Designation: D3939/D3939M – 13 (Reapproved 2017)

Standard Test Method for Snagging Resistance of Fabrics (Mace)[1]

This standard is issued under the fixed designation D3939/D3939M; 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 determines the snagging resistance of a fabric.

1.2 Studies of fabric snagging have shown that this test method is suitable for a range of woven and knitted fabrics made from textured or untextured filament yarns or spun yarns or combinations of these yarns.[2,3] This test method is not suitable for (*1*) open construction fabrics (such as a net) because the points on the mace will snag the felt pad rather than the specimen, (*2*) very heavy or very stiff fabrics that cannot be made to fit tightly on the drum and felt pad, and (*3*) tufted or nonwoven fabrics because the apparatus is designed for woven and knitted fabrics.

1.3 If after using this test method it is found to be too severe for your fabrics, an alternative method can be used, such as BS 8479 Textiles: Method for Determination of the Propensity of Fabrics to Snagging and Related Surface Defects - Rotating Chamber Method.

1.4 The values stated in either SI units or in other units shall be regarded separately as the standard. The values stated in each system may not be exact equivalents; therefore, each system must be used independently of the other, without combining values in any way. In case of referee decisions, the SI units will prevail.

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.* Specific precautionary statements are given in Section 7.

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:*[4]

D123 Terminology Relating to Textiles

D1335 Test Method for Tuft Bind of Pile Yarn Floor Coverings

D1776 Practice for Conditioning and Testing Textiles

D2724 Test Methods for Bonded, Fused, and Laminated Apparel Fabrics

D3136 Terminology Relating to Care Labeling for Apparel, Textile, Home Furnishing, and Leather Products

D4467 Practice for Interlaboratory Testing of a Textile Test Method That Produces Non-Normally Distributed Data (Withdrawn 2010)[5]

D4850 Terminology Relating to Fabrics and Fabric Test Methods

D5362 Test Method for Snagging Resistance of Fabrics (Bean Bag)

2.2 *AATCC Standards:*[6]

65 Test Method for Snag Resistance of Women's Nylon Hosiery (see Note 1)

135 Test Method for Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics

NOTE 1—In 1988, the AATCC voted to withdraw this test method from its technical manual; however, the ASTM task group on fabric snagging decided it should be listed as an alternative for testing open construction fabrics.

3. Terminology

3.1 For definitions of textile terms used in this test method: (color contrast, in textiles; distortion, in fabrics; protrusion, in

[1] This test method is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.59 on Fabric Test Methods, General.

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[2] Finnigan,J.A., "Laboratory Prediction of the Tendency of a Fabric to Snag During Wear," *Textile Institute and Industry,* Vol 10 , No. 6, 1972, pp. 164–167.

[3] Leung, P., and Hershkowitz, R., "Snag- and Fuzz-Resistant Double Knits via Fabric Construction," *Textile Research Journal,* Vol 45, No. 2, 1975, pp. 93–102.

[4] 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.

[5] The last approved version of this historical standard is referenced on www.astm.org.

[6] Available from American Association of Textile Chemists and Colorists (AATCC), P.O. Box 12215, Research Triangle Park, NC 27709, http://www.aatcc.org

fabrics; snag, in fabrics; snagging resistance, in fabrics), refer to Terminology D4850.

3.2 For definitions of other textile terms used in this test method, refer to Terminology D123.

4. Summary of Test Method

4.1 A tubular specimen is placed on a cylindrical drum. Then a mace (spiked ball) bounces randomly against the rotating specimen. Snags are produced to a degree affected by a variety of factors. The degree of fabric snagging is then evaluated by comparison of the tested specimens with visual standards that may be either fabrics or photographs of fabrics. The observed resistance to snagging is reported on a scale ranging from 5 (no or insignificant snagging) to 1 (very severe snagging).

5. Significance and Use

5.1 This test method is not considered satisfactory for acceptance testing of commercial shipments of fabrics because the between-laboratory precision of the test method is poor (see 15.1).

5.1.1 If there are differences of practical significance between reported test results for two laboratories (or more), comparative test should be performed to determine if there is a statistical significant difference between them, using competent statistical assistance. As a minimum, use the samples for such a comparative test that are as homogeneous as possible, drawn from the same lot of material as the samples that resulted in disparate results during initial testing and randomly assigned in equal numbers to each laboratory. The test results from the laboratories involved should be compared using a statistical test for unpaired data, at a probability level chosen prior to the testing series. If bias is found, either its cause must be found and corrected or future testing for that material must be adjusted in consideration of the statistically significant differences.

