Designation: D4966 – 22

Standard Test Method for Abrasion Resistance of Textile Fabrics (Martindale Abrasion Tester Method)[1]

This standard is issued under the fixed designation D4966; 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 method covers the determination of the abrasion resistance of textile fabrics using the Martindale abrasion tester. The method is generally applicable to knit, woven, and nonwoven fabrics; however, material thickness may limit suitability for testing due to specimen holder capacity.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

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.*

NOTE 1—For other current test methods of testing the abrasion resistance of textiles refer to Test Methods D3884, D3885, D3886, D4157, D4158, and AATCC TM93.

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:*[2]

D123 Terminology Relating to Textiles

D1776 Practice for Conditioning and Testing Textiles

D3884 Guide for Abrasion Resistance of Textile Fabrics (Rotary Platform Abrader Method)

D3885 Test Method for Abrasion Resistance of Textile Fabrics (Flexing and Abrasion Method)

D3886 Test Method for Abrasion Resistance of Textile Fabrics (Inflated Diaphragm Apparatus)

D4157 Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method)

D4158 Guide for Abrasion Resistance of Textile Fabrics (Uniform Abrasion)

D4850 Terminology Relating to Fabrics and Fabric Test Methods

2.2 *AATCC Methods and Procedures:*

EP1 Evaluation Procedure for Gray Scale for Color Change[3]

TM93 Test Method for Abrasion Resistance of Fabrics: Accelerator Method[3]

3. Terminology

3.1 For all terminology relating to D13.60, Fabric Test Methods, Specific, refer to Terminology D4850.

3.1.1 The following terms are relevant to this standard: *abrasion*, *abrasion cycle*, *Lissajous figure*, *movement*.

3.2 For all other terms related to textiles, refer to Terminology D123.

3.3 *abrasion cycle, n—in abrasion testing*, one or more movements of the abradant across a material surface, or movement of the material across the abradant, which permits a return to its starting position.

3.3.1 *Discussion*—The abrasion cycle is dependent on the programmed motions of the abrasion machine and the test standard used. It may consist of one back-and-forth unidirectional movement such as for the flexing and abrasion test method; a circular movement such as for the rotary platform test method, or a combination of both such as for the inflated diaphragm test method. For the oscillatory cylinder abrasion method, an abrasion cycle consists of one double-rub.

3.4 *Lissajous figure, n*—any of an infinite variety of curves formed by combining two mutually perpendicular simple harmonic motions, commonly exhibited by the oscilloscope, and used in studying frequency, amplitude, and phase relations of harmonic variables.

[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 Physical Test Methods B.

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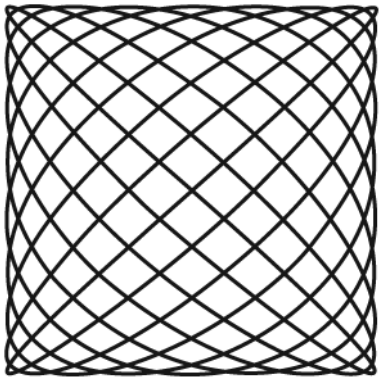
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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

3.4.1 *Discussion—as related to the Martindale Tester*, geometric figure comprised of 16 arcs that start as a straight line, then become a widening ellipse and narrow to again become a straight line.



3.5 *movement, n—as related to the Martindale Tester*, one rotation of the outer gearing of the Martindale tester, creating one of the 16 arcs that form a Lissajous figure.

4. Summary of Test Method

4.1 Abrasion resistance is measured by subjecting the specimen to rubbing motion in the form of a geometric figure, that is, a straight line, which becomes a gradually widening ellipse, until it forms another straight line in the opposite direction and traces the same figure again under known conditions of pressure and abrasive action. Resistance to abrasion is evaluated by various means which are described in Section 11.

5. Significance and Use

5.1 *Acceptance Testing*—this test method is not considered satisfactory for acceptance testing of commercial shipments of fabric. The between-laboratory precision of this test method is poor and, because of the nature of abrasion testing itself, technicians frequently fail to obtain results in agreement on the same type of testing instrument, both within and between laboratories. Although this test method is not recommended for acceptance testing, it is useful because it is used widely, especially outside the United States.

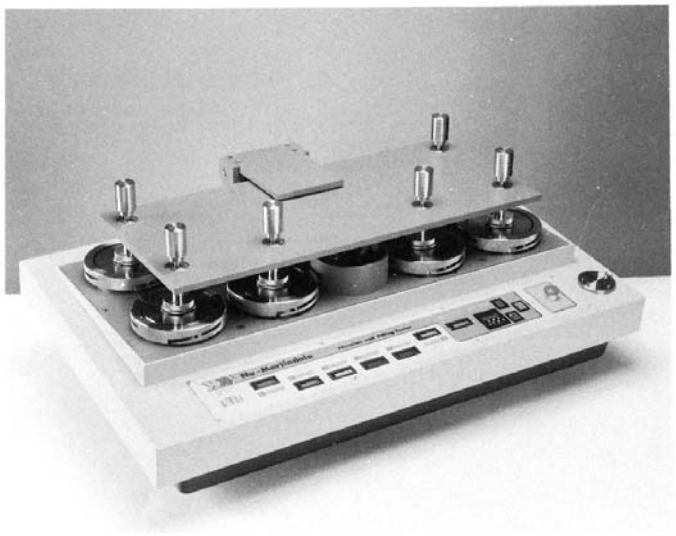


FIG. 1 Martindale Tester

5.1.1 In case 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 that are as homogeneous as possible and that are from a lot of material of the type in question. The test specimens then should be assigned randomly in equal numbers to each laboratory for testing. The average results from the two laboratories should be compared using Students t-test for unpaired data and an acceptable probability level chosen by the two parties before the testing is begun. 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 light of the known bias.

