



Designation: D 3514 – 9902

Standard Test Method for Pilling Resistance and Other Related Surface Changes of Textile Fabrics: Elastomeric Pad¹

This standard is issued under the fixed designation D 3514; 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 surface distortions such as fuzzing of textile fabrics. The method utilizes the Stoll Quartermaster Universal Wear Tester with the frosting attachment. The procedure is generally applicable to all types of woven and knitted fabrics.

NOTE 1—For other current test methods of testing the pilling resistance of textiles, refer to Test Methods D 3511, D 3512, and D 4970.

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

1.3 *This standard may involve hazardous materials, operations, and equipment. 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:*

¹ This test method is under the jurisdiction of ASTM Committee D-13 on Textiles, and is the direct responsibility of Subcommittee D13.60 on Fabric Test Methods, Specific.

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D 123 Terminology Relating to Textiles²

D 1776 Practice for Conditioning Textiles for Testing²

D 3511 Test Method for Pilling Resistance and Other Related Surface Changes of Textile Fabrics: Brush Pilling Tester³

D 3512 Test Method for Pilling Resistance and Other Related Surface Changes of Textile Fabrics: Random Tumble Pilling Tester³

D 4970 Test Method for Pilling Resistance and Other Related Surface Changes of Textile Fabrics (Martindale Pressure Tester Method)³

2.2 *ASTM Adjuncts:*

12-43514 Three Sets of Five Photographic Standards for Elastomeric Pad Pilling Test⁴

3. Terminology

3.1 *Definitions:*

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

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

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

3.1.4 For definitions of other textile terms used in this test method, refer to Terminology D 123.

4. Summary of Test Method

4.1 Pilling and other changes in surface appearance that occur in normal wear are simulated on a laboratory testing machine. Fabric samples are washed or drycleaned, depending on expected refurbishment, followed by controlled rubbing against an elastomeric pad having specifically selected mechanical properties. The degree of fabric pilling is evaluated by comparison of the tested specimens 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 for 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 and the 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.

5.1.1 If there is a disagreement arising from differences in values reported by the purchaser and the supplier when using Test Method D 3514 for acceptance testing, the statistical bias, if any, between the laboratory of the purchaser and the laboratory of the supplier should be determined 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 should then be randomly assigned 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 begins. 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 test results with consideration for the known bias.

5.2 The pilling of textile fabrics is a very complex property because it is affected by many factors which may 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 any series of standards.

5.3 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 may also be advisable. Prior agreement between interested parties should determine the state of test.

5.4 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 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

² *Annual Book of ASTM Standards*, Vol 07.01.

³ *Annual Book of ASTM Standards*, Vol 07.02.

⁴ Available from American Society for Testing and Materials, 100 Barr Harbor Dr., West Conshohocken, PA 19428.

correlate closely in appearance with worn fabrics and show a similar ratio of pills to fuzz. Counting the pills and weighting 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.

5.5 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 (no pilling) to 1 (very severe pilling).

5.6 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 the test method to non-woven fabrics has not been determined.

6. Apparatus and Materials

6.1 *Stoll Quartermaster Universal Wear Tester*,⁵ with frosting attachment.

6.2 *Elastomeric Friction Pad*,⁶ mounted on the bottom side of the tester pressure plate. This is a pad made especially for this test. It is attached to the pressure plate by means of side clamps, and secured at the front by a strip of tape.

6.2.1 *Elastomeric Base Pad*,⁶ attached to the specimen holder of the frosting attachment. This pad is made especially for this test.

6.3 *Twill Fabric*, 65/35 polyester/cotton, approximately 166.5 g/m² (5.0 oz/yd²) with moderately coarse weave, for preparation of friction pad.

6.4 *Emery Paper*, 150-grit, for preparation of the base pad.

6.5 *Rubber Ring*,⁵ 50 ± 1 mm (2 ± 0.1 in.) inside diameter and 61 ± 1 mm (2.44 ± 0.1 in.) outside diameter, to secure the specimen to the holder.

6.6 *Test Tube Brush*, small, to remove loose fibers from specimens after testing.

6.7 *Cleaning Solvent*, acetone or other appropriate solvent to clean the elastomeric pad (see 7.1).

6.8 *Facilities for Laundering Samples*—If needed.

6.9 *Facilities for Drycleaning Samples*—If needed.

6.10 *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.

6.11 *Overhead Lighting for Test Specimen Evaluation*—Two 2.4 m (8 ft) Type F-96 cool-white preheat rapid-start fluorescent lamps with white enamel reflectors, and without baffles or glass (see Fig. 1).

6.12 *Apparatus for Fabric Evaluation*—Facilities for illumination (cool white fluorescent tube) and simultaneous viewing of test specimen and fabric or photograph rating standards. apparatus and option for visual evaluation are listed in Table 1..

