covers the determination of the resistance to abrasion of woven and knitted textile fabrics, both conditioned and wet, using the inflated diaphragm tester. This procedure is not applicable to floor coverings.

NOTE 1—Other procedures for measuring the abrasion resistance of textile fabrics are given in Test Methods [D3884](#), [D3885](#), [D1175](#) and AATCC Test Method 93.

1.2 The values stated in SI units are to be regarded as standard; the values in English units are provided as information only and are not exact equivalents.

1.3 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*³

[D123 Terminology Relating to Textiles](#)

[D1175 Method of Test for Abrasion Resistance of Textile Fabrics \(Oscillatory Cylinder and Uniform Abrasion\);](#)

¹ This test method is under the jurisdiction of ASTM Committee [D13](#) on Textiles and is the direct responsibility of Subcommittee [D13.60](#) on Fabric Test Methods, Specific.

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² This test method is based upon the development described by R. G. Stoll, in “Improved Multipurpose Abrasion Test and Its Application for the Wear Resistance of Textiles,” *Textile Research Journal*, July 1949, p. 394.

³ 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.

[Replaced by D 4157, D 4158 \(Withdrawn 1981\)⁴](#)
[D1776 Practice for Conditioning and Testing Textiles](#)
[D2904 Practice for Interlaboratory Testing of a Textile Test Method that Produces Normally Distributed Data \(Withdrawn 2008\)⁴](#)
[D2906 Practice for Statements on Precision and Bias for Textiles \(Withdrawn 2008\)⁴](#)
[D3884 Guide for Abrasion Resistance of Textile Fabrics \(Rotary Platform, Double-Head Method\)](#)
[D3885 Test Method for Abrasion Resistance of Textile Fabrics \(Flexing and Abrasion Method\)](#)
[D4850 Terminology Relating to Fabrics and Fabric Test Methods](#)
2.2 AATCC Standard:
[Test Method 93 Abrasion Resistance of Fabrics: Accelerator Method⁵](#)

3. Terminology

3.1 For all terminology related to D13.60, Fabric Test Methods, Specific, see Terminology [D4850](#).

3.2 The following term is relevant to this standard: abrasion.

3.3 For definitions of all other textile terms see Terminology [D123](#).

4. Summary of Test Method

4.1 A specimen is abraded by rubbing either unidirectionally or multidirectionally against an abradant having specified surface characteristics. A specimen is held in a fixed position and supported by an inflated rubber diaphragm which is held under constant pressure. A specimen is abraded by rubbing either unidirectionally or multidirectionally against an abradant having specified surface characteristics. The resistance to abrasion is determined using Option 1, the number of cycles to wear a hole in the specimen, or Option 2, visual assessment of the specimen surface after a specified number of cycles.

⁴ The last approved version of this historical standard is referenced on www.astm.org.

⁵ Available from American Association of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle Park, NC 27709.

5. Significance and Use

5.1 The measurement of the resistance to abrasion of textile and other materials is very complex. The resistance to abrasion is affected by many factors, such as the inherent mechanical properties of the fibers; the dimensions of the fibers; the structure of the yarns; the construction of the fabrics; and the type, kind, and amount of finishing material added to the fibers, yarns, or fabric.

5.2 The resistance to abrasion is also greatly affected by the conditions of the tests, such as the nature of abradant, variable action of the abradant over the area of specimen abraded, the tension of the specimen, the pressure between the specimen and abradant, and the dimensional changes in the specimens.

5.3 Abrasion tests are all subject to variation due to changes in the abradant during specific tests. The abradant must accordingly be discarded at frequent intervals or checked periodically against a standard. With disposable abradants, the abradant is used only once or discarded after limited use. With permanent abradants that use hardened metal or equivalent surfaces, it is assumed that the abradant will not change appreciably in a specific series of tests. Similar abradants used in different laboratories will not change at the same rate, due to differences in usage. Permanent abradants may also change due to pick up of finishing or other material from test fabrics and must accordingly be cleaned at frequent intervals. The measurement of the relative amount of abrasion may also be affected by the method of evaluation and may be influenced by the judgment of the operator.

