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Standard Test Methods for Bonded, Fused, and Laminated Apparel Fabrics¹

This standard is issued under the fixed designation D2724; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

^{ε1} NOTE—The title of Referenced Document 124 was corrected editorially in September 2011.

1. Scope

1.1 These test methods cover procedures for characterizing the delamination, strength of bond, appearance, and shrinkage propensity of bonded, fused, and laminated apparel fabrics after drycleaning and laundering.

1.2 The values stated in SI units are to be regarded as standard; the values in parentheses are provided as information only.

1.3 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns 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

[D76 Specification for Tensile Testing Machines for Textiles](#)

[D123 Terminology Relating to Textiles](#)

[D1776 Practice for Conditioning and Testing Textiles](#)

[D4850 Terminology Relating to Fabrics and Fabric Test Methods](#)

[E337 Test Method for Measuring Humidity with a Psychrometer \(the Measurement of Wet- and Dry-Bulb Temperatures\)](#)

2.2 *AATCC Standard:*

[124 Smoothness Appearance of Fabrics after Repeated Home Laundering](#)³

3. Terminology

3.1 For all terminology relating to D13.59, Fabric Test Methods, General, refer to Terminology [D4850](#).

3.1.1 The following terms are relevant to this standard: blister, bonded fabric, bond strength, bubble, crack mark, foam tear, fused fabric, fusible fabric, interlining, laminated fabric, lot, puckering, solvent, relative humidity.

3.2 For definitions of other textile terms used in this test method, refer to Terminology [D123](#).

4. Summary of Test Methods

4.1 Bench marks are placed at specified distances on the fabrics, which are then measured, and subsequently dry-cleaned, or laundered and dried, or both, through a prescribed cycle that is repeated a specified number of times. The drycleaned or washed specimens are examined for appearance and delamination and measured to determine any accompanying shrinkage and, if desired, tested to determine the strength of the bond.

5. Significance and Use

5.1 These test methods for the determination of properties of bonded, fused, or laminated apparel fabrics, are considered satisfactory for acceptance testing of commercial shipments of bonded and laminated apparel fabrics since the methods have been used extensively in the trade for acceptance testing.

¹ These test methods are under the jurisdiction of ASTM Committee [D13](#) on Textiles and are the direct responsibility of Subcommittee [D13.59](#) on Fabric Test Methods, General.

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² For referenced ASTM standards, visit the ASTM Web site, 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 web site.

³ Available from American Association of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle Park, NC 27709.

5.1.1 If there are differences of practical significance between reported test results for two laboratories (or more), comparative tests should be performed to determine if there is a statistical bias 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. Randomly assign specimens in equal numbers to each laboratory. The test results from the laboratories involved should be compared using a statistical test for unpaired data and a probability level chosen prior to the testing series. If bias is found, either its cause must be found and corrected, or future test results for that material must be adjusted in consideration of the known bias.

6. Apparatus and Materials

6.1 *Drycleaning Machine*,⁴single-unit, coin-operated type, capable of providing a complete automatic dry-to-dry cycle using perchlorethylene. It shall consist of a commercial rotating cage type, totally enclosed machine. The diameter of the rotating cage shall be not less than 600 mm (24 in.) and not more than 1080 mm (42 in.). Its depth shall be not less than 300 mm (12 in.). It shall be fitted with two to four lifters. The speed shall be such as to give a *g*-factor between 0.5 and 0.9 for cleaning and between 35 and 120 for extraction. The machine shall be equipped with thermometers for the measurement of the solvent temperature and the air drying temperature.

NOTE 1—The *g*-factor is calculated using Eq 1 or Eq 2:

$$g = 1.42n^2D/100\ 000 \quad (1)$$

$$g = 5.59n^2d/10\ 000\ 000 \quad (2)$$

where:

n = revolutions per minute,
D = cage diameter, in., and
d = cage diameter, mm.

6.2 *Domestic Automatic Washer*,⁴top-loading, spin-extracting type.

6.3 *Domestic Automatic Tumble Dryer*,⁴front-loading type.

