



Designation: **D2594 – 04 (Reapproved 2016) D2594 – 20**

Standard Test Method for Stretch Properties of Knitted Fabrics Having Low Power¹

This standard is issued under the fixed designation D2594; 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 covers the measurement of fabric stretch and fabric growth of knitted fabrics intended for applications requiring low-power stretch properties.~~ fabrics that exhibit high stretch and good recovery from low tension. Fabric stretch is measured when a known load is applied. Fabric growth is evaluated after a known extension is applied and subsequently removed.

1.2 ~~This test method includes.~~ The procedures for fabric growth and stretch and fabric growth can be used individually when required by individual specifications together, or individually.

1.3 ~~This test method is not applicable to.~~ While this test method can be used for a knit fabric, fabrics intended for support or other applications requiring high-power stretch properties are better evaluated using other test methods: [D3107](#), [D4964](#), [D6614](#).

*Note 1—*For information on testing high-power and woven stretch fabrics, refer to Test Methods [D3107](#) and [D6614](#).

1.4 The values stated in either SI or inch-pound units are to be regarded separately as the standard. Within the text, the inch-pound units are shown in parentheses. The values stated in each system are not exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

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:*²

[D123 Terminology Relating to Textiles](#)

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

[D2904 Practice for Interlaboratory Testing of a Textile Test Method that Produces Normally Distributed Data](#) (Withdrawn 2008)³

[D2906 Practice for Statements on Precision and Bias for Textiles](#) (Withdrawn 2008)³

[D3107 Test Methods for Stretch Properties of Fabrics Woven from Stretch Yarns](#)

[D4849 Terminology Related to Yarns and Fibers](#)

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

[D4964 Test Method for Tension and Elongation of Elastic Fabrics \(Constant-Rate-of-Extension Type Tensile Testing Machine\)](#)

[D6614 Test Method for Stretch Properties of Textile Fabrics – CRE Method](#)

3. Terminology

3.1 *Definitions:*

3.1.1 For definition of textile terms used in this test method: bench marks, refer to Terminology [D4849](#).

3.1.2 For definitions of textile terms used in this test method: fabric growth; fabric stretch; low-power stretch and tension, refer to Terminology [D4850](#).

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

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. Current edition approved July 1, 2016 July 1, 2020. Published July 2016 August 2020. Originally approved in 1969. Last previous edition approved in 2012 2016 as D2594 – 04(2012)(2016). DOI: 10.1520/D2594-04R16.10.1520/D2594-20.

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.

4. Summary of Test Method

4.1 *Fabric Growth*—Bench marks of a known distance are made on a fabric specimen. A specified tension is applied to a fabric specimen by a prescribed cycling technique. The tension is removed and after several specific recovery times under zero tension, the distance between the bench marks is remeasured after each time interval. The fabric growth is calculated from the length difference between the bench marks prior to application of the tension and after each respective recovery time interval. looped fabric specimen until it is extended to a specified elongation. The test specimen is held in place for 2 h. The percent change in the test specimen length is measured immediately after removal of the tension. The test specimen is then allowed one hour to recover without tension. The percent change in test specimen length is measured again after this recovery period.

4.2 *Fabric Stretch*—Bench marks of a known distance are made on a fabric specimen. A specified tension is applied to a fabric specimen by a prescribed cycling technique and the resulting distance between the bench marks measured. The fabric stretch is calculated from the length difference between the bench marks prior to application of the tension and under while under the tension and removed from a looped fabric specimen for five cycles. On the fifth time tension is applied, the tension is held and the percent change in the test specimen length is measured.

5. Significance and Use

5.1 This test method specifies test conditions for measuring the fabric growth and fabric stretch of knitted fabrics intended for use in swimwear, anchored slacks, and other form-fitting apparel (also commonly known as semi-support apparel) applications, as well as test conditions for measuring the fabric growth of knitted fabrics intended for use in sportswear and other loose-fitting apparel (also commonly known as comfort stretch apparel) applications. The applicability of this test method to the measurement of fabric growth and fabric stretch of knitted fabrics intended for use in slacks, sport coats, and suits has not been determined. Fabric stretch and fabric growth are useful in selection of fabrics that are required to stretch, but also recover to their original shape.

5.1.1 In apparel, fabric stretch can be caused by a variety of factors. A momentary stress occurs when a fabric is required to accommodate movement, such as sportswear and other loose-fitting apparel (also known as comfort stretch apparel) or external stress such as grabbing and pulling. Additionally, comfort apparel can be subjected to prolonged stress, such as stretching to accommodate positions such as sitting. Another example of prolonged stress occurs when a fabric is required to stretch to accommodate fitting the form of the body, such as swimwear, anchored slacks, and other form-fitting apparel (also known as semi-support apparel).

5.1.2 Fabric growth can also be in response to a variety of stresses. This method evaluates fabric growth due to exposure to prolonged stresses. In form-fitting apparel, fabric growth can apply as garments are worn for a prolonged period of time or under long periods of stress such as sitting. Upon removal of garments or stress, its growth can be seen and evaluated.

