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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Practice for Sampling Yarn for Testing[1]

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1. Scope

1.1 This practice describes a procedure for the division of shipments of yarn into test lots and the sampling of such lots for testing.

1.2 This practice is applicable to single, plied, or cabled yarns, and cords, made of any fiber or mixture of fibers, and supported on any form of package, including beams.

1.3 This practice also describes procedures for the sampling of yarn(s) removed from woven or knitted fabrics, however, when thus sampled, the yarns are usually not representative of entire shipments, as referred to in 1.1. Consequently, the resultant sampling can only be used to determine the characteristics of the yarn and is usually not used for acceptance testing. Moreover, it should be recognized that the characteristics of yarns from fabrics may be different than the characteristics of the same yarn(s), prior to being entered into the fabric manufacturing process.

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

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 123 Terminology Relating to Textiles[2]

D 1578 Test Method for Breaking Strength of Skeins[2]

D 1907 Test Method for Yarn Number by the Skein Method[2]

D 4271 Practice for Writing Statements on Sampling in Test Methods for Textiles[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *beam, n—in textiles,* a large spool containing many ends of yarns wound parallel, and used for such purposes as weaving or warp knitting.

3.1.2 *beam set, n—in textiles,* one or more beams of yarn in a single shipment to be further processed together for a specific end use.

3.1.3 *bulk sample, n— in the sampling of bulk material,* one or more portions which (*1*) are taken from material that does not consist of separately identifiable units and (*2*) can be identified after sampling as separate or composited units.

3.1.4 *case, n—in textiles,* a shipping unit, usually a carton, box, bale, or other container holding a number of yarn packages.

3.1.5 *cone, n—in textiles,* (1) a yarn holder or bobbin of conical shape used as a core for a yarn package of conical form, also called a cone core. (2) the yarn package obtained when yarn is wound upon a cone core.

3.1.6 *end, n*—an individual sliver, roving, yarn, or cord.

3.1.6.1 *Discussion*—For yarns, one of the one or more continuous, multiple parallel lengths of yarn which may be wound on a yarn package or beam. For example, two lengths of yarn wrapped parallel on a single bobbin constitute two yarn ends, likewise, one thousand lengths of yarn wrapped parallel on a single beam constitutes one thousand yarn ends.

3.1.7 *fabric package, n*—a length of fabric in a form suitable for handling, storing, or shipping.

3.1.7.1 *Discussion*—Fabric packages may be unsupported, such as when folded in cases, or supported, such as on tubes, bolts, or creels. Fabric packages are frequently referred to as rolls or pieces.

3.1.8 *laboratory sample, n*—a portion of material taken to represent the lot sample, or the original material, and used in the laboratory as a source of test specimens.

3.1.9 *lot, n—in acceptance sampling,* that part of a consignment or shipment consisting of material from one production lot.

3.1.10 *lot sample, n*—one or more shipping units taken at random to represent an acceptance sampling lot and used as a source of laboratory samples. (*Syn.* bulk sample)

3.1.11 *primary sampling unit, n*—the sampling unit containing all the sources of variability which should be considered in acceptance testing; the sampling unit taken in the first stage of

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

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

selection in any procedure for sampling a lot or shipment.

3.1.12 *production lot, n*—that part of one manufacturer's production made from the same nominal raw material under essentially the same conditions and designed to meet the same specifications.

3.1.13 *sample, n*—(*1*) a portion of a lot of material which is taken for testing or for record purposes. (See also *lot sample, laboratory sample,* and *specimen*); (*2*) a group of specimens used, or observations made, which provides information that can be used for making statistical inferences about the population(s) from which they were drawn.

3.1.14 *sampling unit, n*—an identifiable, discrete unit or subunit of material that could be taken as part of a sample.

