Designation: D 204 – 97

Standard Test Methods for Sewing Threads[1]

This standard is issued under the fixed designation D 204; 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 These test methods can be used to evaluate sewing threads of any fiber.

1.1.1 The test methods in this standard are intended to evaluate only sewing thread taken from thread holders.

1.2 These test methods only provide for the measurement of sewing thread physical properties. These test methods do not address any other properties that may be important for the satisfactory performance of sewing threads under particular end use conditions.

1.3 These test methods can be used to measure the following properties:

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Colorfastness to Drycleaning	73-83
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NOTE 1—For methods covering tests on prepared seams, refer to Test Methods D 1683 and D 3940.[2]

1.4 The values stated in SI units are to be regarded as standard; the values in English units are provided as information only and are not exact equivalents.

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

2. Referenced Documents

2.1 *ASTM Standards:*

D 76 Specification for Tensile Testing Machines for Textiles[3]

D 123 Terminology Relating to Textiles[3]

D 1422 Test Method for Twist in Yarns by the Untwist-Retwist Method[3]

D 1423 Test Method for Twist in Yarns by the Direct-Counting Method[3]

D 1683 Test Method for Failure In Sewn Seams of Woven Fabrics[3]

D 1776 Practice for Conditioning Textiles for Testing[3]

D 1777 Method for Measuring Thickness of Textile Materials[3]

D 1907 Test Method for Yarn Number by the Skein Method[3]

D 2256 Test Method for Tensile Properties of Yarns by the Single-Strand Method[3]

D 2258 Practice for Sampling Yarn for Testing[3]

D 2724 Test Methods for Bonded, Fused, and Laminated Apparel Fabrics[3]

D 3693 Specification for Labeled Length per Holder of Sewing Threads[2]

D 3823 Practice for Determining Ticket Numbers for Sewing Threads[2]

D 3940 Test Method for Bursting Strength (Load) and Elongation of Sewn Seams of Knit or Woven Stretch Textile Fabrics[2]

2.2 *AATCC Standards:*

Method 135 Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics[4]

Evaluation Procedure 1, Gray Scale for Color Change[4]

Evaluation Procedure 3, Chromatic Transference Scale[4]

2.3 *Federal Standard:*

Fed. Std. No. 751a Stitches, Seams, and Stitchings[5]

3. Terminology

3.1 *Definitions:*

3.1.1 *colorfastness, n*—the resistance of a material to change in any of its color characteristics, to transfer its colorant(s) to adjacent materials, or both, as the result of exposure of the material to any real or simulated environment

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[2] *Annual Book of ASTM Standards*, Vol 07.02.

[3] *Annual Book of ASTM Standards*, Vol 07.01.

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

[5] Available from Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA 19120.

that might be encountered during processing, storage, use of testing of the material.

3.1.2 *core yarn*, *n*—deprecated term; see *covered yarn*.

3.1.3 *core-spun yarn*, *n*—a compound structure in which a filament or strand serves as an axis around which a cover of either loose fiber or a yarn is wound.

3.1.3.1 *Discussion*—(1) *General*—In yarn testing, when the core and cover in this type of compound structure need to be separated, for testing of either component, the methods used should not compromise the physical properties of the component to be evaluated; and (2) *Specific*—as a sewing thread, the means by which this compound structure is made will not allow the core and cover to be readily separated without compromising the physical attributes of each component. Hence, the sewing thread should be evaluated as a compound structure.

3.1.4 *covered yarn*, *n*—a compound structure which contains distinguishable inner and outer fibrous elements which can be different.

3.1.5 *elongation*, *n*—the ratio of the extension of a material to the length of the material prior to stretching. (Compare **extension**).

3.1.6 *greige thread*, *n*—undyed or unfinished sewing thread in the state following final plying or equivalent step in processing sequence, such as extruding, or braiding.

3.1.7 *growth*, *n*—an increase in one or more dimensions of an object or material.

3.1.8 *knot-breaking force*, *n—in tensile testing*, the breaking force of a strand having a specified knot configuration tied in the test specimen portion of a strand mounted between the clamps of a tensile testing machine.

3.1.9 *loop-breaking force*, *n—in tensile testing*, the breaking force of a specimen consisting of two lengths of strand from the same supply looped together in a specified configuration and mounted between the clamps of a tensile testing machine.

3.1.10 *sew*, *v*—to unite or fasten with stitches.

3.1.10.1 *Discussion*—In textiles, sewing usually involves a needle and sewing thread.

3.1.11 *sewing force*, *n*—the force applied to a sewing thread at the needle eye during penetration of a material by the needle.

3.1.12 *sewing thread*, *n*—a flexible, small-diameter yarn or strand, usually treated with a surface coating lubricant, or both, intended to be used to stitch or join one or more pieces of material or an object to a material.

3.1.12.1 *Discussion*—Sewing threads are primarily made of textile fibers but may be made from such non-textile materials as stainless steel filaments.

3.1.13 *shrinkage*, *n*—a decrease in one or more dimensions of an object or material.

3.1.14 *stitch*, *n—in sewing*, the configuration of the interlacing of sewing thread in a specific repeated unit. (See stitching stitch type).

3.1.15 *stitching*, *n*—a series of stitches embodied in a material or materials of planar structure such as woven textile fabrics, usually for ornamental purposes or finishing an edge, or both.

3.1.16 *stitch type*, *n—in sewn seams*, a numerical designation relating to the essential characteristics of the interlacing of sewing thread(s) in a specified stitch.

3.1.17 *tex*, *n*—a unit for expressing linear density, equal to the mass in grams of 1 km of yarn, filament, fiber, or other textile strand. (Compare tex ticket number).

3.1.17.1 *Discussion*—Tex is not the same as tex ticket number.

3.1.18 *tex ticket number*, *n*—the designator assigned to a sewing thread to indicate the approximate linear density. (Compare tex).

3.1.18.1 *Discussion*—This designator represents a size variation which will range from 3 number apart up to 50 numbers apart. The narrow range is important so that there is not a wide disparity in the linear density of the sizes indicated by a single designator. The wider range of numbers designate heavier (coarser) yarns where the difference in yield is less of a critical factor relative to the linear density.