6.4 *Aspirated Psychrometer*, which meets the requirements of Test Method E337.

6.5 *Marking Device*⁴—A thin sheet of stainless steel or other rigid flat material in which a square opening 254 by 254 mm (10 by 10 in.) has been cut.

6.6 *Rule*, 305-mm (12-in.) or longer, preferably divided into tenths of an inch. A premarked device calibrated to give the percentage of shrinkage or growth may also be used.

6.7 *Sewing Machine*, suitable for sewing a single row of stitching, preferably with No. 00 mercerized cotton thread, 25 mm (1 in.) from the edge of the fabric specimen.

6.8 *Steam Iron*, hand type.

6.9 *Steam Press*,⁴a press, 600 by 1250 mm (24 by 50 in.), or larger, provided with 60 to 70 psig steam pressure at the press. Any steam press large enough for pressing a specimen 380 mm (15 in.) square may be used.

6.10 *Tensile Testing Machine*, conforming to Specification D76, either a constant rate of traverse type⁴ or a constant rate of extension type, equipped with clamps having a width of 76.2 mm (3.00 in.) and preferably calibrated in kilograms with a range from 0 to 4.5 kg (0 to 160 oz). The constant rate of extension type machine is preferred because of the inherently lower machine-induced errors in this type of machine.

6.11 *Detergent*, home laundry type.

6.12 *Perchlorethylene*, commercial grade.

NOTE 2—**Warning:** Perchlorethylene is toxic, and the usual precautions for handling chlorinated solvents should be taken. It should be used only under well-ventilated conditions. The solvent is nonflammable.

6.13 *Drycleaning Detergent*,⁴anionic drycleaning detergent.

7. Sampling

7.1 *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 units.

NOTE 3—An adequate specification or other agreement between the purchaser and the supplier requires taking into account the variability between rolls

⁴ Apparatus and accessories are commercially available.

of fabric and between specimens from a swatch from a roll of fabric so as to provide a sampling plan with a meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7.2 Laboratory Sample—As a laboratory sample for acceptance testing, take a full width swatch 1 m (1 yd) long from the end of each roll of fabric in the lot sample, after first discarding a minimum of 1 m (1 yd) of fabric from the very outside of the roll.

7.3 Test Specimens—Proceed as follows:

7.3.1 Drycleaning and Laundering—Cut four specimens from each swatch in the laboratory sample with each specimen being 380 by 380 mm (15 by 15 in.) in size, with the one side of the specimens from a single swatch parallel to the selvage. Locate two of the specimens from each swatch about $\frac{1}{3}$ of the distance from one selvage and locate the other two specimens from each swatch about $\frac{1}{3}$ of the distance from the other selvage. Locate each of the two specimens from one side of the swatch along a diagonal line on the swatch so that they will contain different warp ends and filling picks. Sew a straight line of stitching around each specimen 25 mm (1 in.) from each edge. Reserve the rest of the swatch for comparison with the drycleaned and laundered test specimens.

7.3.2 Strength of Bond—Prepare three test specimens, each measuring 76 mm (3 in.) wide, and 152 mm (6 in.) long, the length of the specimens corresponding to the lengthwise direction of the fabric. Do not take the test specimens closer to the selvage than a distance equal to 20 % of the fabric width.

NOTE 4—Samples that are 51 mm (2 in.) wide may be used as the minimum width.

8. Conditioning

8.1 Bring the samples from the prevailing atmosphere and condition them for at least 4 h in the standard atmosphere for testing textiles as directed in Practice **D1776** if shrinkage is to be determined. Preconditioning is not necessary.

9. Specimen Preparation

9.1 Using an indelible fineline marker, mark a 254 by 254 mm (10 by 10 in.) reference square centrally located on the face of each test specimen. Apply three sets of reference markings 254 ± 2 mm (10 ± 0.1 in.) apart, as measured with a rule, in the direction of the fabric length. Locate the markings within 25 mm (1 in.) of each end and at the midpoint of each side of the square. Similarly, apply three sets of markings in the direction of the fabric width. Any other method of accurately locating the 254-mm (10-in.) reference marks is satisfactory as long as the three marks on each side of the square are at least 105 mm (4 in.) apart.

