



Designation: ~~D4966-98 (Reapproved 2007)~~^{ε1} Designation: D4966 – 10

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.

~~^{ε1}Note—Editorial changes were made in August 2007.~~

1. Scope

1.1 This test method covers the determination of the abrasion resistance of textile fabrics using the Martindale abrasion tester. Fabrics of all types may be tested by this method but difficulties may arise with fabrics with a pile depth greater than 0.08 in. (2 mm).

~~1.2 The values stated in inch-pound units are to be regarded as standard; the values in SI units are provided as information only.~~

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 and health 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 Test Method 93.

2. Referenced Documents

2.1 ASTM Standards:²

D123 Terminology Relating to Textiles

D1776 Practice for Conditioning and Testing Textiles

D3884 Test Method for Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head 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)~~ Guide for Abrasion Resistance of Textile Fabrics (Uniform Abrasion)

D4850 Terminology Relating to Fabrics and Fabric Test Methods

2.2 AATCC Methods and Procedures:

Evaluation Procedure 1 Gray Scale for Color Change³

Test Method 93 Abrasion Resistance of Fabrics: Accelerator Method³

3. Terminology

~~3.1 Definitions—For definitions of other textile terms used in this test method, refer to 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, rub, standard atmosphere for preconditioning textiles, standard atmosphere for testing, in textiles.

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

3.2 Definitions of Terms Specific to This Standard:

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. Current edition approved July 1, 2007. Published August 2007. Originally approved in 1989. Last previous edition approved in 2004 as D4966-98(2004). DOI: 10.1520/D4966-98R07E01.

Current edition approved Oct. 1, 2010. Published November 2010. Originally approved in 1989. Last previous edition approved in 2007 as D4966-98(2007)^{ε1}. DOI: 10.1520/D4966-10.

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.

- 3.2.1 *abrasion, n*—the wearing away of any part of a material by rubbing against another surface.
- 3.2.2 *abrasion cycle, n*—total number of movements required to complete a geometric shape in a Martindale abrasion tester.
- 3.2.3 *cycle, n*—16 movements required for the completion of one Lissajous figure on a Martindale tester.
- 3.2.4 *lissajous figure, n*—a geometric figure that starts as a straight line, then becomes a widening ellipse and narrows to again become a straight line. There are 16 movements in one Lissajous figure.
- 3.2.5 *movement, n*—one rotation of the two outer gearing of the Martindale tester.
- 3.2.6 *standard atmosphere for preconditioning textiles, n*—an atmosphere having a relative humidity of 10 to 25% and a temperature not over 122°F (50°C).
- 3.2.7 *standard atmosphere for testing, in textiles, n*—an atmosphere for testing in which the air is maintained at a relative humidity of $65 \pm 2\%$ and at a temperature of $70 \pm 2^\circ\text{F}$ ($21 \pm 1^\circ\text{C}$).

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.

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

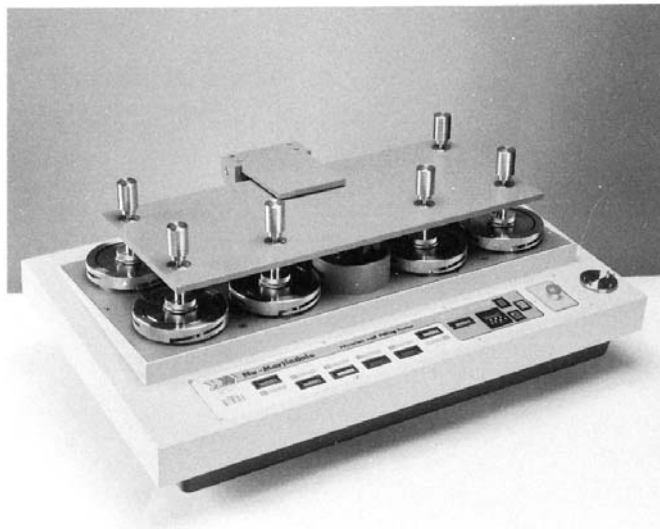


FIG. 1 Martindale Abrasion Tester

not likely change at the same rate due to differences in usage. Permanent abrasants 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, abrasants, 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 Abrasion Tester*,⁴ (Fig. 1) with the following replaceable items:

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

6.1.2 *Standard Felt*, of mass 22 ± 1.5 oz/yd² (750 ± 50 g/m²) and 0.12 ± 0.01 in. (3 ± 0.3 mm) thick.

6.1.3 *Polyurethane Foam Backing*, 0.12 ± 0.04 in. (3 ± 0.01 mm) thick, 1.94 lbf/ft³ (29 to 31 kg/m³) density, and 38.23 to 47.22 lbf (170 to 210 N) hardness.

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

6.1.5 *AATCC Gray Scale for Color Change*.³

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 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 1.5 in. (38 mm) 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.

⁴ Apparatus and accessories are commercially available.

TABLE 1 Specifications for Standard Wool Abrasion Fabric

	Warp	Weft
Yarn linear density	R63, Tex/2	R74, Tex/2
Threads per unit length	(43/in.) 17/cm	(30/in.) 12/cm
Single twist	540 ± 20 tpm ‘Z’	500 ± 20 tpm ‘Z’
Twofold twist	450 ± 20 tpm ‘S’	350 ± 20 tpm ‘S’
Fiber diameter	27.5 ± 20 μ m	29 ± 20 μ m
Mass per unit area of fabric, min	5.8 oz/yd ² (195 g/m ²)	