



AMERICAN NATIONAL
STANDARD

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American Association of Textile Chemists
and Colorist Method 96-1967

Standard Test Method for DIMENSIONAL CHANGES IN LAUNDERING OF WOVEN OR KNITTED TEXTILES^{1, 2}

This Standard is issued under the fixed designation D 1905; 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.

1. Scope

1.1 This method covers the determination of the dimensional changes in woven or knitted fabrics when the cloth is subjected to laundering procedures commonly used in a commercial laundry or in the home.

NOTE 1—For the measurement of dimensional changes of wool fabrics, refer to Method D 1284, Test for Relaxation and Consolidation Dimensional Changes of Stabilized Knit Wool Fabrics³ and Method D 462, Testing and Tolerances for Certain Wool and Part Wool Fabrics.³

2. Applicable Documents

2.1 ASTM Standards:

D 123 Definitions of Terms Relating to Textiles⁴

D 496 Specification for Chip Soap⁵

D 1776 Recommended Practice for Conditioning Textiles and Textile Products for Testing⁴

2.2 Other Standards:

P-S-579a Federal Specification for Soap, Laundry, Chip and Powdered

3. Definitions

3.1 For definitions of terms used in this method, refer to Definitions D 123.

4. Summary of Method

4.1 A specified load of fabric specimens or garments is washed in a cylindrical reversing wash wheel, dried, and subjected to restorative forces where necessary. The temperature and time agitation in the wash wheel can be varied to obtain different degrees of severity. Drying procedures and the application of restorative forces can be varied to conform with

normal handling encountered during home or commercial laundering. The distances between bench marks on the specimen in the warp and filling directions for woven fabrics (or wales and courses for knitted fabrics) are measured before washing, after drying, and after the restoration procedure (if any). From these measurements, the changes in dimension are calculated.

5. Uses and Significance

5.1 The procedures in this method are not recommended for acceptance testing because between-laboratory precision has been established (See Note 9, Section 15).

5.2 Five washing test procedures are included, ranging from very severe to very mild, and are intended to cover the range of practical washing from commercial procedures to hand washing. Five drying test procedures are included to cover the range of drying techniques used in the home and commercial laundries. Three methods for determining the dimensional restorability characteristics are included for those textiles which require restoration by ironing or pressing after laundering. These procedures are not accelerated tests and

¹ This method is under the jurisdiction of ASTM Committee D-13 on Textiles, and is the direct responsibility of Subcommittee D13.59 on Fabric Test Methods.

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² The precision of this method is such that the method's usefulness as an acceptance test is dubious. Additional work is underway by the Subcommittee responsible for this method to improve the precision of this method.

³ *Annual Book of ASTM Standards*, Part 32.

⁴ *Annual Book of ASTM Standards*, Parts 32 and 33.

⁵ *Annual Book of ASTM Standards*, Part 30.

must be repeated to evaluate dimensional changes after repeated launderings.

5.3 A combination of procedures that is practical for any specific item must be established in order to evaluate the dimensional changes of textile fabrics for garments after laundering by procedures commonly used in the home or in a commercial laundry. The test procedure can be completely identified by a code consisting of a Roman numeral, a letter, and an Arabic number, as shown in Table 1. For example, Test III E 1 refers to a specimen that has been washed by procedure III (at 1400°F (600°C) for a total of 45 min in the machine), dried in a tumble dryer by procedure E, and subjected to restorative forces on the tension presser by procedure 1.

5.4 The drying procedure to be used is governed by the intended end use of the fabric. Procedure A is recommended for certain durable press fabrics and garments. Procedure B is used for other durable press fabrics but is not recommended for garments or knitted fabrics, or for fabrics made from thermoplastic man-made fibers. Procedure C is recommended for knitted fabrics and garments. Procedure D is applicable to some knitted fabrics and garments, and to all woven fabrics and garments. Procedure E is applicable to all fabrics and garments.

