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Standard Guide for Conducting Wear Tests on Textiles[1]

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ε[1] NOTE—Section 5.1 was revised editorially in October 2015.

1. Scope

1.1 This guide is intended to provide guidance for the design of an experiment for the purpose of developing a prediction of expected wear performance of apparel and textile products when exposed to actual use conditions.

1.2 This guide recommends the use of a product for which a history of its performance is known from laboratory testing and consumer use as the basis for statistical significance of new product's performance, however, other design or experimental approaches may be used.

1.3 The wide variety of textile products and the conditions under which consumers will use products prevents the inclusion of all types of wear trial experiments for research and development, product innovation studies, and special needs such as those for healthcare industry or military.

1.4 *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:*[2]

2.1.1 *Fabric and Apparel Tests:*

D2051 Test Method for Durability of Finish of Zippers to Laundering

D2052 Test Method for Colorfastness of Zippers to Drycleaning

D2057 Test Method for Colorfastness of Zippers to Laundering

D2058 Test Method for Durability of Finish of Zippers to Drycleaning

D2261 Test Method for Tearing Strength of Fabrics by the Tongue (Single Rip) Procedure (Constant-Rate-of-Extension Tensile Testing Machine)

D2594 Test Method for Stretch Properties of Knitted Fabrics Having Low Power

D3107 Test Methods for Stretch Properties of Fabrics Woven from Stretch Yarns

D3511 Test Method for Pilling Resistance and Other Related Surface Changes of Textile Fabrics: Brush Pilling Tester

D3512 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

D3884 Guide for Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method)

D3885 Test Method for Abrasion Resistance of Textile Fabrics (Flexing and Abrasion Method)

D3886 Test Method for Abrasion Resistance of Textile Fabrics (Inflated Diaphragm Apparatus)

D3938 Guide for Determining or Confirming Care Instructions for Apparel and Other Textile Products

D3939 Test Method for Snagging Resistance of Fabrics (Mace)

D4157 Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method)

D4231 Practice for Evaluation of Launderable Woven Dress Shirts and Sports Shirts

D4390 Practice for Evaluation of the Performance of Terry Bathroom Products for Household Use (Withdrawn 1994)[3]

D4966 Test Method for Abrasion Resistance of Textile Fabrics (Martindale Abrasion Tester Method)

D4970 Test Method for Pilling Resistance and Other Related Surface Changes of Textile Fabrics: Martindale Tester

D5034 Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)

D5035 Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)

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

D6321 Practice for the Evaluation of Machine Washable T-Shirts
D6797 Test Method for Bursting Strength of Fabrics Constant-Rate-of-Extension (CRE) Ball Burst Test
D6828 Test Method for Stiffness of Fabric by Blade/Slot Procedure
2.1.2 *Other ASTM Standards:*
D123 Terminology Relating to Textiles
D4850 Terminology Relating to Fabrics and Fabric Test Methods
D7022 Terminology Relating to Apparel
2.2 *AATCC Standards:*[4]
2.2.1 *Colorfastness and Physical Properties:*
8 Colorfastness to Crocking: AATCC Crockmeter Method
15 Colorfastness to Perspiration
16 Colorfastness to Light
61 Colorfastness to Laundering: Accelerated
88B Smoothness of Seams in Fabrics After Repeated Home Laundering
88C Appearance of Creases in Wash-and-Wear Items After Home Laundering
96 Dimensional Changes in Commercial Laundering of Woven and Knitted Fabrics Except Wool)
116 Colorfastness to Crocking: Rotary Vertical Crockmeter Method
117 Colorfastness to Heat: Dry (Excluding Pressing)
124 Appearance of Fabrics After Repeated Home Laundering
125 Colorfastness to Perspiration and Light
128 Wrinkle Recovery of Fabrics: Appearance Method
130 Soil Release: Oily Stain Release Method
135 Dimensional Changes of Fabric after Home Laundering
143 Appearance of Apparel and Other Textile End Products after Repeated Home Laundering
150 Dimensional Changes of Garments after Home Laundering
179 Skewness Change in Fabric Resulting from Home Laundering
183 Transmittance or Blocking of Erythemally Weighted Ultraviolet Radiation through Fabrics
186 Weather Resistance: UV Light and Moisture Exposure
192 Weather Resistance of Textiles: Sunshine-Arc Lamp Exposure With and Without Wetting
202 Relative Hand Value of Textiles: Instrumental Method
2.2.2 *Vapor, Water and Moisture Management Tests:*
22 Water Repellency: Spray Test
35 Water Resistance: Rain Test
42 Water Resistance: Impact Penetration
70 Water Repellency: Tumble Jar Dynamic Absorption Test
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127 Water Resistance: Hydrostatic Pressure Test
193 Aqueous Liquid Repellency: Water/Alcohol Solution Resistance Test
195 Liquid Moisture Management Properties of Textiles Fabrics
197 Vertical Wicking of Textiles
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199 Drying Time of Textiles: Moisture Analyzer Method
200 Drying Rate of Textiles at their Absorbant Capacity: Air Flow Method
201 Drying Rate of Fabrics: Heated Hot Plate Method
2.2.3 *Evaluation Procedures:*
EP1 Gray Scale for Color Change
EP2 Gray Scale for Staining
EP5 Fabric Hand: Guidelines for Subjective Evaluation
EP6 Instrumental Color Measurement
EP7 Instrumental Assessment of the Change in Color of a Test Specimen
EP8 AATCC 9–Step Chromatic Transference Scale
EP9 Visual Assessment of Color Difference of Textiles
EP12 Instrumental Assessment of Degree of Staining
2.2.4 *AATCC Monographs:*
M5 Standardization of Hand Laundering for Fabrics and Textiles
M6 Standardization of Home Laundering Test Conditions