5.2 This test method may be used for quality control testing of fabrics during manufacturing and product comparisons of different fabrics by manufacturers, retailers, and users. This test method may also be used by researchers to examine the effect of new fibers, yarns, fabric constructions, and finishes on the snagging resistance of fabrics.

5.3 This test method may be used to test the snagging resistance of most apparel and home furnishings fabrics. However, a different test method may be needed for different types of fabrics and different end-uses (such as towels, pants, and upholstery) (see 5.3.1).

5.3.1 Some fabrics that may not be suitable for this test method are described in 1.2. Many open construction fabrics can be tested for snagging resistance using AATCC Test Method 65. The snagging resistance of many pile floor coverings can be tested by Test Method D1335. Test Method D5362 (Bean Bag) may also be considered as an alternative for testing the snagging resistance of fabrics. This test method does not apply to the ABC Snag Tester.

5.4 Since fabric snagging can be affected by laundering or drycleaning, it may be advisable to test the snagging resistance of a fabric before and after laundering or drycleaning.

5.5 The snagging resistance of a specific fabric varies with individual wearers and general conditions of use. Therefore, it can be expected that garments of the same fabric will show a fairly wide snagging resistance spectrum after wear and much greater variation in wear than in replicate fabric specimens subjected to controlled laboratory tests. This factor should be considered when adopting levels of acceptability for any specification that includes snagging resistance.

5.6 Snags observed in worn garments vary appreciably in number and appearance. The appearance of a snag depends particularly on (*1*) the degree of color contrast between the snag and the surrounding area of the fabric or (*2*) the presence of long distortions or long protrusions. These conditions are not evaluated when snagging is rated solely on the number of snags. See Section 13 for a description of color contrast, distortion, and protrusion as used in this test method; and see Figs. 1 through 3 in Test Method D5362 for pictures of fabric defects due to snagging. Because the overall acceptability of a specific fabric is dependent on both the characteristics of the snags and other factors affecting fabric appearance, it is recommended that fabrics tested in the laboratory be evaluated with regard to the defects that may be observed visually and not rated solely on the number of snags developed. A series of visual rating standards (see 6.2.4) may be set up to provide a basis for the ratings. The visual rating standards are most advantageous when the tested laboratory specimens correlate closely in appearance with fabrics from a wear test, for example, when tested laboratory specimens and fabrics from a wear test show similar color contrasts. In the preceding example, a series of fabrics from the wear test would be a good choice for the fabric standards described in 6.2.4.2.

6. Apparatus and Materials

6.1 *ICI Mace Snag Tester (see* Fig. 1*):*

6.1.1 *Specimen Templates,* 205 by 330 mm [8 by 13 in.] for weft knit fabrics and 205 by 320 mm [8 by 12.5 in.] for woven fabrics and warp knit fabrics.

6.1.2 *Felt Sleeves,* wool or chief weight wool synthetic blend with thickness of 3.5 ± 0.5 mm and weight of 1400 ± 200 g/m^2.

6.1.3 *Gage,* for setting position of mace (calibration block).

6.1.4 *Rubber O-rings.*

6.2 *Sewing Machine,* with a sewing needle that is appropriate for the fabric being tested for snagging resistance, or

6.2.1 *Sharps Hand Sewing Needle.*

6.2.2 *Sewing Thread,* cotton, Tex ticket 35 to 50, or equivalent polyester and cotton.

6.2.3 *Standard Calibration Fabric,* having an established snagging resistance rating that has been agreed upon by the purchaser and the supplier. (No standard calibration fabric has been specified by Subcommittee D13.59.)

6.2.4 *Visual Rating Standards:*

6.2.4.1 *Photographic Standards*—A series of photographs of tested specimens that show the degrees of snagging, such as the Imperial Chemical Industries (ICI) photographs;[7] or

[7] Apparatus is commercially available.