5.5 The use of a restoration procedure is dependent upon the characteristics of the fabric. Procedure 1 (tension presser) is used for woven or warp knitted fabrics. Procedure 2 (knit shrinkage gage) is used only for those knitted fabrics which have not stretched in either direction during laundering. Procedure 3 (hand iron) is an alternative procedure corresponding to household practice and will give the least reproducible results because of different techniques in handling and exertion of tension by operators during pressing. It is used primarily for evaluation of garments which require ironing to remove wrinkles prior to wearing and is not recommended for knitted fabrics or garments.

5.6 When using this method, the combination of washing, drying, and restorative procedures to be used in the evaluation of each lot, or of a particular sample, should be agreed upon before the testing is started.

6. Apparatus and Materials

6.1 *Wash Wheel*—A machine of the cylindrical, reversing wash-wheel type, having a wheel (cage) 20 to 24 in. (approx 500 to 600 mm) in inside diameter and 20 to 24 in. (approx 500 to 600 mm) in inside length. Three fins, each approximately 3 in. (75 mm) wide, shall extend the full length of the inside of the wheel at 120-deg intervals around the inside diameter of the wheel. The wash wheel shall rotate at a speed of 30 rpm making 5 to 10 revolutions before reversing. The water inlets shall be large enough to permit filling the wheel to an 8-in. (200-mm) level in less than 2 min, and the outlet shall be large enough to permit discharge of this same amount of water in less than 2 min. The machine shall be equipped with a pipe for injecting live steam that is capable of raising the temperature of water at an 8-in. level from 100 to 140 F (38 to 60 C) in less than 2 min. The machine shall contain an opening for the insertion of a thermometer or other device for determining the temperature of the water during the washing and rinsing procedures. The machine shall be equipped with an outside water gage that will indicate the level of the water in the wheel.⁶

NOTE 2—A domestic automatic washer that will give equivalent results may be used for Tests I, II, and III.⁷

6.2 *Pressing Equipment*—A flat-bed press, 24 by 50 in. (approx 600 by 1250 mm) or larger, maintained at a temperature of not less than 275 F (135 C). Any flat-bed press large enough for pressing a specimen 22 in. (approx 560 mm) square may be used.⁸

6.3 *Dryer*—A rotary-tumble type dryer having a cylindrical basket approximately 30 in. (750 mm) in diameter and 24 in. (600 mm)

⁶ Washing machines of the type described may be obtained from The American Laundry Machinery Co., Cincinnati, Ohio; Robert Ewing and Sons Co., Green Island, N. Y.

⁷ Various brands of home-type automatic washers have been found to give equivalent results. The Sears Roebuck & Co. Model 600, or any washer that gives equivalent results is satisfactory. The Model 600 referred to is obtainable only through Sears Roebuck commercial sales division and should not be confused with the Model 600 sold in their retail stores.

⁸ Pressing equipment of the type described may be obtained from Pantex Co., Pawtucket, R. I. (Flat-Plate Press, Model FPR-60); Ametek Co., East Moline, Ill. (Flat-Plate Press, Model No. on request); and U. S. Testing Co., Inc., Hoboken, N. J. (Flat-Plate Press Model 6584).

in length that rotates at approximately 35 rpm, and having a drying temperature of 120 to 160 F (49 to 71 C) measured in the exhaust vent as close as possible to the drying chamber.

6.4 *Drying Racks*, made of plastic (saran or velon) screening, with 16 openings/1 in. (25.4 mm).

6.5 *Extractor*—A centrifugal extractor of the laundry-type with a perforated basket, approximately 11 in. (280 mm) deep and 17 in. (430 mm) in diameter, with an operating speed of approximately 1500 rpm.⁹

6.6 *Measuring Scale*.¹⁰

6.7 *Detergent*, synthetic.¹¹

6.8 *Softener*—Sodium metaphosphate or sodium hexametaphosphate (if needed in hard water areas).

6.9 *Soap, Neutral*, conforming to Specification D 496, or to the Federal Specification (P-S-579a) on synthetic detergent.