3.1.19 *thread holder*, *n*—the support package on which sewing yarn is wound.

3.1.19.1 *Discussion*—This support package enables sewing yarn to be securely placed for subsequent transportation, storage and utilization at the point of use. The support packages may be in the form of a cone, spool, tube, or bobbin.

3.1.20 *ticket number*, *n*—the tex ticket number assigned to a sewing thread to designate the approximate linear density of the sewing thread.

3.1.20.1 *Discussion*—The ticket number is an indicator of the minimum amount of fiber present. The smaller the number, the finer the thread (lesser amount of fiber), and the larger the number, the coarser the thread (greater amount of fiber).

3.1.21 *twist*, *n*—the number of turns about its axis per unit of length observed in a yarn or other textile strand.

3.1.22 *twist balance*, *n—in glass fiber cord and sewing thread*, the relationship of primary and final twist to each other and to the cord size such that residual torsional effects are nullified.

3.1.23 *yarn number*, *n*—a measure of the fineness or size of a yarn expressed as “mass per unit length” or “length per unit mass,” depending on the yarn numbering system. (Compare tex: tex ticket number).

3.1.24 For definitions of other textile terms used in these test methods, refer to Terminology D 123.

4. Significance and Use

4.1 *Acceptance Testing*—The test methods in Test Methods D 204 for the determination of the properties of sewing thread are considered satisfactory for acceptance testing of commercial shipments of sewing thread, unless specified in the individual test method. These test methods are the best available and are used extensively in the trade.

4.1.1 In cases of a dispute arising from differences in reported test results when using Test Methods D 204 for acceptance testing of commercial shipments, the purchaser and the supplier should conduct comparative tests to determine if there is a statistical bias between their laboratories. Competent statistical assistance is recommended for the investigation of bias. As a minimum, the two parties should take a group of test specimens which are as homogeneous as possible and which are from a lot of material of the type in question. The test specimens should then be randomly assigned in equal numbers

to each laboratory for testing. The average results from the two laboratories should be compared using Student's t-test for unpaired data and an acceptable probability level chosen by the two parties before the testing begins. If a bias is found, either its cause must be found and corrected or the purchaser and the supplier must agree to interpret future test results in the light of the known bias.

5. Sampling

5.1 *Lot Sample*—As a lot sample for acceptance testing, take at random the number of shipping units directed in an applicable material specification or other agreement between the purchaser and the supplier, such as an agreement to use Practice D 2258. Consider shipping cases or other shipping units to be the primary sampling units.

NOTE 2—An adequate specification or other agreement between the purchaser and the supplier requires taking into account variability between shipping units, between packages, or ends within a shipping unit, and between specimens from a single package so as to provide a sampling plan with a meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

5.2 *Laboratory Sample*—As a laboratory sample for acceptance testing, take at random from each shipping unit in the lot sample the number of packages or ends directed in an applicable material specification or other agreement to use Practice D 2258. Preferably, the same number of packages should be taken from each shipping unit in the lot sample. If differing numbers of packages are to be taken from shipping units in the lot sample, determine at random which shipping units are to have each number of packages drawn.

5.3 *Test Specimens*—From each package in the laboratory sample, take three specimens, unless otherwise specified. When packages contain more than one parallel wound end, select one end from which to prepare the three specimens.

6. Conditioning

6.1 For those tests requiring conditioned specimens, precondition the prepared specimens for at least 3 h in an atmosphere with relative humidity between 10 and 25 % and a temperature not exceeding 50°C (122°F).

6.2 After preconditioning, expose the specimens to moving air in the standard atmosphere for testing textiles, 21 ± 1°C (70± 2°F) and 65 ± 2 % relative humidity, until the mass of the specimen(s) increases by no more than 0.1 % after 2 h in the standard atmosphere.

YARN NUMBER

7. Scope

7.1 This test method determines the resultant yarn number of all types of sewing threads taken from a thread holder.

8. Summary of Test Method

8.1 A measured length of conditioned thread is wound on a reel and weighed. The resultant yarn number is expressed in tex.

9. Significance and Use

9.1 This test method should be used in conjunction with Practice D 3823 to designate tex ticket numbers.

10. Apparatus

10.1 *Reel*:

10.1.1 *General*—A hand or motor-driven reel having a specified perimeter. The reel shall be fitted with a traversing mechanism that will avoid bunching the successive wraps, and with an indicator of the length wound. A warning bell that will ring at a specified length is recommended. It is advisable that one arm be collapsible to allow for easy removal of skeins.

10.2 *Balance*:

10.2.1 For the determination of mean yarn number, a balance of suitable capacity graduated in grams with a sensitivity of 1 part in 100.

10.2.2 For ascertaining the completion of conditioning, a balance of suitable capacity graduated in grams with a sensitivity of 1 part in 1000 needed.

11. Conditioning

11.1 Use skeins wound with the given wraps as noted in Table 1 and follow the directions given in Section 6.

TABLE 1 Number of Wraps for Determining Resultant Yarn Number

Resultant Yarn Number	1-m Reel Perimeter	1.5 yd Reel Perimeter
All thread finer than 250 tex	100 wraps 100 m	80 wraps 120 yd
All threads 250 tex and coarser	10 wraps 10 m	8 wraps 12 yd

TABLE 2 Number of Wraps to be Reeled in Any One Skein in Checking Length by Skein Method

Resultant Yarn Number	1-m Reel Perimeter	1.5 yd Reel Perimeter
All thread finer than 50 tex	200 wraps 200 m	200 wraps 300 yd
Threads of 50 tex up to 100 tex	100 wraps 100 m	100 wraps 150 yd
All threads 100 tex and coarser	50 wraps 50 m	50 wraps 75 yd

12. Procedure

12.1 Determine the resultant yarn number in tex as directed in Option 1 of Test Method D 1907, except that in place of Table 2 in D 1907 use Table 1 of Test Methods D 204.

13. Report

13.1 State that the specimens were tested as directed in Test Methods D 204. Describe the material(s) or product(s) sampled and the method of sampling used.