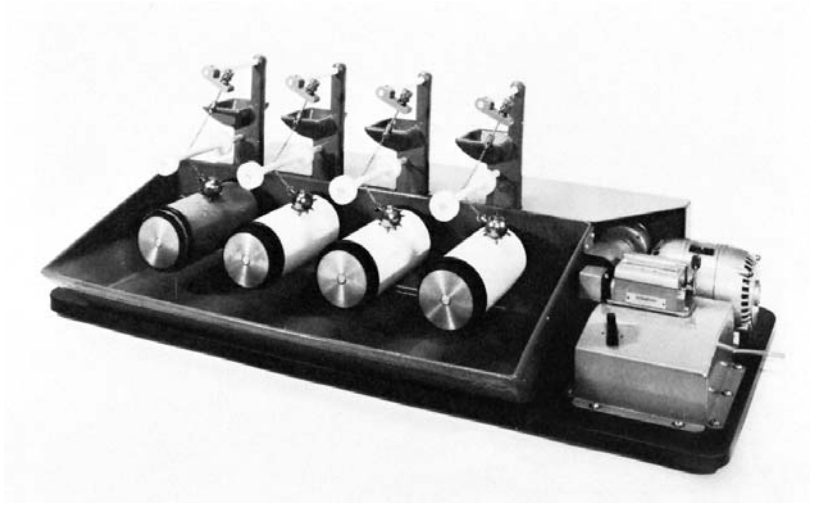


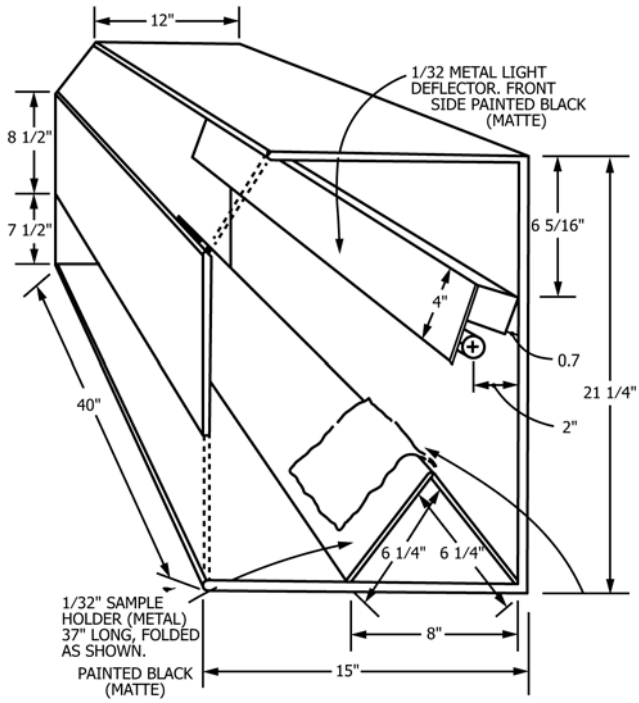
FIG. 1 ICI Mace Tester

6.2.4.2 *Fabric Standards*—A series of tested specimens or fabrics from a wear test that show the degrees of snagging (see 5.6 and Note 2).

NOTE 2—Fabric standards should be stored and handled under conditions that will preserve their original form and appearance. Mount the fabric standards using white poster board or plastic or metal framing.

6.2.5 *Apparatus for Fabric Evaluation,* for illumination and simultaneous viewing of specimens and visual rating standards:

6.2.5.1 *Apparatus for Fabric Evaluation,* (see Fig. 2),[7]



Metric Equivalents

in.	mm	in.	mm
1/32	1	8	203
0.7	18	8½	215
2	50	12	305
4	100	15	380
6¼	159	21¼	540
6 5/16	160	37	940
7½	190	40	1020

FIG. 2 Apparatus for Fabric Evaluation

having a light source of sufficient brightness to illuminate snags on the surface of a fabric.

6.2.5.2 *ICI Viewing Cabinet,* (see Fig. 3),[7] having a light source of sufficient brightness to illuminate snags on the surface of a fabric.

6.3 *Optional Equipment:*

6.3.1 *Steam Iron,* weighted to 2.3 kg or 5 lb and an ironing board.

6.3.2 *Tumble Dryer,* as described in AATCC Test Method 135.

6.3.3 *Washing Machine,* as described in AATCC Test Method 135.