10. Drycleaning Procedure

NOTE 5—Launderable fabrics are expected normally to be drycleanable, except where the face fabric is not drycleanable and is so labeled. For example, the fabric could contain a functional finish soluble in the solvent, or the fiber could be degraded by the solvent, which would be the case with poly(vinyl chloride) fiber.

10.1 Solvent Preparation—Prepare a standard detergent/drycleaning solvent mixture by adding sufficient detergent to the solvent to make a 1 % volume/volume solution. Add sufficient water to the solution to give a solvent relative humidity level of 75 % for the particular drycleaning detergent used. Put this solvent in the machine storage tank. The same solution can be used for repeated cleanings until it becomes dirty and needs replacing as long as the necessary water additions to maintain the solvent relative humidity constant are made prior to each test run. This is so because the specimens being run could conceivably alter the solvent relative humidity for succeeding test runs while the detergent level would remain constant.

10.2 Sample and Dummy Load Preparation—Prepare a load consisting of all specimens to be tested and made up to 3.6 kg (8 lb) total with dummy load of approximately 380 by 380-mm (15 by 15-in.) fabric pieces of similar material. Condition this load at least 4 h in the standard atmosphere for testing textiles. After the drycleaning operation, condition the load again before running through each additional drycleaning cycle. Conditioning before each drycleaning cycle is intended to minimize depletion of water from the drycleaning solution specified in 10.1.1 which may affect shrinkage results.

10.3 Drycleaning Procedure—Run through the complete dry-to-dry cycle in the machine. Run the solvent phase of the drycleaning cycle with the solvent no higher than 32°C (90°F). During the drying phase of the drycleaning cycle, either the air outlet temperature should not exceed 60°C (140°F) or the inlet air temperature should not exceed 80°C (175°F). If heat-sensitive fibers, for example, modacrylic fibers, are involved, the outlet air temperature should not exceed 40°C (105°F) or the inlet air temperature should not exceed 60°C (140°F). After the complete drycleaning cycle, remove the sample from machine for examination and reconditioning.

10.4 Repeat the drycleaning operation through two additional cycles. At the end of the third cycle remove the test specimens from the machine, lay on a flat surface, smooth the test specimens by hand, and examine. Press the test specimens using the steam press according to the following cycle:

10.4.1 Five seconds steam with head up.

10.4.2 Five seconds dry hot press with head down, 145 to 151°C (293 to 303°F) of steam pressure at the press.

10.4.3 Five seconds vacuum, steam off, head down.

10.4.4 Five seconds vacuum, steam off, head up.

10.4.5 Allow the pressed specimens to condition in the standard atmosphere for testing textiles for at least 4 h.

10.5 Measure the distance between each of the six sets of reference marks on each test specimen.

10.6 Lay the fabric flat on a table or board with a surface rough enough so that the fabric side touching the table will not readily slide. Examine each test specimen for any evidence of delamination. Place the fingers on the specimen and attempt to slide the upper fabric layer over the bottom or intermediary substrate. If in doubt, make a small cut through the specimen with scissors to determine if any separation of substrates has occurred. Turn the fabric over and make the same type of examination on the other side.

10.7 Examine the face fabric for any alteration in appearance as compared with the original sample. This may be done with conventional room lighting, or with “Lighting Equipment for Viewing Test Specimens,” as described in Fig. 1 of AATCC Method 124. Examine only the area of the test specimen bounded by the stitching.

11. Laundering Procedure

11.1 *Machine Laundering*—Wash the test specimens in the automatic home laundry machine, using 50 g of laundry detergent, or a sufficient amount to give a safe suds level, at the applicable domestic automatic temperature and procedure under which the fabric is to be marketed. In the absence of this information use the “normal” cycle and high water level settings and determine the washing temperature according to the fabric type and construction as follows:

11.1.1 Face fabrics containing 20 % or more of wool, acetate, modacrylic, or acrylic fibers, $41 \pm 3^\circ\text{C}$ ($105 \pm 5^\circ\text{F}$).