NOTE 3—A stock solution of the soap may be prepared by dissolving 1 lb (0.45 kg) of chip soap in 1 gal (0.0038 m³) or 3.8 liter of hot water. When cooled this forms a thick homogeneous jelly which may be used as required.

6.10 *Flatiron*, approximately 3 lb (1.4 kg).

6.11 *Tension Presser*,¹² consisting of a padded ironing board from which clamping members extend on all four sides (Fig. 1). Two of the clamps are fixed to the edges of the board; two clamps move on guide rails opposite to the fixed clamps. The movable clamps travel on carriages which ride on rails and are drawn by suitable weights.

6.11.1 *Sets of Weights*, such that the load can be selected in the range from ½ to 4 lb (0.23 to 1.81 kg).

6.11.2 *Perforated Aluminum Plate*, ⅜ in. (4.8 mm) thick by 12 in. (305 mm), used to provide the drying surface.

6.11.3 *Special Template*, ⅛-in. by 9½-in. (1.6-by 241-mm) aluminum sheet with a 10-by 10-in. (102-by 102-mm) cutout conforming to Fig. 2.

6.12 *Knit Shrinkage Gage*,¹³ consisting of a set of 20 mounting pins set in guides in radial slots as shown in Fig. 3. Each pin is individually sprung to a tensioning member which is driven outwardly in the slot. The springs have an extension of 1 in. (25.4 mm) at 16 ± ½ oz (0.454 ± 0.014 kg) tension. The tensioning members shall have a common drive so that

the application of restorative force takes place simultaneously in all directions in the plane of the test specimen. The minimum diameter of the pin frame in the collapsed state shall be 11 in. (approx 280 mm) and the maximum diameter in the freely extended state (unloaded) shall be 14 in. (approx 350 mm). The surface of the apparatus in contact with the test specimen shall be uncluttered and polished so as to be essentially friction free.

NOTE 4—The tensions applied to the specimen by this gage are directly proportional to the residual shrinkage remaining in the specimen and will normally vary from point-to-point around the specimen and from specimen to specimen.

6.13 *Source of Live Steam.*

7. Number of Specimens

7.1 Unless otherwise agreed upon, as when specified in an applicable material specification, take a number of specimens such that the user may expect at the 95% probability level that the test result is no more than 10.0% of the average above or below the true average (that is, a theoretical average obtained from an infinite number of observations). Determine the number of specimens as follows:

7.1.1 *Reliable Estimate of v* —When there is a reliable estimate of v based upon extensive past records for similar materials tested in the user's laboratory as directed in the method, calculate the number of specimens using Eq 1:

$$n = (t^2 \times v^2) / A^2 = 0.0384 \times v^2 \quad (1)$$

where:

n = number of specimens (rounded upward to a whole number),

v = reliable estimate of the coefficient of variation of individual observations on similar materials in the user's laboratory under conditions of single-operator precision,

⁹ Extracting machines of the type described may be obtained from Bock Laundry Machine Co., Toledo, Ohio (Model 24 BC); American Laundry Machinery Co., Cincinnati, Ohio.

¹⁰ A mechanical marking device, and a measuring tape calibrated directly in percent dimensional change may be obtained from "Sanforized" Division, Cluett, Peabody and Co., Inc., Troy, N. Y.

¹¹ This type of detergent is available under varying trade names from almost all suppliers of detergents.

¹² The Tension Presser is available from the U. S. Testing Co., Inc., 1415 Park Ave., Hoboken, N. J.

¹³ The Knit Shrinkage Gage is available from the U. S. Testing Co., Inc., 1415 Park Ave., Hoboken, N. J.

$t = 1.960$, the value of Student's t for infinite degrees of freedom, for two-sided limits, and a 95% probability level ($t^2 = 3.842$), $A = 10.0\%$ of the average, the value of the allowable variation, and

$0.0384 =$ a value calculated from t^2/A^2 .

