



## Standard Guide for Conducting Wear Tests on Textiles<sup>1</sup>

This standard is issued under the fixed designation D 3181; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This guide is designed to provide data on which a prediction can be based concerning the expected wear performance of a wide variety of textiles in end-use conditions.

1.2 *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<sup>2</sup>
- D 1335 Test Method for Tuft Bind of Pile Floor Coverings<sup>2</sup>
- D 1683 Test Method for Failure in Sewn Seams of Woven Fabrics<sup>2</sup>
- D 2051 Test Method for Durability of Finish of Zippers to Laundering<sup>2</sup>
- D 2052 Test Method for Colorfastness of Zippers to Dry-cleaning<sup>2</sup>
- D 2057 Test Method for Colorfastness of Zippers to Laundering<sup>2</sup>
- D 2058 Test Method for Durability of Finish of Zippers to Drycleaning<sup>2</sup>
- D 2062 Test Method for Operability of Zippers<sup>2</sup>
- D 2401 Test Method for Service Change of Appearance of Pile Floor Coverings<sup>3</sup>
- D 2960 Test Method of Controlled Laundering Test Using Naturally Soiled Fabrics and Household Appliances<sup>4</sup>
- D 3511 Test Method for Pilling Resistance and Other Related Surface Changes of Textile Fabrics: Brush Pilling Tester Method<sup>5</sup>
- D 3512 Test Method for Pilling Resistance and Other Related Surface Changes of Textile Fabrics: Random Tumble Pilling Tester Method<sup>5</sup>
- D 3514 Test Method for Resistance of Apparel Fabrics to Pilling (Elastomeric Pad Method)<sup>5</sup>

- D 3597 Performance Specification for Woven Upholstery Fabrics—Plain, Tufted, or Flocked<sup>5</sup>
  - D 3884 Test Method for Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method)<sup>5</sup>
  - D 3885 Test Method for Abrasion Resistance of Textile Fabrics (Flexing and Abrasion Method)<sup>5</sup>
  - D 3886 Test Method for Abrasion Resistance of Textile Fabrics (Inflated Diaphragm Method)<sup>5</sup>
  - D 3936 Test Method for Delamination Strength of Secondary Backing of Pile Floor Coverings<sup>5</sup>
  - D 3938 Guide for Evaluation of Textile Products in Relation to Refurbishing Described on Care Labels<sup>5</sup>
  - D 3939 Test Method for Snagging Resistance of Fabrics (Mace Test Method)<sup>5</sup>
  - D 4157 Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method)<sup>5</sup>
  - D 4158 Test Method for Abrasion Resistance of Textile Fabrics (Uniform Abrasion Method)<sup>5</sup>
  - D 4231 Practice for Evaluation of Men's and Boy's Home Launderable Woven Dress Shirts and Sport Shirts<sup>5</sup>
  - D 4390 Practice for Evaluating of the Performance of Terry Bathroom Products for Household Use<sup>5</sup>
  - D 4720 Practice for Evaluation of the Performance of Soft Window Coverings<sup>5</sup>
  - D 4721 Practice for Evaluating the Performance of Woven and Knit Machine Washable and Drycleanable Bedcoverings and Accessories<sup>5</sup>
  - D 4852 Practice for Evaluation of Attached Upholstery Fabrics<sup>5</sup>
- #### 2.2 AATCC Standards:
- 5 Evaluation Procedure: Subjective Evaluation of Fabric Hand<sup>6</sup>
  - 8 Colorfastness to Crocking: AATCC Crockmeter Method<sup>6</sup>
  - 88B Appearance of Seams in Wash-and-Wear Items After Home Laundering<sup>6</sup>
  - 88C Appearance of Creases in Wash-and-Wear Items After Home Laundering<sup>6</sup>
  - 96 Dimensional Changes in Laundering of Woven and Knitted Textiles (Excluding Wool)<sup>6</sup>
  - 119 Color Change Due to Flat Abrasion (Frosting): Screen Wire Method<sup>6</sup>
  - 120 Color Change Due to Flat Abrasion (Frosting): Emery Method<sup>6</sup>

<sup>1</sup> This guide is under the jurisdiction of ASTM Committee D-13 on Textiles and is the direct responsibility of Subcommittee D13.53 on Practices.

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 07.01.

<sup>3</sup> Discontinued; see 1992 *Annual Book of ASTM Standards*, Vol 07.01.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 15.04.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 07.02.

<sup>6</sup> *Annual AATCC Technical Manual*, available from American Association of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle Park, NC 27709.