13.2 Report the following information:

13.2.1 Mean yarn number to three significant figures,

13.2.2 Coefficient of variation of yarn number to two significant figures,
13.2.3 Reel perimeter,
13.2.4 Length of skein, and
13.2.5 Number of specimens.

14. Precision and Bias

14.1 The precision and bias of Methods D 204 for testing yarn number are as given in Test Method D 1907.

STRENGTH AND ELONGATION

15. Scope

15.1 This test method can be used to determine single strand breaking force and elongation of sewing threads. Single strand testing includes loop strength, knot strength and elongation at sewing forces.

16. Summary of Test Method

16.1 Single strand yarn specimens are broken on a tensile testing machine at a predetermined elongation rate and the tensile properties are determined.

16.2 The test method offers the following three physical configurations of the specimen:
16.2.1 straight,
16.2.2 looped,
16.2.3 knotted.

17. Significance and Use

17.1 There are several properties of sewing thread that are significant with regards to sewing and seam performance, including: straight breaking strength, loop breaking strength, loop elongation, elongation at sewing force, and knot strength.

17.1.1 *Straight Strength*—The straight breaking strength of a thread can be used to calculate the loop breaking strength once a regression equation has been determined because the loop properties are strongly dependent on the straight strength.

17.1.2 *Loop Strength*—The loop breaking strength is a measure of the thread's ability to contribute to seam performance. Loop breaking strength of a thread bears a direct relationship to stitch breaking strength and hence to seam breaking strength.

17.1.3 *Loop Elongation*—The loop elongation of the thread is one important factor contributing to elongation of a seam, along with the stitch and seam type, the number of stitches per inch, and the nature of the material stitched.

17.1.4 *Elongation at Sewing Force*—The elongation at sewing force of a thread influences its behavior during the stitching cycle on a sewing machine.

17.1.5 *Knot Strength*—The reduction in breaking force due to the presence of a knot is considered a measure of the brittleness of the thread.

18. Conditioning

18.1 Condition the specimens as directed in Section 6 of these Test Methods D 204.

19. Procedure

19.1 *Straight Strength and Elongation*:

19.1.1 *Conditioned Threads*—Select conditioned specimens and determine breaking force and elongation as directed in Option A1 of Test Method D 2256 except that a 250 ± 3 mm (10.0 ± 0.1 in.) or 500 ± 5 mm (20.0 ± 0.2 in.) gage length and a constant-rate-of-extension (CRE) type tensile testing machine having a jaw separation rate of 300 ± 10 mm/min (12.0 ± 0.5 in./min) shall be used. Disregard the 20 s to break requirement.

19.1.2 *Wet Threads*—Select conditioned specimens and determine the breaking force and elongation as directed in Option A2 of Test Method D 2256 except that a CRE type testing machine having a jaw separation rate of 300 ± 10 mm/min (12.0 ± 0.5 in./min) shall be used. Disregard the 20 s to break requirement.

19.2 *Loop Strength*—Select conditioned specimens and determine the loop breaking force as directed in Option C1 of Test Method D 2256. Disregard the 20 s to break.

19.3 *Knot Strength*—Select conditioned specimens and determine the knot breaking force as directed in Option B1 of Test Method D 2256. Disregard the 20 s to break.

19.4 *Elongation at Sewing Forces*—Test the specimens as directed for conditioned thread in 19.1.1. Read the elongation from the force elongation chart or display at the force specified for the needle thread of the seam to be sewn.

19.4.1 If the force on the needle thread is not known, a guideline for sewing elongation can be obtained by reading the force-extension chart, or display at a force of 227 g (½ lb) for thread used for seams in light-weight fabrics in the 0.135 to 270 g/m^3, or (4 to 8 oz/yd^3) range and at a force of 340 g (¾ lb) for thread used for seams in heavy fabrics 270 to 0.520 g/m^3 (8 to 15 oz/yd^3).

20. Report

20.1 State that the specimens were tested as directed in Test Methods D 204. Describe the material(s) or product(s) sampled and the method of sampling used.

20.2 Report the following information:
20.2.1 Options if other than A1,
20.2.2 Testing machine type if other than CRE,
20.2.3 Gage length tested,
20.2.4 Number of specimens tested,
20.2.5 The average of the breaking forces for a sample is the sample breaking strength.
20.2.6 Average and coefficient of variation of percent elongation at break or at specified force as determined for single-strand, knot and loop configurations, and
20.2.7 Average elongation at sewing forces, loop elongation, either or both, if determined.

21. Precision and Bias

21.1 The precision and bias of Test Methods D 204 for

testing strength and elongation are as specified in Test Method D 2256.

TWIST

22. Scope

22.1 This test method determines the amount and direction of twist at the completion of any stage of twisting in single (spun or filament), plied, or cabled thread. The procedures are designed primarily for thread on holders.

23. Summary of Test Method

23.1 The turns of twist in a known length of thread are counted as they are being removed by rotating one end of the specimen while the other end remains fixed until the elements of the yarn being tested are parallel and free from twist. Twist is reported as the number of turns required to untwist the thread, per unit length.

24. Significance and Use

24.1 Twist is an important factor for determining the ability of a sewing thread to withstand sewing forces and provide strength to the seam.

25. Procedure

25.1 Determine the amount of twist in the component elements of a plied, or cabled thread made on the Linen, or Worsted Spinning System as directed in Test Method D 1423, except take the conditioned specimen directly from the side of the thread holder for testing.

25.2 Determine the amount of ply twist in a plied, or the component elements of a cabled thread made on the Cotton Spinning System as directed in Test Method D 1423, except take the conditioned specimen directly from the side of the thread holder for testing. Determine the singles twist as directed in Test Method D 1422.

26. Report

26.1 State that the specimens were tested as directed in Test Methods D 204. Describe the material or produce sampled and the method of sampling used.

26.2 Report the following information:

26.2.1 Average single, plied, and cabled thread twist in turns per metre to the nearest whole number of turns per inch to one decimal.