7.1.2 No Reliable Estimate of ν —When there is no reliable estimate of ν for the user's laboratory, Eq 1 should not be used directly. Instead, specify the fixed number of 24 specimens. This number of specimens is calculated using $\nu = 24.5\%$ of the average, which is somewhat larger value ν than is usually found in practice. When a reliable estimate of ν for the user's laboratory becomes available, Eq 1 will usually require fewer than 24 specimens.

8. Conditioning

8.1 Precondition the specimen by exposure to moving air for 4 h in the standard atmosphere for preconditioning textiles, having a relative humidity of 5 to 25% at a temperature of not over 122° F (50°C); then bring the sample to moisture equilibrium for testing in the standard atmosphere for testing textiles, having a relative humidity of $65 \pm 2\%$ at $70 \pm 2^\circ\text{F}$ ($21 \pm 1.1^\circ\text{C}$), as directed in Method D 1776.

9. Preparation of Specimens

9.1 Prepare specimens by one of the following procedures, depending upon which drying or restoration procedure is to be used.

9.2 Woven Fabrics to be Dried by Procedure B (Flat-Bed Press) or to be Restored by Procedure 3 (Hand Iron)—Cut specimens at least 22 by 22 in. (approximately 550 by 550 mm), except for fabrics narrower than 22 in., in which case the specimen width shall be that of the fabric. After conditioning as directed in Section 8, measure and mark off three test lengths, each measuring at least 18 in. (approximately 450 mm), except for fabrics narrower than 22 in. parallel to both the warp and three parallel to the filling directions. Make each mark at least 2 in. (approximately 50 mm) from the edge of the specimen.

9.3 Woven or Warp Knitted Fabrics to be Restored by Procedure 1 (Tension Presser)—Cut specimens at least 25 by 25 in. (approximately 635 by 635 mm). After conditioning as directed in Section 8, place the template on the fabric so that the sides of the 10-in. (254-mm)

square cut-out of the template are parallel to the warp and the filling (or to the wales and courses) and so that the same amount of fabric extends beyond the edges of the template on all sides. Mark the specimen at the outer edges of the template with pen and indelible ink. Place three dots on the specimen at each side of the 10 in. square, one dot approximately at the midpoint and one at approximately $\frac{1}{2}$ in. (12 mm) from each corner.

9.4 Knitted Fabrics to be Restored by Procedure 2 (Knit Shrinkage Gage)—Cut specimens approximately 16 in. (400 mm) square. After conditioning as directed in Section 8, mark the specimens with two concentric circles: a 10-in. (254-mm) diameter measuring circle and a 14-in. (approx 355-mm) diameter circle marked with 20 dots equally spaced at 18-deg intervals around the circumference as indicated on the template.

9.5 Garments—After conditioning as directed in Section 8, mark representative distances in both wale and course directions. Mark specimens by laying out without tension on a flat, polished surface, taking care that the fabric is free from wrinkles or creases. Mark with indelible ink and a fine-point pen, with fine threads sewn into the fabric, or with a specially designed stamping machine.⁸

10. Laundering Procedures

10.1 Place the specimen(s) in the wash wheel with sufficient other similar fabric to make a dry load of $3 \pm \frac{1}{4}$ lb (1.3 ± 0.1 kg). Start the wash wheel and note the time. Immediately add water at a temperature from 100 to 109 F (38 to 43 C) to a level of $7 \pm \frac{1}{2}$ in. (approximately 175 ± 10 mm); this level will be increased by condensed steam. When this water level has been reached, inject steam into the wheel until the temperature reaches that shown in Column 2 of Table 2. Add sufficient soap (and softener, if required to counteract hard water) to furnish a good running suds. For domestic automatic washers, use a synthetic detergent formulation in the amount recommended by the manufacturer of the detergent.

10.1.1 Washing Procedure 1—Stop the wash wheel at the end of the time shown in Column 1 and drain. Refill the machine to a level of 8.5 ± 0.5 in. (approx 215 ± 10 mm) with water from 100 to 109 F and start the

machine. Inject steam, if necessary, to reach the temperature shown in Column 4. Again stop the machine at the end of the time shown in Column 3. Repeat this procedure for the second rinse, using the temperatures and time shown in Columns 6 and 5.