6.3.4 *Detergent, Heavy Duty Granule,* the 1993 AATCC Standard Reference Detergent as described in AATCC Test Method 135. When agreed upon by the purchaser and the supplier, a substitute detergent that does not include fabric softener or bleach may be used.

6.3.5 *Equipment for Drycleaning Specimens,* as described in Test Methods D2724.

7. Hazards

7.1 Locate the mace snag tester in a low-traffic area because of the danger from the exposed mace and rotating drum.

7.2 Check that all parts of the mace snag tester are secure and are in good working condition.

7.3 Wear protective gloves when examining the points on the mace snag tester or removing fibers and yarns from the mace points.

7.4 Observe the following safety precautions when operating the tester: (*1*) do not wear loose or dangling clothing that can get caught in the mace points or moving parts; (*2*) do not attempt to change a specimen while the drum is rotating; and (*3*) do not injure your hands on the sharp mace points when placing a specimen on the drum.

8. Sampling

8.1 *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.

8.2 *Laboratory Sampling Unit*—As a laboratory sampling unit for acceptance testing, take a full width swatch 1-m or 1-yd long from the end of each roll of fabric in the lot sample, after first discarding the outermost layer of fabric. When drycleaning and laundering are to be performed, take additional swatches for the laundering and drycleaning tests.

8.3 *Specimens*—Test four specimens from each swatch in the laboratory sampling unit. When drycleaning and laundering tests are to be performed, test four additional specimens for drycleaning and four additional specimens for laundering.

9. Preparation of the Specimens

9.1 When snagging resistance after laundering or drycleaning is to be evaluated, launder or dryclean the swatches as directed in 9.1.1 or 9.1.2 before cutting the specimens.

9.1.1 *Laundering*—Load the washer with a 3.5-kg or 8-lb total load of swatches that comprise a homogeneous load (for example, same manufacturer, same line, same finishing, and same previous care) or a homogeneous group of swatches for testing and a desized unsoftened group of ballast fabrics. Select normal cycle, warm water temperature, and the 1993 AATCC Standard Reference Detergent (see Terminology D3136 and AATCC Test Method 135). Run one machine cycle and do not use softener. Load the dryer with the washed fabrics. Select normal cycle, medium temperature, and run the dryer for 20 min or until the fabrics are dry to the touch. Do not use softener in the dryer. Do not overdry the fabrics (see Note 3).

NOTE 3—When agreed upon by the purchaser and the supplier, other laundering and drycleaning procedures may be used.

9.1.2 *Drycleaning*—Follow the procedure given in Test Methods D2724 (see Note 3).

9.2 Using the template (see 6.1.1), cut the following specimens: (*1*) for determination of the snagging resistance of the fabric in the lengthwise (machine) direction, cut two

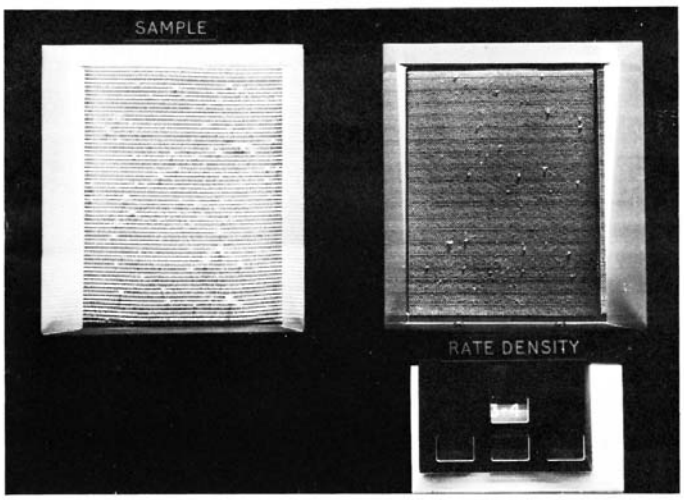


FIG. 3 ICI Viewing Cabinet

specimens, with the shorter dimension parallel to the lengthwise direction of the fabric; and (*2*) for determination of snagging resistance of the fabric in the widthwise direction, cut two specimens, with the shorter dimension parallel to the widthwise direction. Do not take the specimens nearer the selvage than one tenth the width of the fabric. If possible, randomize the specimens in such a manner that no two contain the same set of yarns. Mark each specimen near an edge to indicate the following: (*1*) the face side that will later be tested for snagging resistance, and (*2*) the type of specimen (lengthwise or widthwise direction).

