ASTM INTERNATIONAL

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Standard Test Method for
Yarn Number Based on Short-Length Specimens[1]

This standard is issued under the fixed designation D1059; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

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

1. Scope

1.1 This test method covers the determination of the yarn number of all types of cotton, woolen, worsted, and man-made fiber yarns taken from packages; or from any textile fabrics in which the yarns are intact and can be removed in measurable lengths. The test method is not applicable to yarns taken from napped or cut pile fabrics. Because this test method is based on short-length specimens, the results should only be considered as approximations of yarn number.

Note 1—For a more precise procedure for the determination of yarn number, refer to Test Method D1907.

Note 2—The following additional methods for the determination of yarn number have been approved for yarns made from specific fibers: Specification D541, D578, and D681.

1.2 This test method is applicable to yarns which stretch less than 5 % when tension on yarn is increased from 0.25 to 0.75 cN/tex (0.25 to 0.75 gf/tex). By mutual agreement it may be adapted to yarns which stretch more than 5 % by use of tension lower than that specified in the method for elastomers or use of tension higher than that specified in the method to pull the crimp out of textured yarns.

1.3 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.4 *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.*

1.5 *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:*
D123 Terminology Relating to Textiles
D541 Specification for Single Jute Yarn (Withdrawn 1996)[2]
D578 Specification for Glass Fiber Strands
D629 Test Methods for Quantitative Analysis of Textiles
D681 Specification for Jute Rove and Plied Yarn for Electrical and Packing Purposes (Withdrawn 2000)[2]
D1423 Test Method for Twist in Yarns by Direct-Counting
D1776 Practice for Conditioning and Testing Textiles
D1907 Test Method for Linear Density of Yarn (Yarn Number) by the Skein Method
D2258 Practice for Sampling Yarn for Testing

3. Terminology

3.1 *Definitions*—The following terms are relevant to this standard: cotton count, cut, indirect yarn numbering system, lea, metric count, run, tex, type, worsted count, yarn number, yarn numbering system.

3.2 For definitions of other textile terms used in this test method, refer to Terminology D123.

4. Summary of Test Method

4.1 Specimens of prescribed length, usually 1 m (1.1 yd) or less, are cut from a conditioned sample, which is under prescribed tension, and weighed. The yarn number is calculated from the mass and the measured length of the yarn.

5. Significance and Use

5.1 This is a quick method used for the determination of the approximate yarn number of short-length specimens taken from packages or fabrics.

5.2 Because any error present in the reported length of the specimen is multiplied many times when calculating the theoretical yarn number using Eq 2 or Eq 3, it is extremely important that the length be measured as precisely as practicable.

5.3 For the analysis of fabrics, this test method is adequate for estimating the approximate yarn number of the yarn used to weave or knit the fabric, but the results obtained by this test method may not agree with the nominal yarn number of the yarns actually used to make the fabric because of the changes in the yarn number produced by the weaving or knitting operations, the finishing treatments, and the dissecting operations. This test method is suitable for the evaluation of yarns as they occur in the finished fabric, when that information is needed.

5.4 The yarn number obtained from the lengths taken from packages should not be expected to agree exactly with the values obtained by the use of the more precise methods of determining the yarn number included in Test Method D1907. If a sufficient number of consecutive specimens were tested, however, a close agreement with Option 1 of Test Method D1907 can be expected.

5.5 This test method is designed to measure the yarn number of the single yarns present as a component of a plied yarn and the yarn number of the original single yarns used to produce a high twist yarn for a crepe fabric.

5.6 This test method is not recommended for acceptance testing because of the short lengths used. In some cases, the purchaser and the supplier may have to test a commercial shipment of one or more specific materials by the best available method, even though the method has not been recommended for acceptance testing of commercial shipments.

5.6.1 In such a case, if there is disagreement arising from the differences in values reported by the purchaser and supplier when using this method for acceptance testing, the statistical bias, if any, between the laboratory of the purchaser and the laboratory of the supplier should be determined with each comparison being based on testing specimens randomly drawn from one sample of material of the type being evaluated.

6. Apparatus

6.1 *Twist Tester,* equipped with a tension device and means of measuring the change in length of the specimen due to untwisting, as specified in Test Method D1423.

6.2 *Length Measuring Device,* A tape or scale measuring at least 1.00 m (1.1 yd) in length, graduated in millimetres, and with two clamps, one adjustable, to permit measuring various lengths of yarn up to and including 1 m (1.1 yd). The scale should be accurate to 1 part in 1000. Means should be provided for applying a specified tension to the specimen and for cutting it without damaging the scale.