5.2 This test method is not recommended for acceptance testing of commercial shipment because the between-laboratory precision is known to be poor.

5.2.1 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, ensure the test samples to be used are as homogeneous as possible, are drawn from the material from which the disparate test results are obtained, and are assigned randomly in equal numbers to each laboratory for testing. The test results from the two laboratories should be compared using a statistical test for unpaired data, at a probability level chosen prior to the testing series. If a 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

6.1 *Frame*, suitable for supporting the hanger assembly illustrated in Fig. 1 and tension forces applied during testing.

6.2 *Hanger Assembly*, consisting of hangers, hanger rods, and chain.

6.3 *Lightweight Rule*, fitted with a pin hook at the zero point of the scale for attachment to the specimen, graduated either in units of percent of original gage length of 125 mm (5 in.) or in units of 1 mm ($1/16$ in.).

6.4 *Tensiometer or Weights*, that can be attached to the bottom hanger of the hanger assembly, capable of providing total tensions of 2.27 kgf (5 lbf) and 4.54 kgf (10 lbf) to the specimen, $\pm 1\%$.

6.5 *Turnbuckle*, or equivalent, having a length of 25 to 75 mm (1 to 3 in.).

6.6 *Sanforized Marker*, to establish bench marks on the specimen.

6.7 *Timer*, with increments of at least 1 min.

7. Sampling and Test Specs

7.1 *Primary Sampling Unit*—Consider rolls of fabric, fabric or fabric components of fabricated systems, or garments to be the primary sampling unit, as applicable.

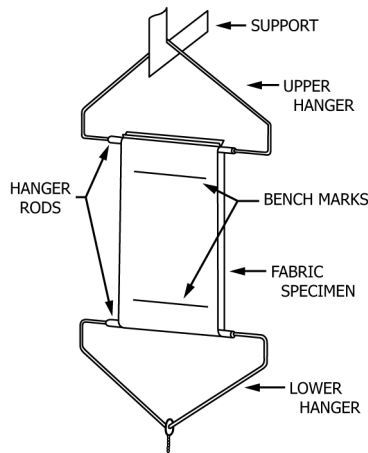


FIG. 1 Hanger Assembly

7.2 *Laboratory Sampling Unit*—As a laboratory sampling unit take from rolls at least one full-width piece of fabric that is 2 m (2 yd) in length along the selvage (machine direction), after removing a first 1 mm (1 yd) length. For fabric components of fabricated systems use the entire system. For garments use the entire garment.

7.3 *Test Specimens*—From each laboratory sampling unit, cut 56 wale-wise (lengthwise) and 56 course-wise (widthwise) test specimens 125 ± 3 mm (5 ± 0.1 in.) by 398400 ± 10 mm (15.5 ± 0.3 in.). Cut the long dimension of the wale-wise specimens parallel to the wale direction and the course-wise specimens parallel to the course direction. In cases where the fabric is designed to primarily stretch in one direction, testing is only required in the intended stretch direction. Take specimens representing a broad distribution from different positions diagonally across the width of the laboratory sampling unit. Consider the long direction as the direction of test. Label to maintain specimen identity.

7.3.1 For fabric widths 125 mm (5 in.) or more, take no specimen closer than 25 mm (1 in.) from the edges of the laboratory sampling unit.

7.3.2 For fabric widths less than 125 mm (5 in.), use the entire width of the laboratory sampling unit for specimens.

7.3.3 Garment samples may not allow for 125 mm specimen widths; use available width.

7.3.4 For fabric and lengths less than 400 ± 10 mm (15.5 ± 0.3 in.), use the longest available length from the sampling unit. In this case, distances between benchmarks may be measured with a metric rule.

7.3.5 Garment samples may not allow for 400 mm specimen lengths. Use available length. Ensure specimens are free of folds, creases, or wrinkles. Avoid getting oil, water, grease, etc., on the specimens when handling.

7.3.6 If the fabric has a pattern, ensure that the specimens are a representative sampling of the pattern.

7.3.7 After cutting, fold each specimen in half lengthwise forming a loop and sew the edges opposite the fold together 6 to 13 mm (0.25 to 0.50 in.) from the cut edges and parallel to the short direction of the specimen.

7.3.8 Lay the specimen on a flat surface and place bench marks 125 ± 3 mm (5 ± 0.01 in.) apart on the central section of one face of the looped specimen establishing a gage length along the length of the specimen. Record as measurement (A).

8. Conditioning

8.1 Bring the test specimens to moisture equilibrium for testing in the standard atmosphere for testing textiles as directed in Practice D1776, or if applicable, in the specified atmosphere in which the testing is to be performed.

