



Designation: ~~D4970/D4970M – 16~~^{ε3} D4970/D4970M – 22

Standard Test Method for Pilling Resistance and Other Related Surface Changes of Textile Fabrics: Martindale Tester¹

This standard is issued under the fixed designation D4970/D4970M; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

^{ε1} NOTE—In ~~10.1~~, the standard atmosphere for testing textiles shown in brackets was corrected from $\{70 \pm 20^\circ\text{F}\}$ to $\{70 \pm 2^\circ\text{F}\}$ in April 2017.

^{ε2} NOTE—In ~~6.6.2~~, the conversion of 105 mm was corrected to 4.13 in. editorially in June 2017.

^{ε3} NOTE—In ~~8.2~~, “a pair” was editorially corrected to “four pairs” to match the language in ~~13.2.1~~ in January 2018.

1. Scope

1.1 This test method covers the determination of the resistance to the formation of pills and other related surface changes on textile fabrics using the Martindale tester. ~~The procedure generally is applicable to all types of fabrics, being particularly suitable for woven fabrics.~~

NOTE 1—For other methods, if testing the pilling resistance of textiles, refer to Test Methods ~~D3511/D3511M~~, ~~D3512/D3512M~~, and ~~D3514~~.

1.2 This test method is ~~not suitable for fabrics thicker than 3 mm [0.125 in.] because such fabrics cannot be mounted in the specimen holder.~~ generally applicable to knit, woven, and nonwoven fabrics; however, material thickness may limit suitability for testing due to specimen holder capacity.

1.3 The fabric may be laundered or dry cleaned before ~~testing.~~ testing as agreed upon among interested parties.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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

1.6 *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

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, Specific 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.



D123 Terminology Relating to Textiles

D1776 Practice for Conditioning and Testing Textiles

D3511/D3511M Test Method for Pilling Resistance and Other Related Surface Changes of Textile Fabrics: Brush Pilling Tester

D3512/D3512M Test Method for Pilling Resistance and Other Related Surface Changes of Textile Fabrics: Random Tumble Pilling Tester

D3514 Test Method for Pilling Resistance and Other Related Surface Changes of Textile Fabrics: Elastomeric Pad

D4850 Terminology Relating to Fabrics and Fabric Test Methods

~~D7018 Terminology Relating to Glass Fiber and Its Products~~

2.2 *ASTM Adjuncts*:³

ADJD3512 Set of 5 Photographic Standards for Random Tumble Pilling Test

3. Terminology

3.1 For all terminology relating to D13.59, Fabric Test Methods, General, refer to ~~Terminologies~~Terminology ~~D4850~~ and ~~D7018~~.

3.1.1 The following terms are relevant to this standard: ~~cycle, fuzz, fuzz, Lissajous figure, movement, pilling resistance, pills.~~

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

3.3 fuzz, n—fiber ends that protrude from the surface of a yarn or fabric.

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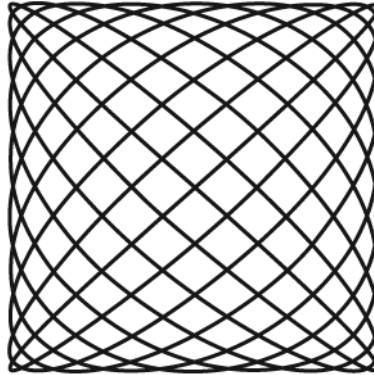
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³ Available from ASTM International Headquarters. Order Adjunct No. [ADJD3512](#).

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.

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.

3.6 pills, *n*—bunches or balls of tangled fibers which are held to the surface of a fabric by one or more fibers. (Compare *fuzz*.)

4. Summary of Test Method

4.1 Pilling and other changes in the surface appearance, such as fuzzing, that occur in normal wear are simulated on a laboratory testing machine. Fabrics are mounted on the Martindale Tester, and the face of the test specimen is rubbed against the face of the same mounted fabric 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 light pressure for a specific number of movements. The degree of fabric pilling or surface appearance change produced by this action is evaluated by comparison of the tested specimen with visual standards that may be actual fabrics, or photographs of fabrics, showing a range of pilling resistance. The observed resistance to pilling is reported using an arbitrary rating scale.