6.3 *Razor-Edge Craft Knife, or Sharp Pointed Scissor or Equivalent.*

6.4 *Tensioning Weights,* accurate to 1 part in 100.

6.5 *Balance,* capable of weighing to within 0.1 % of the specimen mass.

6.6 *Dissecting Needle,* Scribe, or Stylus, (hereafter needle).

6.7 *Auxiliary Equipment for Raveling Tricot Fabric:*

6.7.1 *Metal Clamps,* four to six (1 g to 5 g depending on the mass per unit area of the tricot fabric).

6.7.2 *Sharp Pointed Scissors.*

6.7.3 *Tweezers.*

6.8 *Masking Tape.*

6.9 *Test (or Specimen) Board*—of a stiff material, such as cardboard, covered with a short pile fabric (for example, velvet, velveteen, or a plush or napped surface).

7. Sampling

7.1 *Lot Sample*—As a lot sample for acceptance testing, take at random the number of shipping containers directed in an applicable material specification or other agreement between the purchaser and the supplier, such as an agreement to use Practice D2258.

7.2 *Laboratory Sample*—As laboratory sample for acceptance testing, proceed as follows:

7.2.1 For packages such as cones, spools, or bobbins, take a total number of packages as directed in Section 7 of Test Method D1907.

7.2.2 For beams, remove 1.5 m (1.5 yd) of yarn from all ends across the beam. Handle carefully to avoid tangling. secure the ends of the sample yarns by sandwiching them at the ends with strips of masking tape.

7.2.3 For fabrics, take a swatch of full-width fabric at last 1.5 m (1.5. yd).

7.3 *Test Specimens*—From each unit of the laboratory sample, take specimens at the time of testing as follows:

7.3.1 For packages such as cones, spools, or bobbins, take one specimen per package.

7.3.2 For beams, take ten ends at random from each half of the beam sheet.

7.3.3 For woven fabrics, take ten separate specimens from the warp and ten separate specimens from the filling. Take the filling specimens at random. Discard specimens that appear to be damaged.

7.3.4 For weft knit fabrics, take ten specimens at random unless the fabric is known to be a multifeed fabric or double knit fabric. For multifeed fabric, take ten specimens from ten successive courses in one part of the laboratory sample. For double knit fabric, take five specimens from each knitting type of yarn (short and long feed length courses).

7.3.5 For warp knit fabrics, cut a walewise strip from which specimens can be raveled. Cut the strip at least 0.2 m (8 in.) longer than the specimen length and wide enough to contain more than the required number of specimens. Test five specimens from each bar.

Note 3—When testing for other than acceptance testing, the specimens may have to be taken in a different manner than directed above. A minimum of ten specimens in each test result is recommended.

8. Conditioning

8.1 Bring the laboratory samples or specimens to moisture equilibrium for testing in the standard atmosphere for testing textiles as directed in Practice D1776, except that preconditioning is not necessary.

9. Preparation of Apparatus

9.1 *Yarn from Packages*—Normally, specimens having a length of 1 m (1.1 yd) can be obtained from pirns, cones,

spools, bobbins, and beams. Remove the outer layers from the packages and proceed as described in 10.2.

9.2 *Yarn from Woven Fabrics*—Cut the laboratory samples parallel to the warp (or filling) yarns to be tested. Ravel and discard the warp (or filling) yarns until full length yarns can be removed from the fabric. Trim the fringe.

NOTE 4—If fabric is tightly woven, it may be necessary to cut the fringe frequently to allow the yarns to be raveled from the fabric without stretching.

9.3 *Yarns from Weft Knits*—Cut the fabric along a course line. Clean the raveling edge to obtain a free pulling yarn at least 0.2 m (8 in.) longer than the specimen length required.

9.4 *Yarn from Warp Knits*—Ravel yarn from warp knit fabrics as directed below.

9.4.1 Clamp one side of the fabric, face up, to an edge of the pile board. Stretch the fabric across the board to put a slight tension on the loops and clamp it to the opposite edge of the board. Clamps should be near the raveling end of the fabric (closed wale loop).

9.4.2 Clean the wale loops of cut ends by insertng needle below yarns which enter the loops from the space between, and at the base of, the loops (or catch these yarns with tweezers) and pull gently to free sufficient yarns to supply the required number of yarns for testing plus some spares. See Note 5. Maintain as compact a yarn bundle as possible, avoiding splaying yarns (separated filaments due to splitting yarn bundle with needle or tweezers and pulling on only some of the filament in the bundle). Continue working loops out from the back of succeeding loops, using needle or tweezers on the yarn in the spaces between loops, until sufficient yarn has been raveled to hold onto when stretched slightly. The yarns may now be sandwiched in tape at the end to keep them together and for ease of handling. This initial starting of the raveling process is most easily accomplished using a stereomicroscope, but a magnifying glass may be sufficient.