3. Terminology

3.1 For all terms relating to D13.60 Fabric Test Methods, Specific, refer to Terminology D4850; for terms related to D13.61 Apparel, refer to Terminology D7022.

3.1.1 The following terms are relevant to this standard: *control textile*, *end-use*, *evaluation period*, *grade*, *participant*, *performance property*, *rating*, *wear level*, *wear-refurbishing cycle*, *wear-service condition*, *wear test*.

3.2 For all other terminology related to textiles, see Terminology D123.

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.

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

[4] *Annual AATCC Technical Manual*, available from American Association of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle Park, NC 27709, www.aatcc.org.

same test, or to compare a textile whose properties have not been evaluated with one having a known performance history.

5.5 The standard test methods and guides listed in 2.1 and 2.2 are not to be considered as limited to only those cited. It is recognized that textile innovations of chemistries on fibers and fabrics may require the use of other standards methods or modifications to existing standards. Further, product development efforts within companies may call for the use of internal procedures when investigation of worthiness of the innovation or prediction of consumer preference or satisfaction is questioned.

6. Apparatus and Facilities

6.1 *Laboratory Equipment,* to perform designed tests.

6.2 *Facilities for Conditioning Textiles.*

6.2.1 *Environmental Chambers,* if required.

6.2.2 *Facilities*—for participants to be interviewed, fill out worksheets, change clothes, etc.

6.3 *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 product into lots as agreed upon between the purchaser and the supplier.

7.2 *Lot Sample*—As a lot sample for acceptance testing, take at random the number of shipping cartons directed in an applicable material specification or other agreement between the purchaser and the supplier.

NOTE 1—A realistic specification or other agreement between the purchaser and the supplier requires taking into account the variability between shipping cartons, between items within a carton, and between specimens within an item so as to provide a sampling plan which has a meaningful producer's risk, meaningful consumer's risk, acceptable quality level, and limiting quality level.

7.3 *Laboratory Sample*—As a laboratory sample for acceptance testing, take at least two items from each shipping carton in the lot sample.

7.4 *Test Specimens*—Take test specimens from each item in the laboratory sample as directed in the individual test methods or as agreed upon between the purchaser and the supplier. Perform each test on the product as it will reach the consumer.

7.5 For some wear trials where two elements of a textile are being evaluated for specific benefits, a laboratory specimen might require a test garment to be made with one full side from fabric with one application (fiber content, or other element under consideration) and the other full side having the untreated (fiber content or other element) to be compared by a study participant.

8. Procedure

8.1 Define the objectives of the test.

8.2 List the information to be obtained from the test.

8.3 Determine the type and design of the textile product(s) to be tested.

8.4 Select the performance properties to be evaluated to obtain the necessary information. See Table 1.

Wear Test Identification Number _____
Wear Level _____
Fabric Identification _____

	PARTICIPANTS										
	1	2	3	4	5	6	7	8	9	10	etc.
Evaluation Date											
Times Worn											
Hours Worn											
Times Refurbished											
Abrasion											
Bagging											
Color Change											
Crease Retention											
Dimensional Stability											
Fabric Smoothness											
Holes											
% Length Change											
% Width Change											
Pilling											
Seam Puckering											
Snagging											
Washdown (Hand)											
Wear Wrinkling											
Etc.											