26.2.2 Standard deviation and coefficient of variation, if calculated,

26.2.3 Direction of each twist, S or Z.

26.2.4 Length of test specimens, in millimetres or inches.

26.2.5 Tension used, if different from that specified in Test Methods D 1423 or D 1422.

27. Precision and Bias

27.1 The precision and bias of Test Methods D 204 for testing twist are as specified in Test Method D 2256.

TWIST BALANCE

28. Scope

28.1 This test method determines the tendency of thread to twist on itself when held in loop form.

29. Summary of Test Method

29.1 The thread is held in loop form and its tendency to twist is noted.

30. Significance and Use

30.1 This test method is important in predicting the kinking and snarling tendency of thread during actual sewing operation.

31. Procedure

31.1 Withdraw about 1 m of conditioned thread from the holder in the same manner as that in which the thread is delivered to the sewing machine. Cut the thread and form the segment in a loop with the free ends about 100 mm (4 in.) apart. Suspend the loop in a draft-free environment and let the thread twist on itself until it comes to rest.

31.2 Count the number of complete revolutions made by the thread as an indication of twist balance.

NOTE 3—A twist tester may be used to determine the number of revolutions.

32. Report

32.1 State that the specimens were tested as directed in Test Methods D 204. Describe the material(s) or product(s) sampled and the method of sampling used.

32.2 Report the number of complete revolutions specimen and the average of all specimens.

33. Precision and Bias

33.1 *Precision*—For the components of variance in Table 3,

TABLE 3 Components of Variance as Standard Deviations, Units as Indicated

Names of Properties	Single-Operator Component	Within-Laboratory Component	Between Laboratory Component
Twist balance, turns	0.0100	0.0100	0.200
Length, m	1.69	0.000	1.67
Diameter, mm	0.025	0.025	0.025
Shrinkage, wet or dry percentage points	0.310	0.310	0.340

two averages of observed values should be considered significantly different at the 90 % probability level if the difference equals or exceeds the critical differences tabulated in Table 4.

33.2 *Bias*—The procedure in Test Methods D 204 for measuring twist balance has no bias because the true value of the twist properties can be defined only in terms of a test method.

TABLE 4 Critical Difference,[A] Units as Indicated, for the Conditions noted

Name of Properties	Number Observations in Each Average	Single-Operator Precision	Within Laboratory Precision	Between Laboratory Precision
Twist balance, turns	1	0.0232	0.0329	0.466
	3	0.0134	0.0268	0.466
	5	0.0104	0.0254	0.466
	10	0.00735	0.0244	0.466
Length, m	1	3.93	3.93	5.53
	3	2.27	2.27	4.50
	5	1.76	1.76	4.26
	10	1.24	1.24	4.08
Diameter, mm	1	0.058	0.082	0.100
	3	0.034	0.067	0.089
	5	0.026	0.064	0.086
	10	0.018	0.061	0.084
Shrinkage, wet or dry percentage points	1	0.721	1.02	1.29
	3	0.416	0.833	1.15
	5	0.322	0.790	1.12
	10	0.228	0.756	1.09

[A] The critical differences were calculated using t = 1.645, which is based on infinite degrees of freedom.

LENGTH PER THREAD HOLDER

34. Scope

34.1 This test method determines sewing thread lengths wound on a thread holder.

35. Summary of Test Method

35.1 The length of sewing thread on a thread holder is measured by winding the thread from the thread holder onto a reel of known perimeter into skeins of specified wraps (see Table 2) and any residual part skeins and counted wraps. The total length is the sum of the full skeins and length of any part skein.

36. Significance and Use

36.1 This test method is used to establish the length per thread holder when thread is being sold on a length basis.

37. Apparatus

37.1 *Reel*:

37.1.1 *General*—A hand or motor-driven reel having a specified perimeter. The reel shall be fitted with a traversing mechanism that will avoid bunching the successive wraps, and with an indicator of the length wound. A warning bell that will ring at a specified length is recommended. It is advisable that one arm be collapsible to allow for easy removal of skeins.

38. Sampling

38.1 Sample as directed in Specification D 3693.

39. Procedure

39.1 Determine the tension for reeling as directed in Test Method D 1907. The thread need not be measured for length per thread holder in the standard atmosphere for testing textiles.

39.2 Remove the thread from the holder by reeling skeins having the length specified in Table 2. Determine the length of the final part skein in metres (yards) by counting the number of complete revolutions of the reel and by measuring the length of the last partial wrap to the nearest 0.1 m (4 in.).

40. Calculation

40.1 Calculate the total length of each thread holder to the nearest 1 m (1 yd) for holders with nominal length in excess of 100 m (150 yd) and to the nearest 0.1 m (4 in.) for holders with nominal length of 100 m (150 yd) or less, using Eq 1:

$$\text{Length of thread holder, m} = A \pm B \pm C \quad (1)$$

where:

A = number of whole skeins times length per skein,
B = number of complete wraps in last partial skein times metres per wrap and,
C = length of last partial wrap on the reel, m (yd).

40.2 Calculate the average length per holder of sewing thread for the lot sample.

41. Report

41.1 State that the specimens were tested as directed in Test Methods D 204. Describe the material(s), or product(s) sampled and the method of sampling used.

41.2 Report the individual lengths per holder, and the average length based on the lengths on all the holders tested.

42. Precision and Bias

42.1 *Precision*—For the components of variance in Table 3, two averages of observed values should be considered significantly different in the 90 % probability level if the difference equals or exceeds the critical differences tabulated in Table 4.

42.2 *Bias*—The procedure in Test Methods D 204 for measuring length per thread holder has no bias because the true value of the length properties can be defined only in terms of a test method.

DIAMETER

43. Scope

43.1 This test method determines thread diameter either by a thickness gage (preferred procedure) or by optical measurements.

44. Summary of Test Method

44.1 Segments of thread are placed on the stage of a thickness gage and the diameter is the thickness read from the gage. Optionally, segments of thread are placed on a rotatable microscope stage and their diameters are measured using a calibrated eyepiece.

45. Significance and Use

45.1 A knowledge of thread diameter is important because diameter can affect sewing performance and seam appearance. Sewing performance can be affected because the thread is required to pass through restrictions such as the needle eye and tension disks. Seam appearance can be adversely affected when the diameter of the thread is large enough to displace fabric yarn and result in a puckered seam.