NOTE 5—Warp knits are usually knit from a minimum of two sets of yarn beams, each of which requires a bar to guide threads during knitting. Yarns guided by one of the bars will either knit off one needle or two adjacent needles. Yarns guided by the other bar(s) will usually knit off of nonadjacent needles and may indeed "skip" over more than one needle between stitches. A fabric could contain one bar with each yarn knitting off a needle (chain stitch), one bar using adjacent needles, and a third bar using nonadjacent needles. The technical face side of the fabric shows the wales, and except for double warp knits, the back side usually shows diagonal lines, called laps, which are due to yarn movement from stitch-to-stitch crossing one or more wale lines.

9.4.3 Continue raveling by the ladder technique of gently pulling on the yarns being removed, with slightly more stress and angled pull on those at the edges. Gentle pressure on yarns in spaces at the sides with a needle may be necessary from time to time. Try to keep the yarns raveling at the same rate. When yarns resist raveling, check for broken or looped filaments wrapped about yarn loops. These have to be worked loose (under microscope) or broken, in which case, the yarn with the broken filaments can't be used for testing. Yarns can normally take a fair amount of hand tension during the raveling process without being damaged. When too much tension has been applied, the yarn will lose memory of knit crimp and not recrimp to loop form. (With greige yarns, however, moisture and heat from handling by some people may cause loss of the knit-crimp memory without yarn damage.) This phase can be done with fabric still clamped to board. Or, it can be done with fabric held on each side of the raveling area with heel of thumb and three fingers, leaving thumbs and forefingers to pull on yarns and work needle as needed. Lighted low power magnification may be helpful. Very tightly knit fabrics will ravel more slowly and may require continued use of microscope.

9.4.4 It is a more common practice to ravel sufficient yarn to obtain a standard length from the yarns guided by the bar which "floats" over at least one needle during knitting (sometimes called "long bar" and usually, but not always, the top bar). Shorter, appropriate lengths will necessarily be taken from the other bar(s).

9.5 *Singles from Plied Yarn*—When required, determine the length of singles in the ply as directed below.

9.5.1 Adjust the twist tester to 250 6 0.25 mm (9.85 6 0.01 in.) between clamps. Record this as the twisted length, *T*. Take a length of about 50 mm (2 in.) and fasten the end of the yarn in the tensioning device near the left hand clamp of the twist tester. Draw the yarn through the right-hand clamp under the required tension until the selected length is indicated. Close the right hand clamp and then the left hand clamp. Untwist the yarn until a needle can be passed from clamp-to-clamp between the single yarns. Determine and record the untwisted length, *U*, as directed in Test Method D1423.

9.5.1.1 If the plied yarn is made of different single-yarn components, separate the yarn and prepare sufficient length of each single component type for the determination of its yarn number. Do not allow the twisted state of the separated singles to be disturbed before the specimens for linear density are cut.

NOTE 6—Using a twist tester to hold yarns for cutting specimens for linear yarn density is not recommended since the sharp edges of the blades used may damage the clamp surfaces. If a twist tester is used, extreme care should be exercised.

9.6 *Filament Crepe Yarns*—Determine the untwisted length of high twist, crepe yarns as directed in 9.5.1.

10. Procedure

10.1 *Testing*—Test the conditioned specimens in the standard atmosphere for testing textiles as defined in Practice D1776.

10.2 *Cutting*—In the case of yarn taken from fabric, use sufficient tension to remove the visible crimp. If the tension used is greater than 0.25 cN/tex (0.25 gf/tex), report the load actually used. If the actual yarn number with the tension used is different from the estimated yarn number value from which the tension force was calculated by more than 10 %, repeat the test using a tension calculated on the "actual" or new "linear density." For samples which are more than 1 m (1.1 yd) in length, for example pirns, cones, spools, bobbins, and beams, cut 1 m (1.1 yd) specimens using the device described in 6.2 or equivalent apparatus. Measure the length to the nearest 0.5 mm (0.02 in.) while the specimen is under a tension of 0.25 cN/tex (0.25 gf/tex). Maintain specimen identification.

10.2.1 When specimens having a length of 1 m (1.1 yd) cannot be obtained, as, for example, from some fabrics, take specimens using the device described in 6.2 (see Note 6). With

the measuring device, use the largest common fraction of 1 m (1.1 yd) available for the system being used. Because any errors in the measured length are greatly multiplied, it is important that the lengths be measured as precisely as practicable.

10.3 *Removal of Sizing and Finishing Materials*—If sizing or other finishing materials are present, remove these by treating the yarns, after measuring their length as directed in Section 8 of Test Methods D629. See Note 7. Recondition after extraction. Precautions should be taken against loss of fiber from specimens of spun yarn during the treatment.

NOTE 7—Tensions applied to yarns with high extractables from sizing or finishing materials should be based on mass of specimen before extraction and so noted.

10.4 *Weighing*—Weigh each specimen to within 0.1 % of its mass.

11. Calculation

11.1 If the specimens were obtained from plied yarns or from filament crepe yarns, calculate the change in length per unit length of the yarn in untwisting using Eq 1.

$$C = (U - T)/T \qquad (1)$$

where:

C = change in length per unit length of yarn in untwisting.
T = twisted length of plied or crepe yarns in the same dimensional units as U, and
U = untwisted length of plied or crepe yarns (see 9.5 and 9.6) in the same dimensional units as T.

11.2 Calculate the yarn number using Eq 2 or Eq 3, noting that for single yarns or the resultant single-yarn number of plied yarns, C becomes zero and P=1. (see 3.2).
Yarn number, indirect system =

$$[454 (1 + C)/(G \times L)] Y \times P \qquad (2)$$

Yarn number, direct system =

$$(G \times D)/(1 + C) Y \text{ or } (G \times F)/(1 + C) M \qquad (3)$$

where:

D = constant for the various direct systems: Tex = 1093.6, Denier = 9842.5,
F = constant for the various direct systems: Tex = 1000, Denier = 9000,
G = mass of conditioned yarn, g. (see 10.4),
L = number of yards of No. 1 yarn in 1 lb. The value of L for the various indirect systems is: Cotton = 840, Woolen = 1600, Worsted = 560,
P = number of plies,
M = length of the specimen, m,
Y = length of the specimen, yd, and
C = change in length per unit length of yarn in untwisting.

11.3 Calculate the average yarn number for each laboratory sampling unit and the lot.

11.4 Calculate the standard deviation, coefficient of variation, or both, for each laboratory sampling unit and the lot, if requested.

12. Report

12.1 State that specimens were tested as directed in Test Method D1059. Describe the material or product sampled and the method of sampling used.

12.2 Report the following information:
12.2.1 The yarn number for each laboratory sampling unit and the lot,
12.2.2 Number of specimens tested,
12.2.3 The standard deviation, coefficient of variation, or both, for each laboratory sampling unit and the lot if calculated.
12.2.4 Tension used if other than specified.

13. Precision and Bias[3]

13.1 *Summary*—In 95 cases out of 100 when comparing two averages each based on ten observations on 450-mm lengths, the difference should not exceed 1.29 dtex (1.16 denier) for textured filament yarns with a nominal dtex of 55 (50 denier) to 167 (150 denier) and should not exceed 19.1 dtex (17.2 denier) for spun yarns with a nominal dtex of 278 (250 denier) to 556 (500 denier) when all of the observations are based on 450-mm lengths and are taken over a short interval of time by the same well-trained operator using the same piece of test equipment and specimens randomly drawn from the same sample of material. Larger differences are likely to occur under all other circumstances. Within limitations, the procedure has no known bias.

NOTE 8—Data for the interlaboratory test were measured in denier and converted to dtex in the text followed by denier in parentheses.

13.2 *Interlaboratory Test Data*—An interlaboratory test was run in 1984 in which randomly drawn specimens of five materials, listed in 13.2.1 – 13.2.5 were tested in each of seven laboratories. Each laboratory used two operators, each of whom tested ten specimens of each material. The components of variance for dtex expressed as standard deviations were as given in Table 1.

13.2.1 55 nominal dtex (50 denier) texture filament yarn taken from woven fabric.

TABLE 1 Components of Variance[A] for Yarn Number

Material and Specimen	Single-Operator Component	Within-Laboratory Component	Between-Laboratory Component
	dtex (den)	dtex (den)	dtex (den)
Length All textured	yarns:	4.63 (4.17) 3.51	2.09 (1.88) 2.59
filament 45 mm	3.07 (2.76) 2.26	(3.16) 1.12	(2.33) 3.06
lengths, 90 mm	(2.03) 1.47	(1.01) 11.84	(2.75) 3.28
lengths, 450 mm	(1.32) 35.69	(10.66) 12.80	(2.95) 0.00
lengths. Both	(32.12) 33.80	(11.52) 1.12	(0.00) 9.12
spun yarns: 45	(30.42) 21.80	(1.01)	(8.21)
mm lengths, 90	(19.62)		
mm lengths, 450			
mm lengths			

[A] The square roots of the components of variance are being reported to express the variability in the appropriate units of measure rather than as the square of those units of measure.