3.1.14.1 *Discussion*—Since there are two or more stages in most sampling schemes, the sampling units in each stage must be clearly identified to avoid confusion. The number of stages in sampling schemes is not limited, but may be as few or as many as required by the nature of the material being sampled. There are frequently three stages of sampling: (*1*) taking primary sampling units from a lot of material as a lot sample, (*2*) taking laboratory samples from each of the primary sampling units in the lot sample, and (*3*) taking test specimens from each of the units in the laboratory sample.

3.1.15 *sample skein, n*—skein reeled from the package or beam of the laboratory sample, and used in the laboratory as a source of specimens.

3.1.16 *specimen, n*—a specific portion of a material or laboratory sample upon which a test is performed or which is selected for that purpose. (*Syn.* test specimen.)

3.1.17 *yarn package, n*—a length or parallel lengths of yarn in a form suitable for handling, storing, or shipping.

3.1.17.1 *Discussion*—Packages may be unsupported, such as skeins or cakes, or supported having various winding patterns, such as bobbins, cops, cones, pirns, spools, or tubes. In yarns, the word package designates the smallest unit that can be separated from the shipment without cutting or unwinding the yarn, not a small group of packages. Even a small box containing a dozen spools is treated, for sampling purposes, as a case.

3.1.18 For terminology of other terms used in this practice, refer to Terminology D 123.

4. Summary of Practice

4.1 Instructions are given for dividing the yarn into lots, for determining the number of cases, beams, or fabric packages to be selected from each lot as a lot sample, and for determining the number of packages, including the number of ends, representing those packages taken from the lot sample as a laboratory sample. See Practice D 4271.

5. Significance and Use

5.1 Assigning a value to any property of the material in a container or in a lot, consignment, or delivery involves a measurement process that includes both sampling and testing procedures. The correctness of the value assigned depends upon the variability due to testing. Even when the variability due to testing is minimized by carefully developed procedures, correct and consistent estimates of the true value of the property are possible only when the sampling procedure avoids systematic bias, minimizes variations due to sampling, and provides a laboratory sample of adequate size.

5.2 Practice D 2258 may not give the most efficient sampling plan that might be devised in special situations but does present a general procedure that gives satisfactory precision with an economical amount of sampling and one which does not require elaborate statistical computation based on previous knowledge of the amount of variation between primary sampling units (such as cases, beams or fabric packages), between units of the laboratory sample taken from the primary sampling units of the lot sample (such as yarn packages taken from a case) and between specimens taken from units of the laboratory sample (such as lengths of yarn taken from a yarn package or a fabric swatch taken from a roll or piece). Many plans that include stratified sampling can be found in textbooks.

5.3 The smallest number of specimens required for a given variability in the average result will usually be obtained by (*1*) maximizing the number of shipping containers in the lot sample, (*2*) taking a single package end per shipping container in the laboratory sample, and (*3*) taking only one specimen per package. Unfortunately, this is rarely the most economical way to test a product because it normally costs most to take a shipping container as part of the lot sample, costs an intermediate amount to take a package from a shipping container as part of a laboratory sample, and costs least to take and test a specimen from a package or yarn.

5.4 To minimize the cost of sampling a lot of material, it is necessary to agree on the required variance for the reported average for a lot of material:

5.4.1 Estimate the variance due to lot samples, the variance due to laboratory samples, and the variance due to testing specimens.

5.4.2 Calculate the total variance for average test results for several combinations of the number of lot samples, the number of laboratory samples per lot sample, and the number of specimens per laboratory sample.

5.4.3 Calculate the cost of performing each of the sampling schemes considered in 5.4.2.

5.4.4 Select the sampling scheme that (*1*) has the required precision and (*2*) is most economical to perform.

6. Procedure

6.1 *Division into Lots*—Instructions on the division of product into lots is best given in the appropriate specification. In the absence of such instructions, sample and test as a separate lot any portion of a shipment or order that differs from other portions in specifications, put-up, or physical characteristics, or that is billed or designated by the supplier as a separate lot. If portions of a larger order are shipped on different dates, from plants or warehouses, or in more than one carload or truckload, treat each such separately shipped portion as a separate lot. If the cases in a shipment do not have consecutive numbers, divide the shipment into groups of cases having consecutive numbers and treat each group as a separate lot if it is separated from an adjacent group by as many as ten case numbers. Treat each beam set as a separate lot.