6.13 *Ratings Standards*:

6.13.1 *Fabric*—A series of tested specimens of a specific fabric type which shows degree of pilling or other distortion, or both, for each type of 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.

6.13.2 *Photographic*—Three sets of five photographic standards 80 mm (3.13 in.) corresponding to the size of pills produced (that is, small, medium, and large) and numbered 1 to 5 illustrating varying degrees of pilling from “very severe pilling” to “no pilling.”

7. Hazardous Materials

7.1 Solvents used in this test method may be hazardous. Refer to the manufacturer’s material safety data sheets for information on use, handling, storage, and disposal of these products.

8. Sampling

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

NOTE 2—An adequate specification or other agreement between purchaser and supplier requires taking into account the variability among rolls, bolts, or pieces of fabric and among specimens from a swatch of fabric from a roll, bolt, or piece, or among cartons of garments and between 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.

8.2 *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

8.2.1 For acceptance testing of garments, take one garment from each carton (see Note 2).

9. Test Specimens: Selection, Number, and Preparation

9.1 Unless otherwise specified, samples should be washed or dry cleaned before cutting the test specimens, using conditions

⁵ Available from Atlas Electric Devices Co., 4114 Ravenswood Ave., Chicago, IL 60613.

⁶ Available from Milliken Research Corp., P.O. Box 1927, Dept. M-415 Spartanburg, SC 29304.

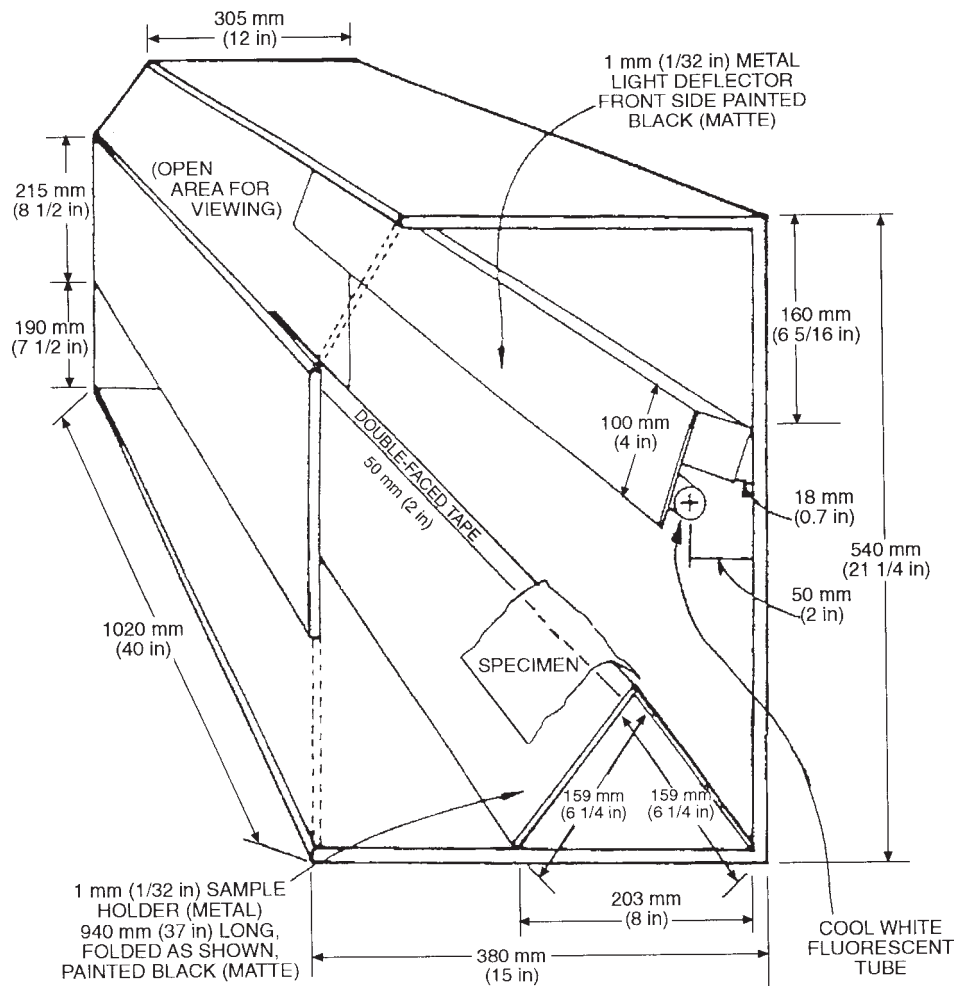


FIG. 1 Apparatus for Fabric Evaluation

TABLE 1 Viewing Apparatus and Options

Apparatus	Specimen Preparation
ASTM Lightbox (Fig. 1) ^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.

appropriate for the fabric end use or conditions agreed upon by all interested parties.