9.2.1 Similarly cut specimens from laundered or drycleaned swatches, when required.

9.3 Fold each specimen face side in and form a sleeve by sewing a seam parallel to the shorter dimension of the specimen at a distance from the edge sufficient for a tight fit on the drum (see Note 4). Use a minimum of 0.4 stitches/mm [10 stitches/in.] when machine or hand sewing the seam.

NOTE 4—It might be necessary to vary the distance of the seam line from the short edges to have a good running test specimen that is smooth and snug on the drum. The ICI Mace Snag Tester is supplied with a template for cutting out and marking weft knit fabrics and a template for cutting out and marking woven fabrics and warp knit fabrics. The weft knit template provides a specimen [205 by 330 mm] [8 by 13 in.], and the seam line is 30 mm [1⅛ in.] from the short edge. The woven or warp knit template is 205 by 320 mm [8 by 12.5 in.], and the seam line is 15 mm [⅝ in.] from the short edge.

9.4 Turn each specimen (sleeve) inside out to expose the surface for testing.

10. Preparation of Apparatus

10.1 *ICI Snag Tester:*

10.1.1 Position the felt sleeve centrally on the drum, wet it with hot water, remove the surplus moisture, and allow to dry completely. Slight heat can be used to accelerate the drying, if necessary. The sleeve will fit tightly on the drum when shrunk.

10.1.2 Replace the felt whenever its surface becomes rough, has holes, or shows excessive wear (see Note 5).

NOTE 5—As a guide, replace the felt after no more than 200 h of running.

10.2 *Conditioning and Adjustment of Mace*

10.2.1 Check the points on the mace to be certain that there are no barbs or other damage by feeling the mace points for roughness. Inspect the mace points under a magnifying glass to show the bad points. Check the mace points daily, or whenever a mace position is suspected of snagging too severely or erratically. Replace the worn or damaged mace points.

10.2.2 Adjust the distance of the mace from the drag bar with the 45-mm [1.8-in.] calibration block, or measure as shown in Fig. 4 by adjusting the screw at the upper coupling. Check this distance daily or whenever a mace position is suspected of not working properly.

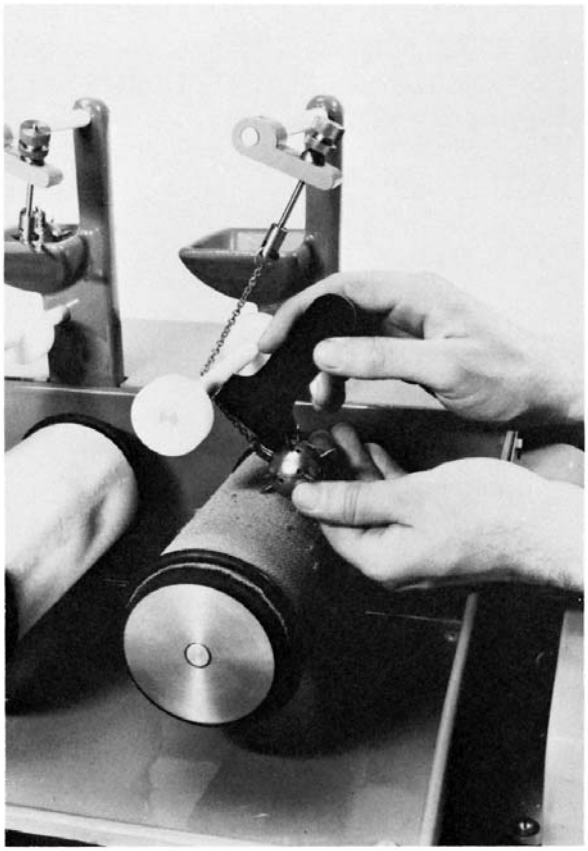


FIG. 4 Adjusting Mace on ICI Snag Tester

10.2.3 Check the mace for freedom of movement in its socket on the link chain.

10.2.4 Set the timing/counting mechanism for 600 total revolutions (approximately 10 min) and verify that the drum speed is 6.3 ± 0.2 rad/s or 60 ± 2 r/min.

10.3 *Calibration of Tester*

10.3.1 Check the operation of the snag tester with the standard calibration fabric. If the equipment is in daily use, check daily; if testing is infrequent, check the equipment each time it is used.