9. Preparation of Test Apparatus and Calibration

9.1 Verify measuring scales and tension weights are within calibration.

10. Procedure

10.1 Test the test specimens in the standard atmosphere for testing textiles, as described in Practice D1776.

10.2 Handle the test specimens carefully to avoid altering the natural state of the material.

10.3 *Fabric Growth:*

10.3.1 Slide the specimen loop over the upper hanger rod and secure the rod in the hanger such that the seam of the loop lies along the rod.

10.3.2 Slide the folded end of the loop over the lower hanger rod and secure the rod to the hanger.

10.3.3 Place the upper hanger in the slot in the top bar of the supporting frame.

10.3.4 Attach the rule to the specimen loop by inserting the rule pin hook through the face of the fabric in the center of the upper bench mark.

10.3.5 Attach the chain by means of the turnbuckle to the lower hanger and extend the specimen loop to the amount specified in **Table 1**, that is, such that the lower bench marks lines up with the specified percentage stretch point on the scale.

NOTE 1—If the scale is in units of measurement, it is helpful to calculate the corresponding percentage.

10.3.6 Lock the chain in the corresponding notch in the lower crossmember of the frame. Adjust the turnbuckle to make minor adjustments of the position of the lower bench mark.

10.3.7 Allow the loop to remain in the extended position for $2\text{ h} \pm 5\text{ min}$.

10.3.8 After $2\text{ h} \pm 5\text{ min}$, unlock and release the chain and remove the lower hanger from the specimen loop.

10.3.9 Measure the position of the lower bench mark relative to the scale on the rule to the nearest 1 % of original gage length or 1 mm ($1/16\text{ in.}$) after recovery under no tension as follows:

10.3.9.1 After $60 \pm 5\text{ s}$ and record as measurement (B), and

10.3.9.2 After $1\text{ h} \pm 5\text{ min}$ record as measurement (C).

10.3.10 Remove the tested specimens, in turn, and continue as directed in **10.3** until three specimens for each the wale and course directions have been tested for each laboratory sampling unit.

10.4 *Fabric Stretch:*

10.4.1 Place a new specimen in the stretch testing equipment as directed in **10.3.1 – 10.3.4**.

10.4.2 Attach the tensiometer to the lower hanger, grasp and manually exercise the specimen loop by cycling four times between 0 to 2.27 kgf (0 to 5 lbf) for loose-fitting (comfort stretch) apparel fabrics, or between 0 and 4.54 kgf (0 and 10 lbf) for form-fitting (semi-support) apparel fabrics allowing 4 to 6 s to complete each cycle.

10.4.2.1 Weights that provide the same tension can be used in place of the tensiometer.

NOTE 2—The choice of the cycling force should be based on the intended end use of the fabric being tested. If the intended end use is not known, the fabric growth and fabric stretch may be determined using both the loose-fitting and the form-fitting apparel test conditions.

10.4.3 Continue and begin a fifth cycle holding the tensiometer at the specified tension force for 5 to 10 s, then measure the position of the lower bench mark relative to the scale on the rule to the nearest 1 % of original gage length or 1 mm ($1/16\text{ in.}$) while under tension. Record as measurement (D).

10.4.4 Remove the tested specimens, in turn, and continue as directed in **10.4** until ~~two~~**three** specimens for each the wale and course directions have been tested for each laboratory sampling unit.

11. Calculation

11.1 If the scale is graduated in percent of original gage length, read the percent fabric growth and fabric stretch directly from the scale to the nearest 1 %, otherwise, use the calculations in **11.1.1**.

11.1.1 Calculate the fabric growth and fabric stretch properties of individual specimens to the nearest 1 % using **Eq 1-3**, as applicable.

$$\text{Fabric Growth}_{60\text{s}}, \% = 100 \times (B - A)/A \quad (1)$$

$$\text{Fabric Growth}_{1\text{h}}, \% = 100 \times (C - A)/A \quad (2)$$

$$\text{Fabric Stretch}, \% = 100 \times (D - A)/A \quad (3)$$

where:

A = original distance between bench marks prior to tension force, mm (in.) (from **7.3.6**);

\bar{A} = original distance between bench marks prior to tension force, mm (in.) (from **7.3.8**);

B = distance between bench marks, mm (in.) measured after release of the tension, force following 60 s recovery, (from **10.3.9.1**),

C = distance between bench marks, mm (in.) measured after release of the tension, force following 1 h recovery, (from **10.3.9.2**), and

D = distance between bench marks, mm (in.) measured while specimen is under tension force (from **10.4.3**).

11.2 Calculate the average of three specimens to the nearest 1 % for the fabric growth calculated in **11.1** for the laboratory sampling unit and for the lot, as applicable.

11.3 Calculate the average of two specimens to the nearest 1 % for the fabric stretch calculated in **11.1** for the laboratory sampling unit and for the lot, as applicable.

TABLE 1 Specimen Stretch Percentage Points

Apparel Type	Wale Direction	Course Direction
Loose-fitting (comfort stretch)	15	30
Form-fitting (semi-support)	35	60