6.2 *Lot Sample*—As a lot sample for acceptance testing, unless otherwise agreed upon, as when specified in an applicable material specification, proceed as follows:

NOTE 1—An adequate specification or other agreement between the purchaser and the supplier requires taking into account the 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.

6.2.1 *Cases or Fabric Packages*—For the lot sample, assign each case or fabric package with consecutive numbers and take for acceptance testing, the number of cases or fabric packages specified in Table 1. Select the cases or fabric packages by a random process using the assigned numbers by either placing these numbers on small slips or chips, placing them in a container, mixing thoroughly and drawing out the number or numbers by selection, or by using a random number table or its computer equivalent.

6.2.1.1 When fabric packages, such as bolts or pieces, are contained in cases, consider the case as the sampling unit. When fabric packages, such as rolls are self-contained, consider the individual fabric package as the sampling unit.

6.2.1.2 When known, fabric packages, such as rolls, pieces, or bolts produced from one beam set may be treated in the same manner as beams.

6.2.2 *Beams*—For the lot sample, assign each beam with consecutive numbers and take for acceptance testing, one beam from the beam set. Select the beam by a random process using the assigned numbers by either placing these numbers on small slips or chips, placing them in a container, mixing thoroughly and drawing out the number by selection, or by using a random number table or its computer equivalent.

6.3 *Laboratory Sample*—For a laboratory sample for acceptance testing, unless otherwise agreed upon, as when specified in an applicable material specification, proceed as follows:

6.3.1 *Cases*—When sampling cases, take a total of ten packages from the lot sample. When there are five cases in the lot sample, select randomly two packages from each case. When there are four cases in the lot sample, select randomly two packages from each case then randomly select two of the four cases and select randomly a third package from each of the selected cases. When there are three cases in the lot sample, select randomly three packages from each case then randomly select one of the three cases and select randomly a fourth package from the selected case. When there are two cases in the lot sample, select randomly five packages from each case. When there is one case in the lot sample, select randomly ten packages from the case.

6.3.2 *Fabric Packages*—When sampling fabric packages, discard the outside layer of the fabric package, and then take a full width swatch, 2 m (2 yd.) from each selected lot sampling unit. Treat each type of yarn in the fabric, the warp and filling yarns in woven fabrics, and the machine direction of knitted fabrics as sepa–rate sampling units. Take a total of ten ends from the fabric swatches. When there are five swatches in the lot sample, select randomly two ends from each swatch. When there are four swatches in the lot sample, select randomly two ends from each swatch then randomly select two of the four swatches and select randomly a third end from each of the selected swatches. When there are three swatches in the lot sample, select randomly three ends from each swatch then randomly select one of the three swatches and select randomly a fourth end from the selected swatch. When there are two swatches in the lot sample, select randomly five ends from each swatch. When there is one swatch in the lot sample, select randomly ten ends from the swatch. Remove ends from the fabric swatches as directed in 6.3.4, 6.3.5, and 6.3.6, as required.

TABLE 1 Number of Cases, Beams, or Fabric Packages[A,B]

In Lot	In Lot Sample
1	1
2 to 4	2
5 to 9	3
10 to 19	4
20 or more	5

[A] For cases containing only a few packages per case, enough cases must be taken in the lot sample so there will be at least ten packages in the lot sample. (See 6.2.2.1 and 6.2.2.2.)

[B] Table 1 is an empirical practice schedule found by experience to be satisfactory for the lot sample from homogeneous lots of yarn or fabric support packages, such as rolls or boards.

NOTE 2—Individual yarns removed from fabric may come from several yarn shipments and may not be representative of a given yarn lot. Yarns removed from fabric are generally used for identification purposes.