10.3.2 If the test result obtained on the standard calibration fabric is not within a ±0.5 rating unit of the established value, run another specimen. If this second specimen is within limits, continue testing; if not, check 10.2.1 – 10.2.4. Repeat, as required, until a specimen is within limits.

11. Conditioning

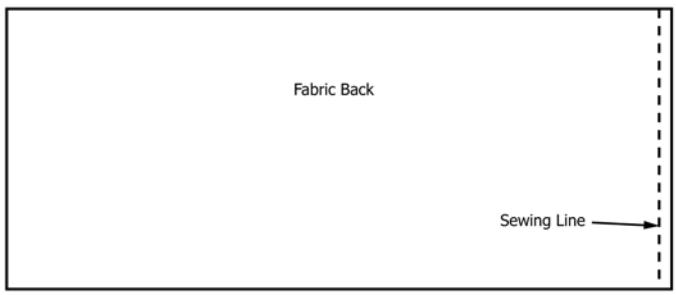
11.1 Preconditioning is not necessary. Place all of the specimens in the standard atmosphere for testing textiles, which is 21 ± 1°C [70 ± 2°F] and 65 ± 2 % relative humidity (see Practice D1776), for a minimum of 4 h before testing. While this conditioning does not necessarily result in equilibrium moisture content in the specimens, it is deemed adequate for the purposes of this test method.

12. Procedure

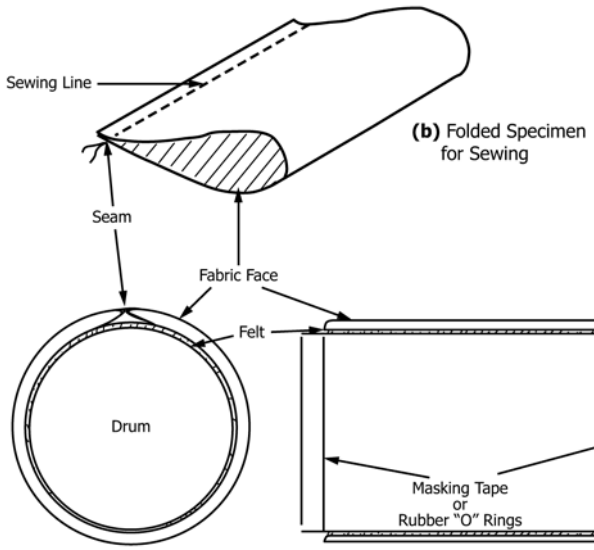
12.1 Test all specimens in the standard atmosphere for testing textiles, which is 21 ± 1°C [70 ± 2°F] and 65 ± 2 % relative humidity.

12.2 Inspect the specimens for the presence of any blemish such as accidental snags, pills, etc., which could affect the ratings for snagging resistance. If possible, replace any blemished specimen with a new specimen that has no blemish and has been prepared and conditioned as directed in Sections 9 and 11. If it is not possible to replace the specimen (for example, the specimen pilled during laundering), record the fact and exclude the blemish when the specimen is evaluated for snagging resistance.

12.3 Place a specimen onto the felt-covered drum with the face of the specimen outwards and with the seam overlap flattened to each side of the seam. Secure the specimen to the drum by taping the edges with 25-mm [1-in.] single-face masking tape, half on the specimen and half on the drum or with rubber O-rings (see Fig. 5) (see Note 6).



(*a*) *Specimen Cut from Fabric*



(*c*) *End View of Mounted Specimen*

(*d*) *Side View of Mounted Specimen*

FIG. 5 Preparation and Mounting of Specimen

NOTE 6—If the mace snag tester has more than one drum, half of the specimens being tested should be lengthwise direction specimens and the other half should be widthwise direction specimens.

12.4 Position the mace (Fig. 4) to allow freedom of movement over the entire drum surface.

12.5 Set the counter for 600 revolutions (approximately a 10-min test) and operate the mace snag tester.

12.6 Remove the specimens from the drums.

12.7 Fold the specimen with the seam in the center and to the back of the specimen.

12.8 *Optional:*

12.8.1 Place the side of the specimen to be rated facing the ironing board (seam facing down).

12.8.2 Preheat the steam iron to 170°C [338°F], or to the safe ironing temperature for the specific fibers in the fabric.