5.4 The resistance of textile materials to abrasion as measured on a testing machine in the laboratory is generally only one of several factors contributing to wear performance or durability as experienced in the actual use of the material. While “abrasion resistance” (often stated in terms of the number of cycles on a specified machine, using a specified technique to produce a specified degree or amount of abrasion) and “durability” (defined as the ability to withstand deterioration or wearing out in use, including the effects of abrasion) are frequently related, the relationship varies with different end uses, and different factors may be necessary in any calculation of predicted durability from specific abrasion data. Laboratory tests may be reliable as an indication of relative end-use performance in cases where the difference in abrasion resistance of various materials is large, but they should not be relied upon where differences in laboratory test findings are small. In general, they should not be relied upon for prediction of actual wear-life in specific end uses unless there are data showing the specific relationship between laboratory abrasion tests and actual wear in the intended end-use.

5.5 These general observations apply to all types of fabrics, including woven, nonwoven, and knit apparel fabrics, household fabrics, industrial fabrics, and floor coverings. It is not surprising, therefore, to find that there are many different types of abrasion testing machines, abradants, testing conditions, testing procedures, methods of evaluation of abrasion resistance and interpretation of results.

5.6 All the test methods and instruments so far developed for measuring abrasion resistance may show a high degree of

variability in results obtained by different operators and in different laboratories; however, they represent the test methods now most widely in use.

5.7 Because there is a definite need for measuring the relative resistance to abrasion, standardized test methods are needed and useful and may clarify the problem and lessen the confusion.

5.8 Because of the conditions mentioned above, technicians frequently fail to get good agreement between results obtained on the same type of testing instrument both within and between laboratories, and the precision of these test methods is uncertain.

5.9 Test Method D3886 is not recommended for acceptance testing of commercial shipment because of the poor between-laboratory precision.

5.9.1 In cases of a dispute arising from differences in reported test results when using this test method for acceptance testing of commercial shipments, the purchaser and the supplier should conduct comparative tests to determine if there is a statistical bias between their laboratories. Competent statistical assistance is recommended for the investigation of bias. As a minimum, the two parties should take a group of test specimens which are as homogeneous as possible and which are from a lot of material of the type in question. The test specimens should then be randomly assigned in equal numbers to each laboratory for testing. The average results from the two laboratories should be compared using appropriate statistical analysis for unpaired data and an acceptable probability level chosen by the two parties before the testing begins. If a bias is found, either its cause must be found and corrected or the purchaser and the supplier must agree to interpret future test results in the light of the known bias.

6. Apparatus

6.1 *Inflated Diaphragm Abrasion Tester*⁶, shown in Fig. 1 and Fig. 2 with the following essential parts:

6.1.1 *Surface Abrasion Head*—The specimen is mounted in a circular clamp over a rubber diaphragm by means of a clamping ring and a tightening collar. The circular opening of the clamping ring is 94.0 mm ± 1.3 mm (3.70 in. ± 0.05 in.) in diameter and that of the collar 95.3 mm (3.75 in.) or more. The height from the surface of the clamped-in specimen to the upper edge of the tightening collar shall not exceed 9.5 mm (3/8 in.). The clamping area of the body of the clamp and the ring should have gripping surfaces to prevent slipping of the specimen and leakage of air pressure during the test. Means should be provided for supplying air pressure to the body of the clamp so that the pressure under the diaphragm can be controlled between 0 and 41 kPa (0 and 6 psi) with an accuracy of ±5 % of range.