5.2 The resistance to abrasion also is affected greatly 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 on the specimen, the pressure between the specimen and abradant, and the dimensional changes in the specimen.

5.3 Abrasion tests are all subject to variation due to changes in the abradant during specific tests. The abradant must be changed accordingly at frequent intervals or checked periodically against a standard. With disposable abradants, the abradant is used only once or changed 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, but obviously similar abradants used in different laboratories will not likely change at the same rate due to differences in usage. Permanent abradants also may 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 also may 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) frequently are related, the relationship varies with different end uses, and different factors may be necessary in any calculation of predicted durability from specific abrasion data.

5.4.1 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 abrasion resistance may show a high degree of variability in results obtained by different operators and in different laboratories; however, they represent the methods now most widely in use.

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

6. Apparatus and Materials

6.1 *Martindale Tester,*[4](Fig. 1) using a Lissajous figure of 60 mm as described in 3.4 and having a 38 mm sample holder.

6.2 *Standard Abradant Fabric,* a plain weave, crossbred, worsted wool fabric described in the finished state as in Table 1.

6.3 *Standard Felt,* of mass 750 g/m^2 ± 50 g/m^2 (22 oz/yd^2 ± 1.5 oz/yd^2) and 3 mm ± 0.3 mm (0.12 in. ± 0.01 in.) thick.

6.4 *Polyurethane Foam Backing,* 3.00 mm ± 0.01 mm (0.12 in. ± 0.04 in.) thick, 29 kg/m^3 to 31 kg/m^3 (1.81 lbf/ft^3 to 1.94 lbf/ft^3-) density, and 170 N to 210 N (38.23 lbf to 47.22 lbf) hardness.

6.5 *Fabric Punches or Press Cutters,*[4] 38 mm (1.5 in.) and 140 mm (5.5 in.) in diameter.

6.6 *AATCC Gray Scale for Color Change,*[3] if needed.

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.

[4] Apparatus and accessories are commercially available.

TABLE 1 Specifications for Standard Wool Abrasion Fabric

	Warp	Weft
Mean fiber diameter, µm	27.5 ± 2.0	29.0 ± 2.0
Yarn linear density, tex	R63 ± 4/2	R74 ± 4/2
Singles "Z" twist, turns per metre	540 ± 20	500 ± 20
Two-fold "S" twist, turns per metre	450 ± 20	350 ± 20
Threads per 10 centimetres	175 ± 10	135 ± 8
Mass per unit area, g·m–2	215 ± 10	

NOTE 2—An adequate specification or other agreement between the purchaser and the supplier requires taking into account the variability between rolls, bolts, or pieces of fabric and among specimens from a swatch from a roll of fabric from a roll, bolt, or piece, or among cartons of garments and among garments within a carton, to provide a sampling plan with a meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7.2 *Laboratory Sample*—For acceptance testing of garments, take one garment from each carton (see Note 2).

7.3 *Test Specimens*—Cut three circular specimens from each swatch in the laboratory sample with each specimen being 38 mm (1.5 in.) in diameter.

8. Preparation of Apparatus

8.1 For the assembly, maintenance, and verification of the apparatus, refer to the manufacturer's instructions.

8.2 See the testing notes given in A1.1.

9. Conditioning

9.1 Condition specimens as directed in Practice D1776 by bringing them to moisture equilibrium with the specified atmosphere.

10. Procedure

10.1 Make all tests in the standard atmosphere for testing textiles.

10.2 On each testing table place a piece of felt, approximately 140 mm (5.5 in.), followed by a piece of the standard abradant fabric of the same size. Place the mounting weight (supplied with the machine) on the table to flatten the fabric/felt pieces. Secure the fabric/felt to the table with the mounting weight in place then remove the weight and inspect for tucks or ridges. If necessary, repeat the mounting process.

10.3 Option 3 (see 11.3) is to be used to interpret the results, weigh a specimen to the nearest milligram.

10.4 Assemble the holder by placing the specimen face down into the specimen holder. For fabric having a mass/unit area less than 500 g/m^2 (14.7 oz/yd^2) place a 38 mm (1¼ in.) disk of polyurethane foam between the specimen and the metal insert. Assemble the holder according to manufacturer's instructions.

10.5 Place the assembled holder on the machine above the table with the fabric/felt pieces and add the required weight to give a pressure on each specimen of 9 kPa ± 0.2 kPa (1.31 psi ± 0.03 psi) for apparel fabrics and 12 kPa ± 0.3 kPa (1.74 psi ± 0.04 psi) for upholstery fabrics.

10.6 Using the manufacturer's directions, set the counter system to record the desired number of movements and start the machine. If Options 1 or 2 (see 11.1 and 11.2) are to be used, examine the specimen to assess the progress toward the endpoint. As the endpoint is approached, reduce the number of movements between examinations. Cut off with sharp scissors any pills that form. If Option 3 (see 11.3) is to be used to interpret the results, the specimen must be weighed to the nearest milligram after the required number of movements.