- 121 Carpet Soiling: Visual Rating Method<sup>6</sup>
- 122 Carpet Soiling: Service Soiling Method<sup>6</sup>
- 123 Carpet Soiling: Accelerated Soiling Method<sup>6</sup>
- 124 Appearance of Fabrics After Repeated Home Launderings<sup>6</sup>
- 128 Wrinkle Recovery of Fabrics: Appearance Method<sup>6</sup>
- 130 Soil Release: Oily Stain Release Method<sup>6</sup>
- 150 Dimensional Changes in Automatic Home Laundering of Woven Garments<sup>6</sup>
- 158 Dimensional Changes on Drycleaning in Perchloroethylene: Machine Method<sup>6</sup>
- 163 Color Fastness: Dye Transfer in Storage: Fabric-to-Fabric<sup>6</sup>
- 2.3 *Other Documents:*
  - Knit Upholstery Fabric Standards and Guidelines<sup>7</sup>
  - Woven Upholstery Fabric Standards and Guidelines<sup>8</sup>

### 3. Terminology

#### 3.1 Definitions:

3.1.1 *control textile, n*—a textile having a known history, the performance of which in a specific end-use has been established previously, and which is used as a standard of comparison.

3.1.2 *end-use, n*—in wear testing, the use for which a textile is intended.

3.1.3 *evaluation period, n*—the period of time an item is used before being evaluated on the specific performance properties.

3.1.4 *grade, n*—in textile testing, the symbol for any step of a multistep standard reference scale, for a quality characteristic.

3.1.4.1 *Discussion*—The grade is assigned to test specimen exhibiting a degree of the quality comparable to that step of the standard. Numerical grades assigned to different specimens from a sample, or by different observers are commonly averaged (AATCC).

3.1.5 *participant, n*—in wear testing, any individual that uses a test or control textile during a wear test.

3.1.5.1 *Discussion*—The term does not include additional personnel contributing other services needed to carry out a test.

3.1.6 *performance property, n*—in wear testing, any chemical or physical property of a fiber, yarn, or fabric that is evaluated during the wear-refurbishing cycles.

3.1.7 *rating, n*—in textile testing, the process for determining or assigning a grade to a material by comparing it to a standard reference scale.

3.1.8 *wear level, n*—the number of wear-refurbishing cycles to which an item has been subjected.

3.1.9 *wear-refurbishing cycle, n*—for a specific wear testing program, one complete series of events that may be terminated by laundering or dry cleaning.

3.1.9.1 *Discussion*—A description of a wear-refurbishing cycle usually includes the number of hours worn or used and

the number of wearing or uses an item receives prior to refurbishing (that is, laundering or drycleaning), or both.

3.1.10 *wear-service condition, n*—the specific conditions under which a textile is used.

3.1.11 *wear test, n*—a test in which textiles are subjected to wear-service conditions and evaluated for performance.

3.1.12 For definitions of other textile terms used in this practice, refer to Terminology D 123.

### 4. Summary of Guide

4.1 Textiles are subjected to actual wear under service conditions. This practice recommends a control textile having a known wear performance history to be included with other items being tested. Statistical methods for design of test and analysis of data are included that are applicable to all wear tests. Standard procedures for evaluation of textiles are provided.

### 5. Significance and Use

5.1 This guide may be used to evaluate textiles used in apparel, upholstered furniture, floor coverings, window treatments, and bed, bath and table linens.

5.2 This guide may be used for several purposes:

5.2.1 To determine the comparative performance of new or existing products,

5.2.2 To determine the suitability of current products in different end-uses, and

5.2.3 To evaluate and compare the effect of wear of construction details as well as specific fabrics, fibers, dyeings, finishing, fabrication techniques, etc.

5.3 This guide provides for flexibility in design and evaluation since the information sought from each wear test will vary (see Appendix X1).

5.4 This guide may be used to compare the wear performance of two or more textiles when these are included in the same test, or to compare a textile whose properties have not been evaluated with one having a known performance history.

### 6. Apparatus

6.1 *Viewing Board*, with standard lighting, as specified in AATCC 124.

6.2 *Smoothness Appearance Replicas*, as specified in AATCC 124.

6.3 *Gray Scale for Color Change*, as specified in AATCC Evaluation Procedure 1.<sup>9</sup>

6.4 *Soil Release Replicas*, as specified in AATCC 130-1981.

6.5 *Pilling Standards*, as specified in Test Method D 3512.

6.6 *Seam Puckering Standards*, as specified in AATCC 88B-1984.