5. Significance and Use

5.1 *Acceptance Testing*—This method of testing fabrics resistance to pilling is not recommended for acceptance testing. If it is used for acceptance testing, it should be used with caution because interlaboratory data are not available. In some cases the purchaser or supplier may have to test a commercial shipment of one or more specific materials by the best available method even though the method has not been recommended for acceptance testing. Although this test method is not recommended for acceptance testing, it is useful because it is used widely outside the United States.

5.2 If there is a disagreement arising from differences in values reported by the purchaser and the supplier when using this test method, the statistical bias, if any, between the laboratory of the purchaser and the laboratory of the supplier should be determined with comparison being based on testing specimens randomly drawn from one sample of material of the type being evaluated. Competent statistical assistance is recommended for the investigation of bias. A minimum of 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 then should be assigned randomly in equal numbers to each laboratory for testing. The average test results from the two laboratories should be compared using an acceptable statistical protocol and probability level chosen by the two parties before the testing is started. Appropriate statistical disciplines for comparing data must be used when the purchaser and supplier cannot agree. If a bias is found, either its cause must be found and corrected, or the purchaser and the supplier must agree to interpret future results with consideration for the known bias.

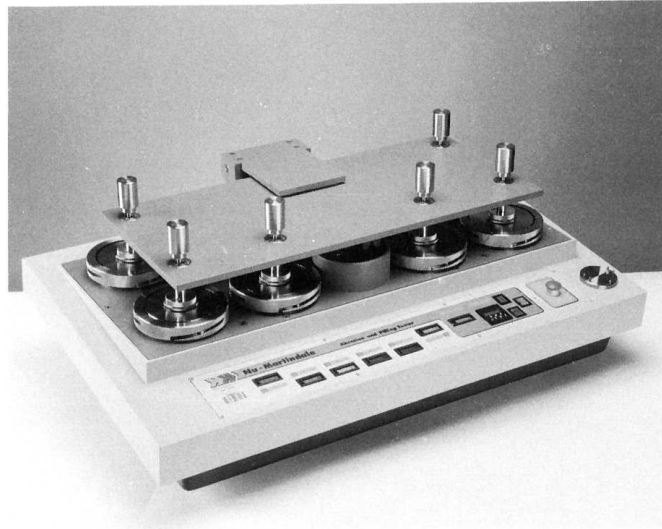


FIG. 1 Martindale Abrasion-Tester

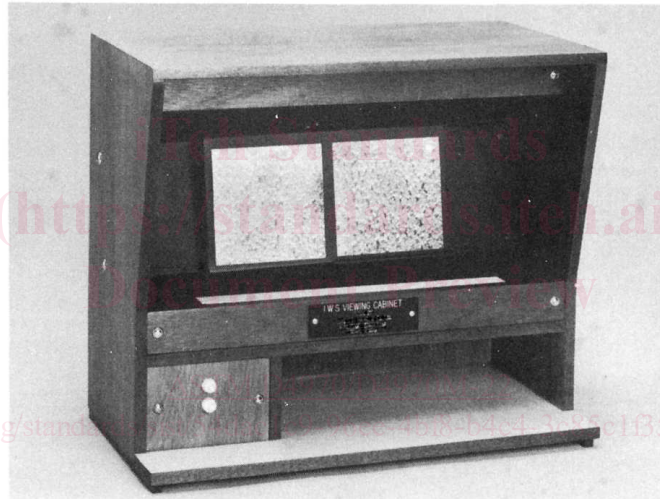


FIG. 2 Apparatus for Fabric Evaluation

5.3 The pilling of textile fabrics is a very complex property because it is affected by many factors that include type of fiber or blends, fiber dimensions, yarn and fabric construction, and fabric finishing treatments. The pilling resistance of a specific fabric in actual wear varies more with general conditions of use and individual wearers than in replicate fabric specimens subjected to controlled laboratory tests. This experience should be borne in mind when adopting levels of acceptability for a series of standards.

5.4 Finishes and fabric surface changes may exert a large effect on pilling. It is recommended that fabrics be tested after laundering or drycleaning, or both. Testing before refurbishing also may be advisable. Prior agreement between interested parties should determine the state of the test. Fabrics may be tested as received or after refurbishing, or both (laundering or drycleaning, or both). Interested parties shall agree on the state of fabric to be tested. The state of tested fabric shall be reported..