9.2 Cut test specimens squares, $125 \times 125 \pm 2.5$ mm ($5 \times 5 \pm 0.1$ in.) with the sides parallel to the warp (wale) and filling (course) directions, or circles, 100 ± 2 mm (4 ± 0.1 in.) in diameter.

9.2.1 Take three specimens from each laboratory unit. Take the specimens evenly spaced across the width of the laboratory sample, or from three different panels in a garment. Specimens should be staggered in such a manner that no two specimens contain the same yarns. Avoid areas with wrinkles and other distortions. Unless otherwise specified, do not take specimens nearer the selvage than one tenth the width of the fabric.

10. Preparation of Apparatus

10.1 Level the specimen holder base pad properly to position the fabric specimen flat against the friction pad during the test. Do this by rubbing the base pad against a piece of 150-grit emery paper mounted snugly on the bottom side of the pressure plate.

10.1.1 Once the base pad is properly prepared, it will last for an indefinite time. Do not remove the base pad thereafter from the specimen holder because this will disturb the alignment. Retain an additional specimen holder for use with other tests on the Stoll tester.

10.2 *Preparation of Friction Pads*—Before a new friction pad is used for testing, prepare it by attaching it to the pressure plate and rubbing it under a 5 N (1 lbf) force against a mounted polyester/cotton twill fabric (see 6.7). Continue this until the surface shine in the rubbing area is completely and uniformly removed.

10.2.1 Use the pad in the same position thereafter to always present a uniformly smooth surface to subsequently tested specimens. Accomplish this by applying appropriate alignment marks to the pad and pressure plate. Always use the friction pad with the same base pad with which it was prepared.

10.3 *Monitoring Repeatability of Instrument Performance*—Periodically run a standard in-house test fabric of known pilling rating to check the reproducibility of the result being obtained with a given pad.

NOTE 3—If the bushing in the rotating base is worn, vibration may produce erratic test results.

10.3.1 In the event that finishing agents have impregnated a pad, it may be possible to remove them by rubbing with suitable solvent (see 7.1), then any household detergent/water solution, rinsing with clean water, and again with solvent. If this should fail to restore the pad to the proper level of performance, replace both pads (see 10.2.1).

11. Conditioning

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

12. Procedure

12.1 Make all of the tests in the standard atmosphere for testing textiles.

12.2 Wipe both the base pad and the friction pad with solvent (see 7.1) before testing each specimen.

12.3 Mount the specimen snugly and securely on the specimen holder using a rubber ring.

NOTE 4—If there is evidence of specimen slippage, the specimen should be discarded and another test should be run. Be sure the subsequent specimen has been pulled more tightly onto the specimen holder.

12.4 Rub the specimen under a 5 N (1 lbf) force for 300 strokes.

12.5 Remove the specimen and brush lightly with a small test tube brush to remove loose fibers. Any material that is easily brushed off should not be considered pills.

13. Evaluation

13.1 Rotate

13.1 Using the viewing apparatus and option selected from Table 1 and either suitable fabric or photographic standards (6.11), subjectively rate the angle at which the pills are the most obvious under the overhead lighting (see 6.11). Rate the appearance of the face of the three specimens using the rating standards (see 6.12) and the following scale below. 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 5):

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

NOTE 5—Working standards collected from tested specimens of the types of fabrics being evaluated, and that represent the level of pilling equivalent to each of the five rating steps, are valuable as a reference to ensure uniformity in rating. Fabrics of different constructions may produce pills varying in size. Hence, care should be taken to select the proper standards for the different test fabrics.

13.1.1 Average the values for each laboratory sampling unit and for the lot.

13.2 Check the pillied specimen for nonuniformity of pilling. If pills are concentrated in any one strip in the length or width direction, or in any one portion of the specimen, report this condition. Strips indicate that different yarns may have been used to make the fabric being tested.

NOTE 6—If absolute rather than relative performance is the objective of the test, correlate the observed pilling test results with appropriate wear tests for each type of fabric.

13.3 Evaluate the specimens for other surface effects such as fuzzing. It is advisable to have a separate set of in-house fabric rating standards for each effect to be rated.

14. Report

14.1 State that the specimens were tested as directed in Test Method D 3514. Describe the material or product sampled and the method of sampling used.

14.2 Report the following information:

14.2.1 Ratings of each individual specimen and the average rating of the three specimens from each laboratory sampling unit and the average for the lot,

14.2.2 If the fabric was washed before testing, laundering conditions used,

14.2.3 If the fabric was dry cleaned before testing, conditions used,

14.2.4 Running times, and

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

15. Precision and Bias

15.1 *Precision*—The repeatability standard deviation has been determined for 1 laboratory to be ± 1.0 . The reproducibility of this test method is being determined and will be available during or before 1998.

15.2 *Bias*—The value for pilling resistance of fabrics and garments is defined only in terms of a test method. Within this limitation, Test Method D 3514 has no bias.

16. Keywords

16.1 fabric; fuzz; pills

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