6.7 *Crease Retention Standards*, as specified in AATCC 88C.

6.8 *Photographic Standards for Evaluating Shirt Components (collar, pocket, placket)*, as specified in Practice D 4231.

6.9 *Work Sheets*, to record data (see Fig. 1).

### 7. Sampling, Selection, and Number of Specimens

7.1 *Division into Lots*—For acceptance testing, divide the

<sup>7</sup> Issued in 1982 by the Joint-Industry Fabric Standards Committee. Available from the American Furniture Mfrs. Assc., P. O. Box Hp-7, High Point, NC 27261.

<sup>8</sup> Re-issued in 1986 by the Joint-Industry Fabric Standards Committee. Available from the American Furniture Mfrs. Assc., P. O. Box Hp-7, High Point, NC 27261.

<sup>9</sup> This is the same as ISO R105/1, Part 2.



**TABLE 1 Properties That May Be Examined After Each Wear-Refurbishing Cycle or Evaluation Period**

Property	Existing Test Methods or Other Standards
<b>Possibilities for Apparel Evaluation</b>	
Abrasion Resistance	D 3884, D 3885 D 3886, D 4157
Appearance of collar	D 4231
Appearance of creases	AATCC 88-C
Appearance of pocket	D 4231
Appearance of placket	D 4231
Appearance of seams	AATCC 88-B, AATCC 119
Appearance of zippers	D 2051, D 2052 D 2057, D 2058
Color change, frosting	AATCC 119, AATCC 120
Color change, crocking	AATCC 8
Dimensional stability	AATCC 96
Fabric smoothness	AATCC 124
Fabric hand	AATCC Eval. 5
Pilling resistance	D 3511, D 3512 D 3514 D 3939
Snagging resistance	D 3939
Wear wrinkling	
<b>Possibilities for Carpet Evaluation</b>	
Abrasion resistance	D 3884
Delamination of backing	D 3936
Shampooing	AATCC 138
Soiling	AATCC 121 AATCC 122 AATCC 123
Tuft bind	D 1335
<b>Possibilities for Upholstery Fabric Evaluation</b>	
Abrasion resistance	D 4157, 63-110 Joint Ind
Coating	
Color change	AATCC Eval. 1, 2, 3
Durability of back	63-110 Joint Ind.
Retention of hand	AATCC Eval. 4
Retention of appearance	D 4852 63-110 Joint Ind. 63-110 Joint Ind.
Shade difference, part to part	
<b>Possibilities for Bed Coverings Evaluation</b>	
Appearance of seam joinings	D 4721
Dimensional stability	AATCC 96
Shade difference, part to part	D 4721
Smoothness appearance	AATCC 124
Surface abrasion	D 3884, D 3885, D 3886
Surface pilling	D 3511

8.16 Determine the exact sizes of the garments or other textiles required for each participant.

8.17 Decide on the style, color, etc., of the textiles to be wear tested to reach the objective.

8.18 When garments or other textiles are manufactured, determine the necessary yardage and provide for extra yardage to be used for laboratory tests.

8.19 Secure the required number of textiles and permanently label each with a code that identifies both the textile and the participant. Suggest that one textile of each type be retained in its new condition for comparison with the used textiles.

8.20 Issue the textiles to the proper participant along with written instructions regarding how the textile is to be used (worn) and cared for, as well as when it is to be returned for evaluation.

8.21 After each wear-refurbishing cycle or wear period has been completed, evaluate the textiles for previously specified performance properties. Where visual ratings are involved, it is recommended that three trained observers be used. Record the test value or grade for each property on a separate form to

**TABLE 2 Examples of Areas of Potential Wear That May Be Evaluated**

Garment	Area	
Shirts and blouses	collar, right and left	
	cuff, right and left	
	elbow, right and left	
	underarm, right and left	
	pocket, right and left	
	front, right and left	
	back	
	placket	
	front pocket area and below right and left	
	fly	
Trousers and ladies slacks	knee, right and left	
	crotch area	
	back pocket area, right and left	
	seat	
	cuffs	
	crease	
	collar or neckline	
	cuff, right and left	
	elbow, right and left	
	underarm, right and left	
Dresses	bodice, front and back	
	skirt, front and back	
	pocket	
	hem line	
	pleats	
	traffic path areas	
	seamed areas	
	armrest	
	head rest	
	seating area	
Floor coverings	edges in cushions and frames	
	seams	
	Upholstery	

facilitate statistical analysis of the data. See Fig. 1.