FIG. 1 Example of a Wear Test Work Sheet

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

Property	Existing Test Methods or Other Standards
Possibilities for Apparel Evaluation	
Abrasion Resistance	D3884,D3885,D3886, D4157
Appearance of collar	D4231
Appearance of creases	AATCC 88C
Appearance of pocket	D4231
Appearance of placket	D4231
Appearance of seams	AATCC 88B,
Appearance of zippers	D2051,D2052,D2057, D2058
Color change, crocking	AATCC 8,116
Dimensional changes, fabric, garments & textile products	AATCC 135 & 150
Smoothness appearance, fabric, garments & textile products	AATCC 124 & 143
Fabric hand	AATCC Eval. 5
Pilling resistance	D3511, D3512,D3514

8.4.1 The physical properties listed in Table 1 are not to be considered exhaustive but rather as illustrative. Standard test methods are sometimes modified to address new textile innovations. Also, research and product development activities within companies necessitate the creation of new evaluations or procedures, and while not approved by standards developing organizations, are useful in select circumstances for wear trials.

8.5 Select the specific areas of the textile that will be evaluated for each property. See Table 2.

8.5.1 Some wear trials may be designed to evaluate garments in the environment in which the items will be used or worn to determine consumer perceptions of acceptance or relative approval. In such cases, areas of evaluation may be general areas on contact with skin, as in wear trials intended to evaluate perceptions of comfort during use.

TABLE 2 Areas on Apparel 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
Trousers and ladies slacks	front pocket area and below right and left
	fly
	knee, right and left
	crotch area
	back pocket area, right and left
	seat
	cuffs
	crease
Dresses	collar or neckline
	cuff, right and left
	elbow, right and left
	underarm, right and left
	bodice, front and back
	skirt, front and back
	pocket
	hem line
	pleats

8.6 Establish how each performance property will be evaluated and what rating scale will be used.

8.7 For each performance property, decide what test value or grade will constitute a satisfactory or unsatisfactory performance to meet the objectives of the test.

8.8 Identify which evaluation procedures are destructive and nondestructive. Nondestructive evaluations can occur during the total wear period at predetermined times. Destructive evaluations should occur at the end of the total wear period, unless additional textile items are included in the initial wear test plan for withdrawal and destructive testing.

8.9 Establish the wear period at which time the test is terminated automatically.

8.10 Alternatively, establish the percentage of specimens that must fail to constitute overall unsatisfactory performance. Terminate the test when the established level for failure has been reached.

8.11 Establish the number of wear-refurbishing cycles that will constitute overall satisfactory performance. The wear test may be terminated at this point even though no specimen may have failed.

8.12 Define the use-refurbishing cycle by establishing the number of hours (days) worn or used, and the number of uses the textile will receive before refurbishing, or both, and the method by which the item will be refurbished.

8.13 Select a suitable control textile to include in the test as a standard of comparison.

8.14 Based on the number of conditions being tested, as well as the time and cost involved, develop a suitable design for the wear test. (See Appendix X1 for examples of some statistical experimental designs, however other designs and data analysis may be used (see 9.1.7).

8.15 Decide on, and arrange for, the number of participants needed to conduct the test according to the selected plan.

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 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 2—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 D3938, D4231, and D4390, 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,[5] 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.

9.1.7 Other data analysis methods may be used.

10. Report

10.1 State that the specimens were tested as directed in Guide D3181. Describe the type of material or fabric used and the types of textiles used.

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 Test methods used and any modifications to standard test methods,

10.2.6 Description of wear-refurbishing cycle, if refurbishing is part of the wear trial's design.

10.2.7 Number of participants and descriptions (occupation, sex, age group, etc.),

10.2.8 Results and statistical analysis (see Section 9),

10.2.9 Use conditions of the textiles such as dress, casual, work, etc.,

10.2.10 Presentation of data that best illustrates the wear performance of the items tested, and

10.2.11 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 wearservice 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 wear testing

[5] Davies, O. L., "Design and Analysis of Industrial Experiments," Oliver and Boyd, 1961.

APPENDIX

(Nonmandatory Information)

X1. DESIGNS FOR WEAR TRIALS

X1.1 Three designs are suggested for consideration:[6] (1) randomized block (Table X1.1), (2) balanced incomplete block (Table X1.2) or Scheffe's[7] paired comparison (Table X1.3).

[6] More details concerning these and other designs may be found in Davis, O. L., "Design and Analysis of Industrial Experiments."

[7] Scheffe, H., *Journal of the American Statistical Association*, Vol 47, 1952, pp. 381– 400.

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.	

TABLE X1.2 Scheffe's Paired Comparison[7]

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.	

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 X1.3 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. (2) Reduces total number of textiles in wear trial. Will reduce cost. (3) Allow wear trial to be completed faster.	(1) More difficult to analyze. (2) In case of missing data, analysis is complex. (3) Does not control individual wear severity as well as randomized block.