45.1.1 Thread diameter is also a consideration when selecting sewing threads for embroidery, contrast stitching, or other decorative applications since cover is important with such threads.

45.2 *Acceptance Testing*—The optical procedure for testing sewing threads for diameter is not recommended for acceptance testing of commercial shipments since the optical procedure suffers from difficulty in determining the exact boundaries of threads having protruding fibers on the surface.

46. Apparatus

46.1 *Thickness Gage Procedure*:

46.1.1 *Thickness gage*, as described in Test Method D 1777, with a presser foot diameter of 9.52 ± 0.02 mm (0.375 ± 0.001 in.). The presser foot and moving parts connected therewith shall be weighted to apply a total force of 1.67 ± 0.03 N (6 ± 0.1 oz) equivalent to a pressure of 23.4 kPa (3.5 psi).

46.2 *Optical Procedure*:

46.2.1 *Microscope*, having a stage that can be rotated to bring the thread parallel to the movable cross hair in the eyepiece, a magnification to allow the thread to cover approximately one quarter of the field of view, and either a micrometer eyepiece with a scale, or a filar micrometer eyepiece.

46.2.2 *Mounting Plate*, with clips or other means suitable for holding thread at a constant tension sufficient to remove slack without stretching the specimen while it is measured on the microscope stage.

47. Procedure

47.1 *Thickness Gage*:

47.1.1 Draw the thread from the side of the holder, taking care not to disturb the twist. Place four strands of the thread side by side on the anvil and approximately mid-way between the sides of the presser foot of the thickness gage.

47.1.2 Read the thickness from the gage indicator to the nearest 0.02 mm (0.001 in.) and record this as the diameter of the thread.

47.1.3 Remove at least 300 mm (12 in.) of thread from the holder.

47.1.4 Repeat 47.1.1-47.1.3 to obtain a total of ten readings.

47.2 *Optical*:

47.2.1 Draw the thread from the side of the holder, taking care not to disturb the twist. Mount the thread on the movable stage of the microscope using the mounting plate. Take care that no change in twist occurs and that the tension applied is sufficient to remove slack without appreciably stretching the thread. Rotate the stage until the thread is parallel to the movable cross hair.

47.2.2 Determine the diameter of the thread to the nearest 0.02 mm (0.001 in.) as the difference in the micrometer settings when the cross hair is moved from one edge of the thread to the other.

47.2.3 Repeat 47.2.1 and 47.2.2 for a total of 20 measurements on segments of thread separated by at least 300 mm (12 in.).

48. Calculation

48.1 Calculate the average of the ten thickness gage values recorded in 47.1 or 20 optically measured values recorded in 47.2 for each thread holder to the nearest 0.02 mm (0.001 in.).

48.2 Calculate the average for the lot to the nearest 0.02 mm (0.001 in.).

49. Report

49.1 State that the specimens were tested as directed in Test Methods D 204. Describe the material(s) or product(s) sampled and the method of sampling used.

49.2 Report the following information:

49.2.1 The procedure used,

49.2.2 The average diameter of the sewing thread on each thread holder, and

49.2.3 The average diameter of the sewing thread in the lot.

50. Precision and Bias

50.1 *Precision*—For the components of variance in Table 3, two averages of observed values should be considered significantly different at the 90 % probability level if the difference equals or exceeds the critical differences tabulated in Table 4.

50.2 *Bias*—The procedure in Test Methods D 204 for measuring diameter has no bias because the value of the diameter properties can be defined only in terms of a test method.

SHRINKAGE, SINGLE STRAND

51. Scope

51.1 This test method determines single strand thread shrinkage due to exposure to boiling water or dry heat.

52. Summary of Test Method

52.1 A conditioned single strand of thread is tied in a loop and measured under a prescribed tensioning force before and after exposure to boiling water or dry heat. The change in length is expressed as a percentage of the length before exposure.

53. Significance and Use

53.1 Shrinkage in sewing thread is of interest because it can cause puckering along seams, adversely affecting seam appearance.

53.1.1 A knowledge of the shrinkage in sewing thread by itself is not a sound basis for predicting the effect the thread shrinkage will have on seam shrinkage. Any combination of the following can alter the effects of sewing thread shrinkage on the seam: the construction and mass of the seamed fabric, the nature of the seam assembly, or the tensions on the sewing thread during the sewing operation.

54. Apparatus

54.1 *Vertical Stand with Hook*—A stand to which is affixed a measuring scale with the hook located at the top of the measuring scale so that the top of a loop of thread when hung on the hook will coincide with the zero index of the measuring scale.

54.2 *Measuring Scale*, graduated in increments of 1 mm.

54.3 *Roller Wringer or Centrifugal Extractor*.

54.4 *Drying Oven*—A ventilated drying oven maintained at a temperature of 65 ± 3°C (150 ± 5°F) in which the specimens are not exposed to direct radiation from the heating units.

54.5 *Tensioning Weights*, accurate to 1 part in 1000, and having the mass needed for the yarn number of the specimen. (See 52.1).

54.6 *Metal Hook*, designed to hang from the specimen and shaped to receive the tensioning weights. The mass of the hook is to be included in determining the tension force applied to the specimen.

54.7 *Treating Oven*—A forced-draft, quick-recovery oven that can be maintained at 176 ± 3°C (350 ± 5°F) in which the yarn specimens are not exposed to direct radiation from the heating units.

55. Number of Test Specimens

55.1 Take three specimens from each laboratory sample unit.

NOTE 4—Each specimen should be taken at points separated from each other by at least 90 m (100 yd).

56. Preparation of Test Specimens

56.1 After discarding the outer-layer of thread from the holder, remove an approximately 1200 mm (47 in.) length of thread from the holder and form a loop by knotting the ends together.

56.2 Place the specimen on the hook of the vertical stand and position the knot to rest on the hook. Using care that the loop does not twist back upon itself, hang the metal hook and appropriate tensioning weights on the free end of the loop.

56.2.1 Select the appropriate weight(s) for applying a tensioning force equal to 10 mN/tex (1 g/den) based on the tex (denier) of the original strand.