8.22 Continue to wear-test and evaluate the textiles until the predetermined endpoint of the test has been reached. Surveys may be conducted to determine the participants' opinions of the textiles being tested.

NOTE 3—Use as a guide in the evaluation of the textile, the practices and guides developed by Subcommittees D13.54, D13.56, D 13.61, and D13.63, such as D 3938, D 4231, and D 4390, if applicable.

## 9. Interpretation of Results

9.1 Following each evaluation, analyze the data statistically using one or more of the types of methods listed in 9.1.1-9.1.6 (methods for statistical analysis may be found in the literature,<sup>10</sup> or other statistical texts).

9.1.1 Average value or grade.

9.1.2 Frequency distribution of values or grades.

9.1.3 Table depicting difference between participants.

9.1.4 Percentage of items that failed, after each cycle.

9.1.5 Cumulative percent failures plotted against hours wear or time of use.

9.1.6 *F*-ratio— Analysis of variance.

## 10. Report

10.1 State that the specimens were tested as directed in Guide D 3181. Describe the type of material or fabric used and the types of textiles used.

<sup>10</sup> Davies, O. L., "Design and Analysis of Industrial Experiments," Oliver and Boyd, 1961.



- 10.2 Report the following information:
- 10.2.1 Objective of the test,
  - 10.2.2 Number of textiles tested,
  - 10.2.3 Number and types of conditions tested,
  - 10.2.4 Performance properties evaluated,
  - 10.2.5 Description of wear-refurbishing cycle,
  - 10.2.6 Type of participants (occupation, sex, age group, etc.),
  - 10.2.7 Results and statistical analysis (see Section 9),
  - 10.2.8 Use conditions of the textiles such as dress, casual, work, etc.,
  - 10.2.9 Presentation of data that best illustrates the wear performance of the items tested, and
  - 10.2.10 Conclusions.

## 11. Precision and Bias

11.1 *Precision*—Because of the wide variety of materials and types of textiles tested, and the variability exhibited by individual wear testers as well as the wide variety of wear-service conditions used, it is not practical to establish the precision of this practice.

11.2 *Bias*—The procedures in this practice have no bias since these properties can be evaluated only in terms of such procedures.

## 12. Keywords

12.1 appearance; bedding material; floor covering; table cloth fabrics; upholstery; wear testing; window coverings

## APPENDIX

### (Nonmandatory Information)

#### X1. DESIGNS FOR WEAR TRIALS

X1.1 Three designs are suggested for consideration:<sup>11</sup> (1) randomized block (Table X1.1), (2) balanced incomplete block (Table X1.2) or Scheffe's<sup>12</sup> paired comparison (Table X1.3). Where few conditions are being tested, and time and cost is not a vital factor, the randomized block offers the best design. In cases where many conditions are being tested and time and cost are critical factors, the balanced incomplete block offers the best design. A comparison of methods is listed in Tables X1.1-X1.3.

**TABLE X1.2 Scheffe's Paired Comparison<sup>8</sup>**

Advantages	Disadvantages
(1) Large number of participants required, thus sampling a large population.	(1) Logistics of handling data from large number of participants.
(2) Easy subjective evaluation, since only two textiles are compared by each participant.	(2) Does not control individual wear severity as well as randomized block.
(3) Faster.	
(4) Dropouts do not increase difficulty in analysis of data.	

**TABLE X1.3 Incomplete Block**

Advantages	Disadvantages
(1) Each participant will use certain assigned textiles according to test design, but will not use all types. This will allow more than four types of textiles to be tested. As a general rule, most wear tests will include more than four types of textiles.	(1) More difficult to analyze.
(2) Reduces total number of textiles in wear trial. Will reduce cost.	(2) In case of missing data, analysis is complex.
(3) Allow wear trial to be completed faster.	(3) Does not control individual wear severity as well as randomized block.

**TABLE X1.1 Randomized Block**

Advantages	Disadvantages
(1) Each participant will use all textile types, thus minimizing effect of user severity.	(1) Requires more time to complete wear trial because each person uses all types.
(2) Easy to handle missing data.	(2) More costly—same reason as (1).
(3) Best method for analysis of data.	(3) Not practical for wear tests involving four or more different types of textiles because of time involved to complete test.
(4) May be used for all trials that involve less than four different types of textiles.	

<sup>11</sup> More details concerning these and other designs may be found in Davis, O. L., "Design and Analysis of Industrial Experiments."

<sup>12</sup> Scheffe, H., *Journal of the American Statistical Association*, Vol 47, 1952, pp 381-400.

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