5.5 Pills vary appreciably in size and appearance and depend on the presence of lint and degree of color contrast. These factors are not evaluated when pilling is rated solely on the number of pills. The development of pills may be accompanied by other surface phenomena, such as loss of cover, color change, or the development of fuzz. Since the overall acceptability of a specific fabric is dependent on both the characteristics of the pills and the other factors affecting the surface appearance, it is suggested that fabrics tested in the laboratory be evaluated subjectively with regard to their acceptability and not rated solely on the number of pills developed. A series of standards, based on graduated degrees of surface change of the fabric type being tested, may be set up to provide a basis for subjective ratings. The visual standards are most advantageous when the laboratory test specimens

correlate closely in appearance with worn fabrics and show a similar ratio of pills to fuzz. Counting the pills and weighing their number with respect to their size and contrast, as a combined measure of pilling resistance, is not recommended because of the excessive time required for counting, sizing, and calculation.

5.6 The degree of fabric pilling is evaluated by comparing the tested specimens with visual standards, which may be actual fabrics or photographs of fabrics, showing a range of pilling resistance. The observed resistance to pilling is reported on an arbitrary scale ranging from 5 to 1 (no pilling to very severe pilling).

5.7 This test method is applicable to a wide variety of woven and knitted fabrics that vary in pilling propensity as a result of variations in fiber, yarn and fabric structure, and finish. The applicability of this test method to nonwoven fabrics has not been determined.

6. Apparatus and Materials

6.1 *Martindale Tester* (see Fig. 1) using a Lissajous figure of 60 mm as described in Terminology 3.4 D4850 and having a 38 mm sample holder.

NOTE 2—Apparatus and accessories are available commercially.

6.2 *Standard Felt*, of mass $750 \pm 50 \text{ g/m}^2$ [$22 \pm 1.5 \text{ oz/yd}^2$] and $33 \text{ mm} \pm 0.3 \text{ mm}$ [$0.12 \text{ in.} \pm 0.01 \text{ in.}$] thick.

6.3 *Polyurethane Foam Backing*—Backing, $0.12 \pm 0.04 \text{ in.}$ [$3 \pm 0.01 \text{ mm}$] thick, 1.94 lbf/ft^3 [$3.00 \text{ mm} \pm 0.01 \text{ mm}$ ($0.12 \text{ in.} \pm 0.04 \text{ in.}$) thick, 29 ^3 to 31 kg/m^3] (1.81 lbf/ft^3 to 1.94 lbf/ft^3) density, and 38.23 to 47.22 lbf [170 to 210 N] 170 N to 210 N (38.23 lbf to 47.22 lbf) hardness.

NOTE 3—Apparatus and accessories are available commercially.

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

6.5 *Apparatus for Fabric Evaluation*—Facilities for illumination (cool white fluorescent tube) and simultaneous viewing test specimens and fabric or photographic rating standards. Apparatus and options for visual evaluation are listed in Table 1.

6.6 *Standard In-House Pilling Test Fabric*, having an established pilling resistance rating for checking machine performance. No universal standard fabric is available. Each test facility must decide on an appropriate fabric.

6.7 Rating Standards:

6.7.1 *Fabric*, a series of tested specimens of a specific fabric type, which show degrees of pilling or other distortion, or both, for the fabric to be tested. Store the fabric rating standards and handle them under conditions that will preserve their original form and appearance. Mounting with thick cardboard framing around the specimens is recommended.

6.7.2 *Photographic*—A set of five photographs 105 mm [4.13 in.], numbered 1 to 5, illustrating varying degrees of pilling from “very severe pilling” to “no pilling.”³

TABLE 1 Viewing Apparatus and Options

Apparatus	Specimen Preparation
ASTM Lightbox (Fig. 2) ^A	0.78 rad [45°]
Lightbox ^B	0.78 rad [45°]
Lightbox ^B	flat
Lightbox ^B	critical angle
As determined by the buyer and supplier	

^AThe sole source of supply of the viewing apparatus known to the committee at this time is Standard Scientific Supply Co., 601 West Market Street, Bethlehem, PA 18018–5208. If you are aware of alternate suppliers, please provide this information to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend.

^BAvailable commercially.