10.1.2 *Washing Procedures II, III, IV, and V*—Run the machine continuously until completion of the washing test. Drain off the soap solution so that the wheel is substantially free from liquid at the end of the time shown in Column 1. Refill the machine with water from 100 to 109 F to a level of $8\frac{1}{2} \pm \frac{1}{2}$ in. When this water level has been reached, inject steam until the temperature is that shown in Column 4. Drain off the water at the end of the sum of times shown in Columns 1 and 3. Immediately refill with water at 100 to 109 F to a level of $8\frac{1}{2} \pm \frac{1}{2}$ in. When this water level has been reached, inject steam until the temperature is that shown in Column 6. Drain off the water at the end of the sum of times shown in Columns 1, 3, and 5. For Procedures II and III stop the wash wheel after the time listed in Column 5. For Procedures IV and V run the wash wheel without further addition of water, and stop it 60 min after the time it was started.

11. Drying Procedures

11.1 Dry specimens by one of the following procedures:

11.1.1 *Drying Procedure A (Drip Dry)*—Remove the specimen from the wheel (or from the automatic washer just before the water begins to drain for the final spin cycle) and hang it by two adjacent corners, with the warp in the vertical position, in still air at room temperature until dry.

11.1.2 *Drying Procedure B (Flat-Bed Press Dry)*—Remove the specimen from the wheel and centrifuge it until the flow of water from the extractor has substantially ceased. If an automatic washer is used, allow the washer to complete its full rinse and spin cycles. Smooth the extracted specimens to remove wrinkles, without distorting or stretching, and press dry on the flatbed press.

11.1.3 When the tests are to be made only for within-laboratory comparisons, the following modified technique may be used: Remove the specimen from the wash wheel and squeeze out the excess water by hand. Do

not wring, twist, or pass through squeeze rolls. Spread the specimen on a horizontal screen or similar perforated surface, remove wrinkles, but do not distort or stretch the fabric, and allow it to dry. Then dampen the specimen with water, allow to stand for 5 min, and press dry on the flat-bed press.

11.1.4 *Drying Procedure C (Screen Dry)*—Extract the specimen as described in 11.1.2, or spread it on a horizontal screen or similar perforated surface, remove wrinkles but do not distort or stretch the fabric, and allow it to dry.

11.1.5 *Drying Procedure D (Line Dry)*—Extract the specimen as described in 11.1.2 and hang it by two adjacent corners (or on a nonrusting hanger for garments) with the warp in the vertical position in still air at room temperature until dry.

11.1.6 *Drying Procedure E (Tumble Dry)*—Extract the specimen as described in 11.1.2, and then place it in a tumble dryer from 120 to 160 F (49 to 71 C) for 30 min, or until dry.

11.2 Condition the specimen in the standard atmosphere for testing textiles for at least 4 h.

11.3 Lay each specimen without tension on a flat polished surface and measure the distances between the marks to the nearest 0.1 in. or 1 mm.

12. Restoration Procedures

12.1 Where appropriate or specified, subject specimens to restorative forces by one of the following procedures:

12.1.1 *Restorative Procedure 1 for Woven Fabrics (Tension-Presser)*—If, after pressing on the flat-bed press, conditioning as directed in Section 8, and measuring the dimensional change, the shrinkage exceeds 2 percent, proceed as follows (if the change is 2 percent or less in both directions, the specimen would not normally require restoration) (Note 5): Cut out the corners of the specimen as indicated by the dotted lines in Fig. 2. Immerse the test specimen in tap water at approximately 100 F (38 C) until saturated. Centrifuge (Note 6) lightly until the water content of the specimen is about 100 percent of its dry weight. Place the damp specimen on the bed of the tension presser (Fig. 1) so that the marked lines (*AB* and *GH* in Fig. 2) on the two short flaps are between the fixed clamps. In the same manner, place the longer flaps so that the marked lines (*CD*

