Designation: D 4970 – 02

Standard Test Method for Pilling Resistance and Other Related Surface Changes of Textile Fabrics: Martindale Tester[1]

This standard is issued under the fixed designation D 4970; 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 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 D 3511, D 3512, and D 3514.

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 SI units are to be regarded as the standard. The values given in parentheses are provided for information only.

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.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 123 Terminology Relating to Textiles[2]

D 1776 Practice for Conditioning Textiles for Testing[2]

D 3511 Test Method for Pilling Resistance and Other Related Surface Changes of Textile Fabrics: Brush Pilling Tester[3]

D 3512 Test Method for Pilling Resistance and Other Related Surface Changes of Textile Fabrics: Random Tumble Pilling Tester Method[3]

D 3514 Test Method for Resistance of Apparel Fabrics to Pilling (Elastomeric Pad Method)[3]

3. Terminology

3.1 *Definitions*—For definitions of other textile terms used in this test method, refer to Terminology D 123.

3.2 *Description of Terms Specific to This Standard:*

3.2.1 *cycle*, *n*—in the Martindale tester, the sixteen movements required to complete one Lissajous figure.

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

3.2.3 *movement*, *n*—one rotation of the outer gearing of the Martindale tester.

3.2.4 *pilling resistance*, *n*—resistance to formation of pills on the surface of a textile fabric.

3.2.5 *pills*, *n*—bunches or balls of tangled fibers, which are held to the surface of a fabric by one or more fibers.

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 test method for resistance to pilling for fabrics 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.

[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] *Annual Book of ASTM Standards*, Vol 07.01.

[3] Discontinued 1995, *Annual Book of ASTM Standards*, Vol 07.02.

FIG. 2 Apparatus for Fabric Evaluation

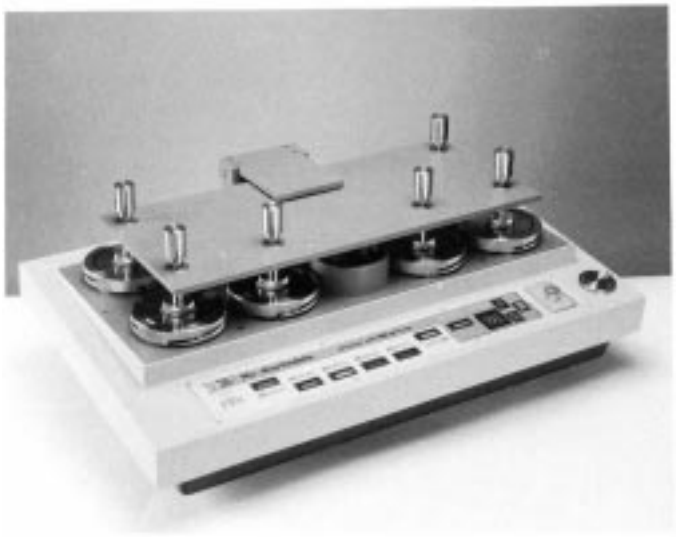

FIG. 1 Martindale Abrasion Tester

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.

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.

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*[4] (see Fig. 1).

6.2 *Standard Felt,*[4] of mass 750 ± 50 g/m^2 (22 ± 1.5 oz/yd^2) and 3 ± 0.3 mm (0.12 ± 0.01 in.) thick.

6.3 *Apparatus for Fabric Evaluation* —Facilities for illumination (cool white fluorescent tube) and simultaneous viewing test specimens and fabric or photographic rating standards.

[4] Available with accessories from Ahiba, 2175 Hawkins St., Charlotte, NC 28203, or from other commercial manufacturers and distributors.

Apparatus and options for visula evaluation are listed in Table 1.

6.4 *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.

6.5 *Rating Standards*:

6.5.1 *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.

6.5.2 *Photographic*[5]—A set of five photographs 105 mm (.125 in.), numbered 1 to 5, illustrating varying degrees of pilling from "very severe pilling" to "no pilling."

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

6.7 *Facilities for Laundering Samples*, if needed.

6.8 *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 systmes 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 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 ± 1°C (70 ± 20°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.

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 options selected from Table 1 and either suitable fabric or photograpic stnadards (6.5), subjectively rate the face of each specimen, using the rating standards and the following scale (Note 2):

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

NOTE 2—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 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 D 4970. 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.

[5] Available from ASTM Headquarters. Request ADJD3512.

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	

[A] The source of supply of the apparatuse 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.

[B] Available commercially.

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