11.1.2 Face fabrics of tricots, circular knits, woven nylon, and print fabrics other than those described under 11.1.1, $49 \pm 3^\circ\text{C}$ ($120 \pm 5^\circ\text{F}$).

11.1.3 All other woven face fabrics, $60 \pm 3^\circ\text{C}$ ($140 \pm 5^\circ\text{F}$).

11.2 *Load for Machine Laundering*—Use a total load of 1.8 kg (4 lb) including test specimens plus a dummy load of approximately 380 by 380 mm (15 by 15 in.) fabrics of similar fabric construction. Load all fabrics in the flat position.

11.3 *Hand Laundering*—If the fabrics are to be designated “Hand Washable,” dissolve 20 g of laundry detergent in 7.6 L (2 gal) of water at $41 \pm 3^\circ\text{C}$ ($105 \pm 5^\circ\text{F}$) in a 9.5-L (10-qt) pail and then add two test specimens. Wash by lifting each specimen out of the bath followed by immediate reimmersion at least ten times. Just before the final reimmersion, lightly rub by hand the center of each specimen separately for a period of 1 min. Rinse by transferring the specimens to 7.6 L of water at $41 \pm 3^\circ\text{C}$ ($105 \pm 5^\circ\text{F}$) and gently agitating the specimens by hand for a period of 2 min with no twisting or wringing. Remove the specimens and dry as directed in 11.6.

11.4 *Tumble Drying*—Immediately after the first wash cycle, as directed in 11.1, remove the test specimens and dummy load from the laundry machine and transfer to the tumble dryer. Run the dryer at the “moderate” setting and dry for the minimum time required for adequately drying the fabrics being tested. Remove the test specimens and dummy load immediately following the shut-off and examine.

11.5 Repeat the washing and drying cycles as directed in 11.1 and 11.4 four more times. After the fifth cycle, remove the test specimens, lay on a flat surface, smooth by hand, and examine. Press the face fabric side lightly with a sliding action using the hand steam iron, with no pressure other than the weight of the iron. If no ironing temperature is specified for the face fabric, use the safe ironing temperature guide appearing in Table 1. Allow the specimens to condition on a flat surface in the standard atmosphere for testing textiles for a minimum of 4 h before rating and measuring as directed in 10.5 – 10.7.

11.6 *Drip Drying*—Remove the specimens from the pail or from the automatic washer just before the water begins to drain for the final spin-dry cycle, squeeze by hand without wringing or twisting, and hang each specimen by two adjacent corners, with the fabric length in the vertical direction, in still air at room temperature until dry and examine.

11.7 Repeat the washing and drying cycles as directed in 11.2 or 11.3, and 11.6, four more times. After the fifth cycle, lay on a flat surface, smooth the test specimens by hand, and examine. Press the face fabric side lightly with a sliding action using a hand steam iron with no pressure other than the weight of the iron. If no ironing temperature is specified for the face fabric, the safe

TABLE 1 Safe Ironing Temperature Guide

Class 0	Class I	Class II	Class III	Class IV
Below 121°C (250°F)	121 to 135°C (250 to 275°F)	149 to 163°C (300 to 325°F)	177 to 191°C (350 to 375°F)	204°C (400°F) and Above
Modacrylic 93 to 121°C (200 to 250°F)	Acetate	Triacetate (unheat set)	Nylon 66	Cotton
	Olefin (polypropylene)	Acrylic	Polyester	Fluorocarbon Glass Hemp, Jute Ramie Linen Rayon, Viscose Triacetate (heat set)
Olefin (polyethylene) 79 to 121°C (175 to 250°F)	Silk	Azlon Nylon 6		
Rubber 82 to 93°C (180 to 200°F)		Spandex		
Saran 66 to 93°C (150 to 200°F)		Wool		
Vinyon 54°C (130°F)				