and *EF* in Fig. 2) are between the movable clamps. If necessary, stretch that portion of the fabric entering the clamp so that it fills the width of the clamp, being careful to avoid distortion of the measured area. Select the proper weights for both the warp and filling direction from Table 3. Apply the selected weights to both warp and filling simultaneously and gently. Allow the specimen to remain under this fixed load during the drying operation. Preheat the perforated drying plate by placing a heated flatiron on it until the temperature of the plate is approximately 300 F (149 C) (Note 7), then place the heated plate (with the iron maintained at a temperature of 300 F and *centrally located* on the plate) on the specimen which is under tension on the bed of the Tension Presser. Do *not* apply pressure to the iron. After 10 s, lift the flatiron and the plate for 5 s to allow steam to escape and then replace the assembly for another 10 s. Again lift the assembly for 5 s. This procedure is repeated as many times as necessary until no appreciable steam is released from the fabric and the specimen is completely dry. Remove the weights simultaneously, unfasten the fabric clamps and carefully remove the specimen from the Tension Presser in such a way that the specimen is not distorted. Press the *end tabs* of the specimen with the flatiron, being careful not to distort the 10-in. (254-mm) center square. Allow the specimen to lie flat, free from external tensions, and condition for a minimum of 4 h in the standard atmosphere for testing textiles before measuring. Measure the distances between the marks to the nearest 0.1 in. or 1 mm.

NOTE 5—Flat-bed pressed specimens have been subjected to some restorative forces during drying. Such restorative forces are sufficient for the great majority of woven fabrics which do not have the property of dimensional restorability.

NOTE 6—Gentle hand squeezing (so as not to distort the fabric specimen) may be used instead of a centrifuge if the latter is not available.

NOTE 7—Temperature can be measured with a surface pyrometer on other means.¹⁴

12.1.2 Restorative Procedure 1 for Warp Knitted Fabrics (Tension Presser)—After drying the specimens by Procedure E (tumble dry), cut out the corners of the specimen along the dotted lines as shown in Fig. 2 so that the specimen has two short and two

long flaps. Do not cut along the 13-in. dimension of each flap marked *AB*, *CD*, *EF*, and *GH* in Fig. 2. Then immerse the specimen in tap water for 15 min, or until completely wet out. Centrifuge lightly (30 s), and roll the specimen in a turkish towel, being careful not to distort the fabric. Remove after 5 min and place the damp specimen on the Tension Presser so that the two short flaps are between the fixed clamps with the marked lines, *AB* and *GH*, under the clamps. Fix the longer flaps in the movable clamp bars in the same way, except that the edges are flared out to as near the original measurement as possible. Apply 1-lb (0.45-kg) weights to both directions gently and simultaneously and allow the specimen to remain under this fixed tension until dry. To dry a specimen, place the preheated perforated drying plate on the fabric with the flatiron at a temperature of 300 F (149 C) on top of it (Fig. 1). Lift the iron and plate off the specimen after 10 s and allow the steam to escape for 5 s, then replace them on the specimen. Repeat this procedure until no appreciable steam is released. Then replace the plate and iron on the specimen and allow them to remain until the specimen is completely dry. Remove the weights, unclamp the bars, and carefully remove the specimen from the apparatus, being careful not to distort the fabric. Press the tabs of the specimen with the flatiron, taking care not to distort the 10-in. center square. Allow the specimen to lie flat in a standard atmosphere for a minimum of 4 h. Measure the distances between the marks to the nearest 0.1 in. or 1 mm.

12.1.3 Restorative Procedure 2 for Knitted Fabrics (Knit Shrinkage Gage)—After conditioning as directed in Section 8, mount the specimen on the pin frame in the fully collapsed state. To mount a specimen, insert a pin in each of the 20 premarked points in its perimeter. Operate the handwheel drive mechanism to bring the tensioning members to their outer extremities at a smooth and uniform rate. Measure the distance between corresponding points in each direction in a direct line along the central wale or course.

¹⁴ Tempil Stiks, supplied by Central Scientific Co., No. 13756, or equivalent, have been found satisfactory.