6.3.3 *Beams*—When sampling beams of yarn, take ten ends from the first beam in the lot sample. Randomly take the first end from among those included between 2.5 and 7.5 % of the beam end count from one beam flange. Take the other nine ends from positions each 10 % of the beam end count from the first end toward the other beam flange. When sampling yarn on beams, reel sample skeins, or reel test skeins directly from the beams using minimal tension to prevent stretching of yarns. Place the beam containing the yarn to be tested on two bearings high enough for the beam flanges to clear the floor. Attach a crank arm to one end of the beam shaft. Place the reel a convenient distance from the beam to draw the yarn from the beam at less than a 20° angle. Fasten the required number of ends from the beams to the reel. Let one operator turn the beam slowly to unwind the yarn while a second operator turns the reel fast enough to take up the yarn as it comes from the beam.

NOTE 3—In using beams after the test ends have been removed, a set of spools containing the same kind of yarn or thread as that on the beam may be placed behind the beam on a small creel to replace the ends that have been used for testing. When the ends which supply the test skeins come up on the beam, the auxiliary spools may be broken out.

6.3.4 *Sample Skeins*—It is often preferable, but is not mandatory except when sampling yarn on beams, to reel sample skeins. Skeins condition more rapidly than tightly wound packages, and it is sometimes more convenient to handle the laboratory sample in skein form. From each of the yarn packages or ends selected for the laboratory sample, reel a skein containing sufficient length to provide all the specimens required. If yarn strength or yarn number is to be determined by skein methods, the test skeins specified in Test Method D 1578 and Test Method D 1907 may be reeled directly from the yarn packages or beams, and additional sample skeins may be reeled as a source of specimens for other tests. Remove the yarn from packages either by drawing over the end of bobbins, cops, cones, etc., or from the side of flanged spools or beams, whichever is done in normal use. When the normal means of yarn removal is not known, draw the yarn from the side of the

package. Removal of yarn over-end drawing from the side results in a difference of twist of $1/\pi d$, where d is the package diameter. When several ends are wound parallel on a single package or beam, draw each end through a separate guide and reel a skein from each selected end in the laboratory sample, drawing from the side of the package form or beam.

6.3.5 *Removing Yarn from Woven Fabrics*— Cut the fabric parallel to the direction (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 swatch.

NOTE 4—If the 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.

6.3.6 *Removing Yarn from Weft Knit Fabrics*—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 for the property of interest. For double knit fabric, randomly take five ends from the short feed length courses and five ends from the long feed length courses to obtain the required ten ends. Treat dial and cylinder yarns as the same unless there is reason to think that they are different, such as different colors.

6.3.7 *Removing Yarn from Warp Knit Fabrics*—Clamp one side of the fabric, face up, to an edge of a pile board. Stretch the fabric across the board to put slight tension on the loops and clamp it to the opposite side of the board. Place clamps near the raveling end of the fabric (closed wale loop). Randomly take ends from the wale direction consisting of an appropriate number of ends from each bar throughout the lot sample and at least 0.2 m (8 in.) longer than the specimen length required for the property of interest. When known, treat the yarns from different bars as the same unless there is reason to think that they are different. When yarns are known to be different from different bars, treat each different yarn type separately.

NOTE 5—Warp knit fabrics normally use at least two bars, but may use as many as five and possibly more. With two-bar knits, the yarns may be the same or different. When more than two bars are used, yarns on the different bars usually are not all the same type. Warp knit fabrics can be made with one bar, but it is unusual and rarely used.

6.3.7.1 Clean the wale loops of cut ends by inserting dissecting needle (hereafter, 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. 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 part 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. This initial starting of the raveling process is most easily accomplished using a stereomicroscope, but a low-power magnifying glass may be sufficient. The yarns may now be sandwiched in tape at the end to keep them together and for ease of handling.

6.3.7.2 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 such that a uniform line is maintained across the courses as the wales are being ravelled. 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.

6.3.7.3 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).

6.4 *Test Specimens*—Randomly take9 the number of ends per unit in the laboratory sampling unit that is specified in the applicable test method.

7. Keywords

7.1 sampling; yarn