56.3 Measure the length of the loop to the nearest 1 mm (0.04 in.), while the loop is under tension.

57. Conditioning

57.1 Condition samples in the standard atmosphere for testing textiles as directed in Practice D 1776 for a period of ½ h when moisture regain is 2 % or less, and precondition and condition per Practice D 1776 when the regain exceeds 2 %.

58. Procedure

58.1 *Shrinkage in Dry Heat*:

58.1.1 Preheat the treating oven to 176 ± 3°C (350 ± 5°F). Then suspend the specimen freely from a stationary object or rack inside the oven. Loops should not be near the sides of the oven, or allowed to touch them. After the oven returns to temperature, expose the specimen for 30 ± 2 min.

58.1.2 Remove the specimen from the oven and condition it as directed in Section 57.

58.1.3 Remeasure the loop lengths as directed in 56.2 and 56.3.

58.2 *Shrinkage in Boiling Water*:

58.2.1 Wrap the specimens prepared and measured in Section 56 in cheesecloth.

58.2.2 Prepare a bath, made up of a volume of tap water, in millilitres, that is at least 40 times the mass, in grams, of the specimen and the cheesecloth wrapper.

58.2.3 Immerse the wrapped specimens in the boiling water and continue boiling for 30 ± 2 min. Keep the wrapped specimen immersed in the bath throughout the boiling period.

58.2.4 Remove the cheesecloth with specimens from the bath and centrifuge it or pass it through a roller wringer. Then, remove the specimens from the cheesecloth, dry them in the drying oven at 65°C (150°F) for 1 h, and condition them as directed in Section 57.

58.2.5 Remeasure the loop lengths as directed in 56.2 and 56.3.

59. Calculation

59.1 Calculate the shrinkage of each test specimen to the nearest 0.1 % using Eq 2:

$$\text{Shrinkage, \%} = [(L - F)/L] \times 100 \quad (2)$$

where:

L = original loop length, and
F = loop length after exposure.

59.1.1 When F is greater than L due to growth, use $(L - F)$ in Eq 2 and report the calculated growth.

59.2 Calculate the average shrinkage, or growth for the lot to the nearest 0.1 %.

60. Report

60.1 State that the specimens were tested as directed in Test Methods D 204. Describe the material(s) or product(s) sampled and the method of sampling used.

60.2 Report the following information:

60.2.1 Exposure conditions, whether to dry heat or to boiling water.

60.2.2 Average shrinkage, or growth and

60.2.3 Number of specimens tested.

61. Precision and Bias

61.1 *Precision*—For the components of variance in Table 3, two averages of observed values should be considered significantly different at the 90 % probability level if the differences tabulated in Table 4.

61.2 *Bias*—The procedure in Test Methods D 204 for measuring shrinkage, single end, has no true bias because the value of the shrinkage properties can be defined only in terms of a test method.

COLORFASTNESS TO LAUNDERING

62. Scope

62.1 This test method determines the alteration in shade and of staining by sewing thread under conditions similar to that experienced in domestic washing of apparel and other textile end products. This test method is applicable to sewing threads made from natural or man-made fibers, or to combinations of them.

63. Summary of Test Method

63.1 Sewing thread in contact with a multifiber test cloth is laundered in home laundry and drying equipment with or without bleach under conditions intended to reproduce the effect of home laundering on sewing thread. The alteration in shade of the sewing thread and the degree of staining of the multifiber test cloth are graded by reference to the AATCC Gray Scale for Color Change or to the AATCC Chromatic Transference Scale, as appropriate.

64. Significance and Use

64.1 This test method is not necessarily useful for the evaluation of sewing thread to be used for decorative stitching such as embroidery.

65. Apparatus

65.1 *Automatic Washing Machine*,[6] with "Normal Setting" agitator speed of 70 ± 5 cycles/min, washing time 12 min, spin speed 500 to 510 rpm, final spin cycle 4 min, and rinse temperature 41 ± 5°C (105 ± 10°F).

65.2 *Automatic Tumble Dryer*,[7] with controlled exhaust temperature which cycles from 60 to 71°C (140 to 160°F) and a cooling period while tumbling 5 min at the end of the drying cycle.

66. Reagents and Materials

66.1 AATCC Multifiber Test Fabric No. 18.[8]

66.2 Any household laundry detergent.

66.3 *Bleach*:

66.3.1 Any liquid chlorine household type containing 5.25 % sodium hypochloride (5 % available chlorine).

66.3.2 Any dry nonchlorine household type based on sodium perborate/sodium carbonate (pH of a 1 % solution should be 10.7 to 11.3).

67. Sampling

67.1 *Lot Sample*—Take at random one container from a dye lot.

67.2 *Laboratory Sample*—Take at random one thread holder from the container.

67.3 *Test Specimens*—Prepare one test specimen and one control from each thread holder.

68. Preparation of Test Specimens

68.1 Sew three parallel lines of stitching on a 50 mm (2 in.) square of AATCC No. 10 Multifiber Test Fabric using thread from a thread holder and a type 301 stitch. The thread need not be a continuous length but should be taken from the same holder. The stitching should be perpendicular to the stripes and completely across the multifiber fabric with 8 stitches per 25 mm (8 stitches per inch) unless otherwise agreed upon between the purchaser and supplier. The stitch lines should be spaced approximately 10 mm (0.40 in.) apart, with the first line starting about 15 mm (⅝ in.) in from the test fabric edge.

68.2 Prepare two specimens from each thread holder, retaining one for comparison in evaluating the test results.

69. Procedure

69.1 Launder each specimen for testing as directed in AATCC Test Method 135 using a machine cycle setting of "Normal"; except use the water temperature and bleach condition from Table 5 of Test Methods D 204 and any household laundry detergent in place of the AATCC detergent specified. The water temperature, bleach conditions, and detergent used shall be as agreed upon by the purchaser and supplier. When chlorine bleach is used, introduce 240 mL (1 cup) into the

TABLE 5 Laundering Conditions

Machine Washing Temperature	Bleach Condition
No. 1 30 ± 5°C	(a) chlorine bleach
No. 2 40 ± 5°C	(b) nonchlorine bleach
No. 3 60 ± 5°C	(c) no bleach

[6] A Kenmore Automatic Washer has been accepted as the standard machine. Source: Sears, Roebuck and Co. For model number and nearest Commercial Sales Department, write AATCC, P.O. Box 12215, Research Triangle Park, NC 27709. Any other washer which is known to give comparable results may be used.