6.1.2 *Diaphragm*—The rubber diaphragm should be 1.40 mm ± 0.25 mm (0.055 in. ± 0.010 in.) in thickness. A metallic contact pin 3.2 mm (1/8 in.) in diameter is sealed into the center of the diaphragm flush with the diaphragm surface. Provision should be made for a flexible electrical connection

⁶ Apparatus is available commercially.

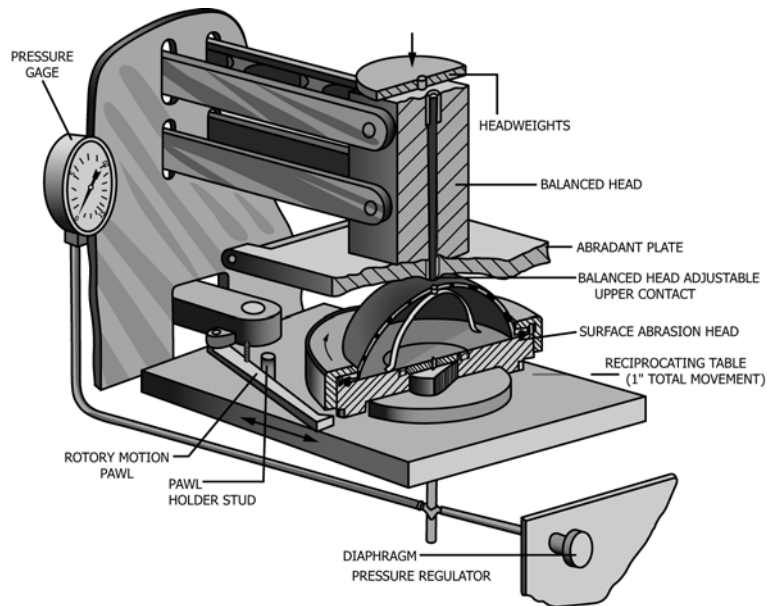


FIG. 1 Schematic Diagram of Inflated Diaphragm Abrasion Tester



FIG. 2 One Type of Commercial Inflated Diaphragm Abrasion Tester

from this contact pin to the ground of the machine. The strain distribution on the diaphragm must be uniform so that when inflated without the specimen, it assumes the shape of a section of a sphere. Pressure can be controlled from 0 to 41 kPa (0 to 6 psi).

6.1.3 *Driving Mechanism*—The design of the driving mechanism is such that the circular clamp makes a reciprocal motion of 115 ± 15 double strokes per minute of 25 mm (1-in.) stroke length. Provision shall be made for rotation of the clamp

in addition to the reciprocating motion so that one revolution can be completed in 100 ± 10 double strokes.

6.1.4 Balance Head and Abradant Plate—The abradant is mounted upon a plate, which is rigidly supported by a double-lever assembly to provide for free movement in a direction perpendicular to the plane of the reciprocating specimen clamp. The abradant plate assembly should be well balanced to maintain a vertical pressure equivalent to a mass of 0 kg to 2.2 kg (0 lb to 5 lb) by means of dead weights. Provision should be made to mount different abradants such as abrasive paper, fabrics, etc., on this plate, and to stretch them into an even position. An electrically insulated contact pin, adjustable to the thickness of the abradant is mounted into this plate on the length axis at one of the turning points of the center of the clamp.

6.1.5 Some testers can also be equipped with a continuous changing abradant head which is optional.

NOTE 2—The machine manufacturer does not provide adequate instructions for the use of the continuous changing abradant head. Work is being done with the manufacturer to write a set of instructions.

6.1.6 Machine Stopping Mechanism—Contact between the adjustable pin on the lower side of the abradant plate and the contact pin inserted into the center of the diaphragm closes a low-voltage circuit and stops the machine.

6.1.7 Indicators—Means should be provided for indicating the diaphragm pressure, and the number of abrasion cycles (1 cycle = 1 double stroke).