12.8.3 Steam-iron the specimen in both fabric directions for a total of 10 to 12 s, using only the weight of the iron for pressure.

13. Evaluation

13.1 *General*—Choose the visual rating standards (see 6.2.4) and the apparatus for fabric evaluation (see 6.2.5). The ICI photographic snagging standards (see Note 7) and the apparatus for fabric evaluation (see Fig. 2) are recommended. See 13.1.1 through 13.1.4 for general information about snags, protrusions, distortions and color contrasts.

13.1.1 For the purpose of this test method, a snag is created when an object pulls, plucks, scratches, or drags a group of fibers, a yarn, or a yarn segment from its normal pattern. Snags can be classified into three types: (*1*) snags that have a protrusion and no distortion, (*2*) snags that have a distortion and no protrusion, and (*3*) snags that have both a protrusion and a distortion.

13.1.2 For the purpose of this test method, a protrusion is a visible group of fibers, a yarn, or a yarn segment that extends above the fabric surface.

13.1.3 For the purpose of this test method, a distortion is characterized by a group of fibers, a yarn, or a yarn segment that is displaced from its normal pattern so that there is a visible change in the texture of the fabric; however, the displaced group of fibers, yarn, or yarn segment does not extend above the fabric surface. Distortions include conditions where (*1*) tension on a snagged yarn has changed the size of some of the loops within a knitted fabric and the result is a pucker on the surface of the fabric, and (*2*) tension on a snagged yarn has caused the yarn to break off within a woven fabric and the result is a change in the texture where the yarn used to be.

13.1.4 For the purpose of this test method, a color contrast is a visible color difference between a snag and the immediate surrounding area of the fabric that has no defects. Color contrasts often occur when printed fabrics are snagged.

NOTE 7—The ICI photographic snagging standards consist of a set of nine photoreplicas in which the intermediate rating is indicated as 3-4, 2-3, etc. Because the ICI standards differ only in the number of protrusions, it is recommended that appearance changes, such as color contrasts, also be reported (see 14.2.6).

13.2 If the ICI photographic snagging standards and the apparatus for fabric evaluation (see Fig. 2) have been selected, rate the appearance of the face (as indicated by markings) of each specimen. Rate for density of snagging on the face side opposite the seam on an evaluation area corresponding to the area of the rating standards being used (see Note 8), in accordance with the following scale (see Notes 9 and 10):

5 no or insignificant snagging
4 slight snagging
3 moderate snagging
2 severe snagging
1 very severe snagging

For rating number 5, insignificant snagging means a few snags are present (approximately 1 to 4 snags are present). The ICI snagging standards have photographs showing intermediate values (see Note 7). For standards that do not have intermediate values, an intermediate value can be assigned when the appearance of a specimen falls roughly equidistant between that of two whole number rating standards, for example 2-3, 3-4.

NOTE 8—The outer dimensions of the ICI photographic snagging standards are 130 by 95 mm [5.2 by 3.8 in.], and the evaluation area of each specimen should be the same size as the standard. It is recommended that a standard specimen viewing mask be used to be sure the evaluation area of each specimen is the same size as the outer dimensions of the ICI photographic snagging standards. This mask can be made of approximately 2-mm [0.1-in.] thick poster board, plastic or metal. For the ICI photographic snagging standards, the white mask for the specimen should have a center cutout of 130 by 95 mm [5.2 by 3.8 in.], and the outer dimensions should be large enough so the mask can sit on the base of the apparatus for fabric evaluation (see Fig. 2).

NOTE 9—Rating standards assembled from tested specimens of the types of fabrics tested, representing the level of snagging equivalent to each of the five rating steps, are valuable as a reference to ensure uniformity in rating. Individual laboratories should have available rating standards for each type of fabric of particular interest.

NOTE 10—When rating the specimens, the rater's eyes must be approximately 300 mm [12 in.] from the fabric surface. This is the rating distance used in 6.2.5.1.

13.2.1 For each laboratory sampling unit, calculate the average rating of the lengthwise direction specimens to the nearest 0.1 scale unit.

13.2.2 For each laboratory sampling unit, calculate the average rating of the widthwise direction specimens to the nearest 0.1 scale unit.