[7] A Kenmore Electric Dryer has been accepted as the standard machine. Source: Sears, Roebuck and Co. For model number and nearest Commercial Sales Department, write AATCC, P.O. Box 12215, Research Triangle Park, NC 27709. Any other dryer which is known to give comparable results may be used.

[8] Available from Testfabrics, Inc., P.O. Drawer O, Middlesex, NJ 08846.

washer in the manner directed on the bleach container. When nonchlorine bleach is used, introduce it into the water in the amount and manner directed on the bleach container.

69.2 Dry specimens using procedure A in Table 1, and the setting conditions listed under "Cotton/Sturdy" in Table III of AATCC Test Method 135.

NOTE 5—It has been found that there is no appreciable difference in staining regardless of which household laundry detergent is used. Because of differences in water hardness, different detergents may affect shade because of varying degrees of deposition from the hard water. However, the deposition would be the same on the entire item in which the thread was sewn.

69.3 Repeat the washing-drying procedure through two additional cycles or as agreed upon by the purchaser and supplier.

70. Evaluation

70.1 Grade each specimen for change in color from the control to the nearest one-half rating unit as directed in AATCC Evaluation Procedure 1.

70.2 Grade each specimen for change in degree of staining from the control to the nearest one-half rating unit as directed in AATCC Evaluation Procedure 3.

71. Report

71.1 State that the specimens were tested as directed in Test Methods D 204. Describe the material or product sampled, and the method of sampling used.

71.2 Report the following information:

71.2.1 The test option used,

71.2.2 The brand name and amount of detergent used.

71.2.3 The brand name and amount of bleach used, and the type (chlorine or nonchlorine).

71.2.4 Number of specimens tested,

71.2.5 Alteration in shade of the thread in each specimen as the noted grade on the AATCC Gray Scale for Color Change and

71.2.6 Staining for each multifiber stripe on each specimen as the grade on the AATCC Chromatic Transference Scale.

72. Precision and Bias

72.1 *Precision*—An interlaboratory test and calculation of components of variance was felt to be inappropriate because of the restricted and discontinuous rating scales, the nonlinear relationships between rating scales and color difference units, the increased variability in color difference units as the true value of the ratings decrease, and the restriction of the data for degrees of staining. Based on these reasons and on general practice in the trade, a lot or consignment of sewing thread is generally considered as having a rating that is significantly worse than a specified value when a specimen from the lot or consignment has a rating for change in color that is more than one-half step below the specified rating on the AATCC Gray Scale for Color Change or for degree of staining, a rating that is more than one-half step below the specified rating on the AATCC Chromatic Transference Scale.

72.2 *Bias*—No justifiable statement can be made on the bias of Test Methods D 204 for grading sewing thread for change in color or for degree of staining, since the true values can be defined only in terms of a test method.

COLORFASTNESS TO DRYCLEANING

73. Scope

73.1 This test method determines the alteration in shade and of staining by sewing thread under drycleaning conditions. This test method is applicable to sewing thread made from natural or man-made fibers, or to combinations thereof.

74. Summary of Test Method

74.1 Sewing thread, in contact with a multifiber test cloth, is subjected to drycleaning. The alteration in shade of the sewing thread and the degree of staining of the multifiber test cloth are graded by reference to AATCC Gray Scale for Color Change or the AATCC Chromatic Transference Scale, as appropriate.

75. Significance and Use

75.1 This test method is not necessarily useful for the evaluation of sewing thread to be used for decorative stitching such as embroidery.

76. Apparatus

76.1 The apparatus shall be as specified in Test Methods D 2724.

76.2 AATCC Multifiber Test Fabric No. 10.

77. Sampling

77.1 *Lot Sample*—Take at random one container from a dye lot.

77.2 *Laboratory Sample*—Take at random one thread holder from the container.

77.3 *Test Specimens*—Prepare one test specimen and one control from each thread holder.

78. Preparation of Test Specimens

78.1 A 50 mm (2 in.) square of No. 10 multifiber test fabric shall be sewn with a 301 stitch perpendicular to the stripes and completely across the multifiber fabric using the sewing thread to be tested. The thread need not be a continuous length but should not be taken from the same holder. Sew three parallel lines of stitching spaced 10 mm (0.40 in.) apart with the first line 15 mm (⅝ in.) from the test fabric edge. Stitch length shall be 8 stitches per 25 mm (8 stitches per inch) unless otherwise agreed upon between the purchaser and the supplier.

78.2 Prepare two specimens from each thread holder retaining one for comparison in evaluating the test results.

79. Conditioning

79.1 Condition the samples as directed in Section 6.

80. Procedure

80.1 Dryclean the specimen as directed in Procedure for Drycleaning of Test Method D 2724, Sections 10.1 and 10.3.

80.2 Repeat the drycleaning procedure through two additional cycles for a total of three cycles.

81. Evaluation

81.1 Grade each specimen for change in color from the control to the nearest one-half rating unit as directed in AATCC Evaluation Procedure 1.

81.2 Grade each specimen for change in degree of staining from the control to the nearest one-half rating unit as directed in AATCC Evaluation Procedure 3.

82. Report

82.1 State that the specimens were tested as directed in Test Methods D 204. Describe the material or product sampled, and the method of sampling used.

82.2 Report the following information:

82.2.1 Number of cycles specimens were tested,

82.2.2 Number of specimens tested,

82.2.3 Alteration in shade of the thread in each specimen as the noted grade on the AATCC Gray Scale for Color Change, and

82.2.4 Staining for each multifiber stripe on each specimen as the grade on the AATCC Chromatic Transference Scale.

83. Precision and Bias

83.1 *Precision*—An interlaboratory test and calculation of components of variance was felt to be inappropriate because of the restricted and discontinuous rating scales, the nonlinear relationships between rating scales and color difference units, the increased variability in color difference units as the true value of the ratings decrease, and the restriction of the data for degrees of staining. Based on these reasons and on general practice in the trade, a lot or consignment of sewing thread is generally considered as having a rating that is significantly worse than a specified value when a specimen from the lot or consignment has a rating for change in color that is more than one-half step below the specified rating on the AATCC Gray Scale for Color Change or for degree of staining, a rating that is more than one-half step below the specified rating on the AATCC Chromatic Transference Scale.

