



Designation: D4970/D4970M – 16^{ε1}

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.

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.

1.3 The fabric may be laundered or dry cleaned before testing.

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 and health 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.*

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. Referenced Documents

2.1 ASTM Standards:²

[D123](#) Terminology Relating to 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 [D4850](#) and [D7018](#).

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

3.2 For all other terms related to textiles, refer to Terminology [D123](#).

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

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

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

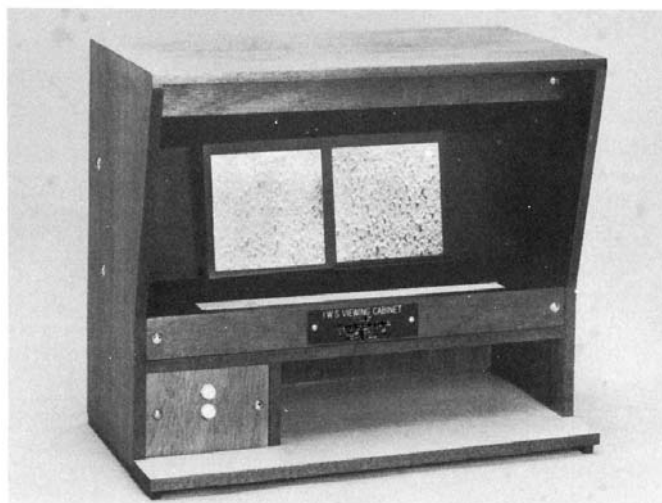


FIG. 2 Apparatus for Fabric Evaluation

the purchaser and the supplier must agree to interpret future results with consideration for the known bias.

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.

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.

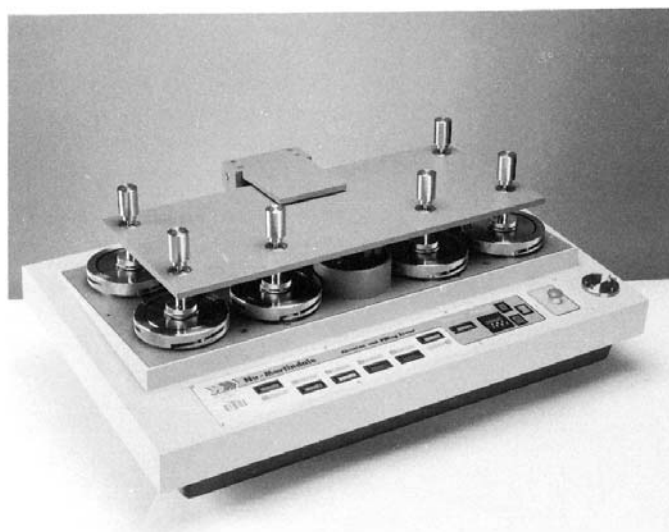


FIG. 1 Martindale Abrasion Tester

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 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 $3 \pm 0.3 \text{ mm}$ [$0.12 \pm 0.01 \text{ in.}$] thick.

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

NOTE 3—Apparatus and accessories are available commercially.

6.4 *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.

6.5 *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.

6.6 *Rating Standards*:

6.6.1 *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.

6.6.2 *Photographic*—A set of five photographs 105 mm [0.125 in.], numbered 1 to 5, illustrating varying degrees of pilling from “very severe pilling” to “no pilling.”³

6.6.3 Digital imaging or rating system, or both.

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 source of supply of the 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.

6.7 *Fabric Punches or Press Cutters*, 38 mm [1.5 in.] and 140 mm [5.5 in.] in diameter.

6.8 *Facilities for Laundering Samples*, if needed.

6.9 *Facilities for Drycleaning Samples*, if needed.

7. Sampling

7.1 *Primary Sampling Unit*—Consider rolls of fabric or fabric components of fabricated systems to be the primary sampling unit, as applicable.

7.2 *Laboratory Sampling Unit*—From each primary sampling unit take one full-width piece of fabric that is 1 m [1 yd] in length along the selvage (machine direction), after first removing a 1 m [1 yd] length. For fabric components of fabricated systems use the entire system,

8. Test Specimens: Selection, Number, and Preparation

8.1 Unless otherwise specified, samples should be washed or drycleaned before cutting the test specimens. Conditions appropriate for the fabric end-use or conditions agreed upon by interested parties should be used.