6.1.8 Fig. 2 shows a commercially available machine that conforms to the requirements of this method.

7. Sampling

7.1 Lot Sample—As a lot sample for acceptance testing, take at random the number of rolls of fabric directed in an applicable material specification or other agreement between the purchaser and the supplier. Consider rolls of fabric to be the primary sampling unit.

NOTE 3—An adequate specification or other agreement between the purchaser and the supplier requires taking into account the variability between rolls of fabric and between test specimens from a swatch from a roll of fabric to produce a sampling plan with a meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7.2 Laboratory Sample—Take a laboratory sample from each roll or piece of fabric in the lot sample. The laboratory sample should be full width and at least 50 cm (approximately 20 in.) long and should not be taken any closer to the end of the roll or piece of fabric than 1 m (1 yd).

7.3 Test Specimens—Test five specimens from each laboratory sampling unit. Cut the specimens 112 mm ($4\frac{3}{8}$ in.) in diameter and space them on a diagonal to represent different machine and cross-machine direction areas of the laboratory sampling units. Take no specimen within one tenth of the fabric width from the edges.

8. Conditioning

8.1 Precondition and condition samples or specimens as directed in Practice D1776. Consider equilibrium to have been reached when the increase in mass of the specimen in succes-

sive weighings made at intervals of not less than 2 h does not exceed 0.1 % of the mass of the specimen.

9. Procedure

9.1 Test the specimen in the standard atmosphere for testing textiles, which is $70^\circ\text{F} \pm 2^\circ\text{F}$ ($21^\circ\text{C} \pm 1^\circ\text{C}$) and $65\% \pm 2\%$ relative humidity.

9.2 Place the specimen over the rubber diaphragm in a smooth condition, clamp the specimen in place without distorting it.

9.3 Place the abrasive paper or other abradant on the abradant plate under sufficient tension to be held smooth and in such a position that the contact pin, reaching through a hole in the abradant, is even with the surface of the abradant. No. 0 emery polishing paper is the standard abradant (see Note 4). The method may be modified to use other abradants but this information should be included in the final report. Interested parties should agree on the abradant supplier before testing.

NOTE 4—The alphabetic grading system, that is No. 0, is no longer used by the abradant industry and has been replaced by the numerical "grit" system. The comparable material to No. 0 is 600 grit emery.

NOTE 5—Emery is a naturally occurring material and batch to batch variations in roughness are to be expected. Laboratories should conduct internal testing to confirm repeatability when switching from 0 grade to an alternate abradant.

NOTE 6—If the continuous changing abradant head is used, it should be noted that, although the weight of the head is counter-balanced, the balance changes during use as the paper passes from the back roll to the front roll unless the continuous changing abradant head is used.

NOTE 7—Unless the continuous changing abradant head is used, it is recommended that the abradant paper be changed at some regular frequency, such as every 100 to 300 cycles. As this frequency is dependent upon the type of fabric being tested, the task group is working on devising a more extensive system.

9.4 Set the air pressure under the diaphragm and force on the abradant plate. The air pressure should be 28 kPa (4 psi) and the load on the abradant should be 454 g (1 lb). Be sure that the air pressure control and contact between inflated specimen and loaded abradant is in a state of equilibrium before abrasion is started. To ensure consistent inflation of the diaphragm, inflate to a higher air pressure (25 %) and then reduce to testing pressure.

9.5 Direction of Abrasion:

9.5.1 Standard Multidirection—Engage the rotation mechanism of the specimen clamp.

9.5.2 Unidirection—When this is used, disengage the rotation mechanism of the specimen clamp and bring the specimen into the desired direction by turning and setting the clamp after the diaphragm has been inflated. Include this information in the final report.

9.6 Remove pills of matted fibers interfering with proper contact between the specimen and abradant during the test if they cause a marked vibration of the abradant plate.

9.7 If the specimen slips in the clamp or the air pressure does not remain constant during the test or an anomalous wear pattern is obtained, discard such individual measurements and test an additional specimen.

9.8 This table is intended as a guide for visual assessment: