



Designation: D204 – 02

## Standard Test Methods for Sewing Threads<sup>1</sup>

This standard is issued under the fixed designation D204; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

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

### 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:

	Sections
Colorfastness to Drycleaning	73-83
Colorfastness to Laundering	62-72
Colorfastness to Water Migration	84-94
Diameter	43-50
Length per Thread Holder	34-42
Shrinkage, Single Strand	51-61
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Single Strand—Conditioned	19.1.1
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Loop Strength	19.2
Knot Strength	19.3
Twist	22-27
Twist Balance	28-33
Yarn Number	7-14

NOTE 1—For methods covering tests on prepared seams, refer to Test Methods [D1683](#) and [D3940](#).

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.*

<sup>1</sup> These test methods are under the jurisdiction of ASTM Committee [D13](#) on Textiles and are the direct responsibility of Subcommittee [D13.58](#) on Yarns and Fibers.

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### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

- [D76](#) Specification for Tensile Testing Machines for Textiles
- [D123](#) Terminology Relating to Textiles
- [D1422](#) Test Method for Twist in Single Spun Yarns by the Untwist-Retwist Method
- [D1423](#) Test Method for Twist in Yarns by Direct-Counting
- [D1683](#) Test Method for Failure in Sewn Seams of Woven Apparel Fabrics
- [D1776](#) Practice for Conditioning and Testing Textiles
- [D1777](#) Test Method for Thickness of Textile Materials
- [D1907](#) Test Method for Linear Density of Yarn (Yarn Number) by the Skein Method
- [D2256](#) Test Method for Tensile Properties of Yarns by the Single-Strand Method
- [D2258](#) Practice for Sampling Yarn for Testing
- [D2724](#) Test Methods for Bonded, Fused, and Laminated Apparel Fabrics
- [D3693](#) Specification for Labeled Length per Holder of Sewing Thread
- [D3823](#) Practice for Determining Ticket Numbers for Sewing Threads
- [D3940](#) NO TITLE
- [D4848](#) Terminology Related to Force, Deformation and Related Properties of Textiles
- [D4849](#) Terminology Related to Yarns and Fibers
- [D6193](#) Practice for Stitches and Seams

#### 2.2 AATCC Standards:

- [Test Method 135](#) Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics<sup>3</sup>
- [Evaluation Procedure 1](#), Gray Scale for Color Change<sup>3</sup>
- [Evaluation Procedure 3](#), Chromatic Transference Scale<sup>3</sup>

### 3. Terminology

#### 3.1 Definitions:

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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

3.1.1 Refer to Terminology **D4848** for definitions of the following terms used in this standard elongation; force and loop-breaking force.

3.1.2 Refer to Terminology **D4849** for definitions of the following terms used in this standard colorfastness; covered yarn, greige thread, growth, sew, sewing force, sewing thread, tex, thread holder, ticket number, and yarn number.

3.1.3 Refer to Terminology **D123** for definitions of other terms used in this standard including the following; shrinkage, stitch, stitching, stitch type, and twist balance.

#### 4. Significance and Use

4.1 *Acceptance Testing*—The test methods in Test Methods D204 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 If there are differences of practical significance between reported test results for two laboratories (or more) comparative test should be performed to determine if there is a statistical bias between them using competent statistical assistance. As a minimum, use the samples for such a comparative tests that are as homogeneous as possible, drawn from the same lot of material as the samples that resulted in disparate results during initial testing and randomly assigned in equal numbers to each laboratory. The test results from the laboratories involved should be compared using a statistical test for unpaired data, 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.

#### 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 **D2258**. 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 **D2258**. 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 routine testing, condition the samples as directed in Practice **D1776**.

6.2 When preconditioning is specified in a material specification or contract order 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) as directed in Practice **D1776**.

6.2.1 After preconditioning, expose the specimens to moving air in the standard atmosphere for testing textiles,  $21 \pm 1^\circ\text{C}$  ( $70 \pm 2^\circ\text{F}$ ) and  $65 \pm 2\%$  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 to establish standard ticket numbers for sewing threads according to Practice **D3823**.

#### 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 **D1907**, except that in place of Table 2 in **D1907** use **Table 1** of Test Methods D204.

## 13. Report

13.1 State that the specimens were tested as directed in Test Methods D204. 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 for testing yarn number are as given in Test Method **D1907**.

## 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 D204.

### 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 **D2256** except that a  $250 \pm 3$  mm ( $10.0 \pm 0.1$  in.) or  $500 \pm 5$  mm ( $20.0 \pm 0.2$  in.) gage length and a constant-rate-of-extension (CRE) type tensile testing machine having a jaw separation rate of  $300 \pm 10$  mm/min ( $12.0 \pm 0.5$  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 **D2256** except that a CRE type testing machine having a jaw separation rate of  $300 \pm 10$  mm/min ( $12.0 \pm 0.5$  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 **D2256**. 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 **D2256**. 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, or (4 to 8 oz/yd) range and at a force of 340 g (¾ lb) for thread used for seams in heavy fabrics 270 to 0.520 g/m (8 to 15 oz/yd).

## 20. Report

20.1 State that the specimens were tested as directed in Test Methods D204. 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 for testing strength and elongation are given in Test Method D2256.

## 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 D1423, 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 D1423, except take the conditioned specimen directly from the side of the thread holder for testing. Determine the singles twist as directed in Test Method D1422.

### 26. Report

26.1 State that the specimens were tested as directed in Test Methods D204. 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 D1422 or D1423.

### 27. Precision and Bias

27.1 The precision and bias for twist testing are given in Test Methods D1422 and D1423, as applicable.



**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 approximately 1 m (1 yd) 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 approximately 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 D204. 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, 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*—This procedure for measuring twist balance has no known bias because the value of the twist properties can be defined only in terms of a test method.

**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

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**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 D3693.

**39. Procedure**

39.1 Determine the tension for reeling as directed in Test Method D1907. 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

**TABLE 4 Critical Difference,<sup>A</sup> 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

<sup>A</sup> The critical differences were calculated using  $t = 1.645$ , which is based on infinite degrees of freedom.

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 D204. 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*—This procedure for measuring length per thread holder has no known bias because the value of the length properties can be defined only in terms of a test method.

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#### 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 D1777, with a presser foot diameter of  $9.52 \pm 0.02$  mm ( $0.375 \pm 0.001$  in.). The presser foot and moving parts connected therewith shall be weighted to apply a total force of  $1.67 \pm 0.03$  N ( $6 \pm 0.1$  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