8.2 Cut a pair of circular specimens from each swatch in the laboratory sample with one of each pair of specimens being 38 mm [1.5 in.] in diameter and the other 140 mm [5.5 in.] in diameter.

8.3 Take the specimens evenly-spaced across the width of the laboratory sample or from two different panels in a garment. Specimens should be staggered in such a manner that no specimens contain the same yarns. Avoid areas with wrinkles and other distortions. Unless otherwise specified, do not cut specimens nearer the selvage less than $\frac{1}{10}$ of the width of the fabric.

9. Preparation of Apparatus

9.1 *Maintenance Check*—Follow instruction manual for proper maintenance of apparatus.

10. Conditioning

10.1 Condition specimens in the standard atmosphere for testing textiles, which is $21 \pm 1^\circ\text{C}$ [$70 \pm 2^\circ\text{F}$] and 65 % RH ± 2 % relative humidity for at least 4 h prior to testing.

11. Procedure

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

11.2 Mount one 140-mm [5.5-in.] diameter of standard felt and one fabric specimen on each table (see Fig. 1). Place one 38-mm [1.5-in.] diameter disk of 3-mm polyurethane foam and a specimen of the same fabric in each of the holders, making sure the face of the fabric is exposed for both specimens.

11.3 Place the specimen holders on the same table as the other fabric specimen and insert a spindle into each specimen holder to give a pressure on the larger specimen of approximately 3 kPa [0.44 psi]. This pressure is the same as any other setup but without additional weights.

11.4 Start the machine and allow it to run for 100 movements. Run additional movements in increments of 100 up to

1000 movements as directed in a material specification or contract. Rate the specimen at each specified interval as directed in Section 12 and record the final rating.

12. Evaluation

12.1 Place the 38-mm [1.5-in.] disk specimen squarely on the double-faced tape in the viewing cabinet (see Fig. 2).

12.1.1 Using the viewing apparatus and option selected from Table 1 and either suitable fabric or photographic standards, subjectively rate the face of each specimen in comparison to the original specimen, using the following scale:

For pilling:

- 5—no pilling
- 4—slight pilling
- 3—moderate pilling
- 2—severe pilling
- 1—very severe pilling

For fuzzing:

- 5—no fuzzing
- 4—slight fuzzing
- 3—moderate fuzzing
- 2—severe fuzzing
- 1—very severe fuzzing

12.1.1.1 When the appearance of a test specimen falls between that of two rating standards, assign the half value (for example, 3.5 or 2.5).

NOTE 4—If the test method is to be used as a referee method, a minimum of two graders, the agreed-upon standards, and the viewing apparatus and option selected from Table 1 for fabric evaluation shall be used.

12.1.2 A digital imaging or rating system may be used as agreed upon by the purchaser and supplier.

12.1.3 Average the rating for each laboratory sampling unit and for the lot.

13. Report

13.1 State that the specimens were tested as directed in Test Method D4970. Describe the material or product sampled and the method of sampling used.

13.2 Report the following information:

13.2.1 Ratings of each individual specimen for pilling, the average rating of the four specimens from each laboratory sampling unit, and the average for the lot.

13.2.2 If the fabric was washed before testing, laundering conditions used.

13.2.3 If the fabric was drycleaned before testing, conditions used.

13.2.4 Number of movements.

13.2.5 Type of viewing apparatus, viewing option, and rating standard used.

14. Precision and Bias

14.1 *Precision*—Two fabrics were evaluated on each of two days by two operators.

Fabric #1			
day #1		day #2	
operator 1	operator 2	operator 1	operator 2
4.0	4.0	3.5	4.0
3.5	4.5	4.0	4.0
4.0	4.0	4.0	4.5
4.0	4.5	4.0	4.5
4.0	4.5	4.0	4.5

Fabric #2			
day #1		day #2	
operator 1	operator 2	operator 1	operator 2
3.0	3.0	3.0	3.0
3.5	3.5	3.0	3.0
3.0	3.0	3.0	3.5
3.0	3.5	4.5	3.5
3.0	3.0	4.0	3.5

The reproducibility of this test method is being determined and will be made available.

14.2 *Bias*—The value for pilling resistance of fabrics and garments is defined only in terms of a test method. Within the limitation, this test method has no bias.

15. Keywords

15.1 fabrics; fuzz; pills

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