83.2 *Bias*—No justifiable statement can be made on the bias of Test Methods D 204 for grading sewing thread for change in color or for degree of staining, since the true values can be defined only in terms of a test method.

COLORFASTNESS TO WATER MIGRATION

84. Scope

84.1 This test method determines staining by sewing thread under home care conditions similar to those experienced when items are left in a wet state for a specified period of time. This test method is applicable to sewing threads made from natural or man-made fibers, or to combinations thereof.

85. Summary of Test Method

85.1 Sewing thread in contact with a multifiber test cloth is laundered in home laundry equipment and then retained in the wet state for a specified period of time. The degree of staining of the multifiber test cloth is graded by reference to the AATCC Chromatic Transference Scale.

86. Significance and Use

86.1 This test method is not necessarily useful for evaluating high density decorative stitching such as embroidery.

87. Apparatus

87.1 *Automatic Washing Machine*,[6] with "Normal Setting" agitator speed of 70 ± 5 cycles/min, washing time 12 min, spin speed 500 to 510 rpm, final spin cycle 4 min, and rinse temperature 41 ± 5°C (105 ± 10°F).

88. Reagents and Materials

88.1 AATCC Multifiber Test Fabric No. 10.[8]

88.2 Bleached cotton/polyester 84/16 terry cloth.[8]

88.3 Test tubes, 19 mm (¾ in.) diameter with stoppers.

89. Sampling

89.1 *Lot Sample*—Take at random one container from a dye lot.

89.2 *Laboratory Sample*—Take at random one thread holder from the container.

89.3 *Test Specimens*—Prepare one test specimen and one control from each thread holder.

90. Preparation of Test Specimens

90.1 A 50 mm (2 in.) square of No. 10 multifiber test fabric shall be sewn with a 301 stitch perpendicular to the stripes and completely across the multifiber fabric using the sewing thread to be tested. The thread need not be a continuous length but should not be taken from the same holder. Sew three parallel lines of stitching spaced 10 mm (0.40 in.) apart with the first line 15 mm (⅝ in.) from the test fabric edge. Stitch length shall be 8 stitches per 25 mm (8 stitches per inch) unless otherwise agreed upon between the purchaser and the supplier.

90.2 Prepare two specimens from each thread holder retaining one for comparison in evaluating the test results.

90.3 Cut strips of 8 4⁄16 cotton/polyester terry cloth 50 mm (2 in.) by 150 mm (6 in.) equal in number to that of the specimens to be tested.

91. Procedure

91.1 Treat each specimen for testing and the strips of terry cloth as directed in AATCC Test Method 143, except for the following. Use a 1.8 kg (4 lb) force. Use temperature conditions in Table 5 of Test Methods D 204. Use no detergent or bleach. Remove the load from the washer immediately at the

conclusion of the final rinse. Separate the test specimens and terry cloth strips.

NOTE 6—Multiple specimens sewn with like or different color sewing threads can usually be tested simultaneously since normally the mass of the test specimens would be small compared to the total test load.

91.2 Roll each specimen in a terry cloth strip and insert into a test tube. Stopper the test tube and let stand for 4 h at ambient temperature.

92. Evaluation

92.1 Remove the specimens from the test tubes and immediately grade each specimen for change in degree staining from the control to the nearest one-half rating unit as directed in AATCC Evaluation Procedure 3.

93. Report

93.1 State that the specimens were tested as directed in Test Methods D 204. Describe the material or product sampled, and the method of sampling used.

93.2 Report the following information:

93.2.1 Test conditions selected from Table 5,

93.2.2 Number of specimens tested,

93.2.3 Staining for the terry cloth and for each multifiber stripe on each specimen as the grade on the AATCC Chromatic Transference Scale.

94. Precision and Bias

94.1 *Precision*—An interlaboratory test and calculation of components of variance was felt to be inappropriate because of the restricted and discontinuous rating scales, the nonlinear relationships between rating scales and color difference units, the increased variability in color difference units as the true value of the ratings decrease, and the restriction of the data for degrees of staining. Based on these reasons and on general practice in the trade, a lot or consignment of sewing thread is generally considered as having a rating that is significantly worse than a specified value when a specimen from the lot or consignment has a rating for change in color that is more than one-half step below the specified rating on the AATCC Gray Scale for Color Change or for degree of staining, a rating that is more than one-half step below the specified rating on the AATCC Chromatic Transference Scale.

94.2 *Bias*—No justifiable statement can be made on the bias of Test Methods D 204 for grading sewing thread for change in color or for degree of staining, since the true values can be defined only in terms of a test method.

PRECISION AND BIAS

95. Precision and Bias

95.1 *Interlaboratory Test Data*[9]—An interlaboratory test was run in 1968 in which randomly drawn samples of two materials were tested for twist balance, diameter by the thickness gage procedure, and shrinkage in each of five laboratories. Each laboratory used two operators, each of whom tested eight specimens of each material. An interlaboratory test was run in 1972 in which randomly drawn samples of two materials were tested for length of each of three laboratories. Each laboratory used two operators, each of whom tested five specimens of each material. The calculated components of variance expressed as standard deviations are listed in Table 3.

95.2 *Precision*—For the components of variance in Table 3, two averages of observed values should be considered significantly different at the 90 % probability level if the difference equals or exceeds the critical difference tabulated in Table 4.

95.3 *Bias*—The procedures in Test Method D 204 for measuring twist balance, length, diameter and shrinkage of sewing threads has no bias because the true values of those properties can be defined only in terms of a test method.

96. Keywords

96.1 breaking strength; strand; colorfastness; diameter; dimensional change; length; sewing thread; textile strand; twist; twist balance; yarn number

[9] ASTM Research Report No. D-13-1009 is available from ASTM Headquarters, 100 Barr Harbor Drive, West Conshohocken, PA 19428.