13.2.3 For each laboratory sampling unit, calculate the overall average rating by averaging the observations from all the specimens to the nearest 0.1 scale unit.

13.2.4 For each laboratory sampling unit, examine the specimens to determine whether color contrasts, long distortions (longer than 15 mm [0.6 in.]), or long protrusions (longer than 4 mm [0.15 in.]) are present. If at least half of the specimens have color contrasts, long distortions, or long protrusions, then these attributes should be reported (see 14.2.6). For standards that differ only in the number of protrusions (see Note 7), also report the presence of short distortions (shorter than or equal to 15 mm [0.6 in.]) if short distortions were found on at least half of the specimens.

13.3 If other visual rating standards or apparatus for fabric evaluation were selected in 13.1 (such as fabric standards or the ICI viewing cabinet), the evaluation procedures described

in 13.2 – 13.2.4 will have to be adapted to the standards and equipment actually used (see Note 10).

14. Report

14.1 State that the specimens were tested as directed in this test method. Describe the material or product sampled and the method of sampling used.

14.2 Report the following information:

14.2.1 Method of preparation of the specimens, including the use of laundering or drycleaning.

14.2.2 Duration of test in number of revolutions, if other than 600.

14.2.3 Visual rating standards, apparatus, and illumination used to rate the specimens.

14.2.4 Whether the specimens were ironed or not and, if so, at what temperature.

14.2.5 For each laboratory sampling unit, the average of all of the lengthwise direction specimens and the average of all of the widthwise direction specimens.

14.2.6 For each laboratory sampling unit, the overall average of all specimens and any appearance changes (see 13.2.4) in the specimens.

14.2.7 If laundering tests were conducted, repeat 14.2.1 – 14.2.6 for the laundered specimens.

14.2.8 If drycleaning tests were conducted, repeat 14.2.1 – 14.2.6 for the drycleaned specimens.

15. Precision and Bias

15.1 *Precision*[8]—The results of an interlaboratory study of the ICI Mace Tester were reported by J. A. Finnigan.[9] This interlaboratory study had six bulked-polyester double-jersey materials, four laboratories, one operator at each laboratory, and four specimens (two lengthwise direction and two widthwise direction specimens) for each material. Because the test results of the Mace Test Method are expressed as nine rating steps or grades, the data from this study fit a non-normal distribution. Table 1 gives the results from the interlaboratory study, with each datum within the body of the table being a mean of four specimens (these data are from Finnigan's Table 1—Assessment X). Using the Friedman Rank-Sum Test described in Practice D4467, the Friedman Rank-Sum Statistic for the difference between laboratories was calculated by the D13.59 snagging task group to be 14.55. This statistic is significant at the 5 % level of significance, indicating that the laboratories were obtaining different test results for each material.

15.1.1 Using a different type of analysis, Finnigan concluded that significant interlaboratory differences did exist, so all of the specimens were sent to one laboratory to be rated by one experienced rater. For each of the materials, when the specimens were re-evaluated by one experienced rater, there was good agreement among the test results from the specimens snagged by different laboratories. Finnigan concluded that the effect of the machines was not significant, but the effect of having raters with various levels of training was significant. Finnigan recommended that all raters use the same rating procedures to obtain consistent test results.

15.1.2 A way to develop more consistent rating procedures among the raters would be to have a set of snagged specimens that have been evaluated by experienced raters and then to circulate the specimens and correct ratings among the laboratories for training new operators.

15.2 *Bias*—The procedure in this test method has no bias because the value of this property can be defined only in terms of a test method.

TABLE 1 Interlaboratory Test of the Mace Test Method

Laboratory	Material						
	A	B	C	D	E	F	Average
I	3.5	4.3	4.5	4.3	3.8	5.0	4.2
II	3.0	3.9	3.8	4.1	3.5	4.5	3.8
III	2.3	2.7	2.8	3.7	2.8	4.1	3.1
IV	2.8	3.6	3.8	4.5	3.4	4.9	3.8
Average	2.9	3.6	3.7	4.1	3.4	4.6	

16. Keywords

16.1 knitted fabric; snagging resistance; woven fabric

[8] Supporting data are available from ASTM Headquarters. Request RR:D13-1081.

[9] See footnote 2 for the reference. Written permission to use the data from the Finnigan study was obtained from The Textile Institute.