



## Standard Test Method for Commercial Mass of a Shipment of Yarn or Manufactured Staple Fiber or Tow<sup>1</sup>

This standard is issued under the fixed designation D 2494; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This test method provides a measurement of the commercial mass of a shipment of yarn or manufactured staple fiber or tow. This test method applies to (1) yarn of all fiber types except silk, glass, asbestos, and bast; (2) tops and slivers of all fiber types except wool, silk, glass, asbestos, and bast; and (3) manufactured fibers or tow, except glass and other fibers used for special purposes such as flock (Note 1).

NOTE 1—For other test methods for measuring mass of fibrous materials, refer to Practice D 2720.

1.1.1 Sampling in this test method is primarily for use in acceptance testing rather than production control. Manufactured fiber producers usually sample for the commercial “mass” of product on an on-going basis rather than each shipment to a customer.

1.2 Commercial mass has been traditionally based on one of three options depending on the state of the material: (1) dried, unscoured yarn, staple fiber, tow, and so forth, using commercial moisture regain in the calculations; (2) dried, scoured yarn, staple fiber, tow, and so forth, using commercial moisture regain values in the calculations; and (3) dried, scoured yarn, staple fiber, tow, and so forth, using a commercial allowance agreed upon between the purchaser and the supplier in the calculations.

1.3 *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<sup>2</sup>

D 629 Test Methods for Quantitative Analysis of Textiles<sup>2</sup>

D 1909 Table of Commercial Moisture Regains for Textile Fibers<sup>2</sup>

D 2257 Test Method for Extractable Matter in Textiles<sup>2</sup>

D 2258 Practice for Sampling Yarn for Testing<sup>2</sup>

D 2720 Practice for Calculation of Commercial Weight and Yield of Scoured Wool, Top, and Noil for Various Commercial Compositions<sup>2</sup>

D 3333 Practice for Sampling Manufactured Staple Fibers, Sliver, or Tow for Testing<sup>3</sup>

D 3888 Terminology Relating to Open-End Spinning<sup>3</sup>

D 3990 Terminology Relating to Fabric Defects<sup>3</sup>

D 4849 Terminology Relating to Fibers and Yarns<sup>3</sup>

#### 2.2 AATCC Standard:

150 Dimensional Changes in Automatic Home Laundering of Woven Garments<sup>4</sup>

### 3. Terminology

#### 3.1 Definitions:

3.1.1 *commercial allowance (CA)*, *n*—an arbitrary value, equal to the commercial moisture regain, plus a specified allowance for finish, used with the mass of scoured, oven-dried yarn, to compute (1) yarn linear density, (2) the commercial or legal mass of a shipment or delivery of any specific textile material (see also *commercial moisture regain*), or (3) the mass of a specific component in the analysis of fiber blends.

3.1.2 *commercial mass*, *n*—billed mass (weight) as determined by a generally accepted method or as agreed upon between the purchaser and the seller.

3.1.2.1 *Discussion*—The basis for determining the commercial mass of a shipment of yarn or manufactured fibers is generally one of the following:

(1) *CAS Basis (commercial allowance with scoured material)*—the mass of oven-dry fiber or yarn after scouring by definite prescribed methods plus the mass corresponding to its *commercial allowance*.

(2) *CMRS Basis (commercial moisture regain with scoured material)*—the mass of oven-dry fiber or yarn after scouring by definite prescribed methods plus the mass corresponding to its *commercial moisture regain*.

(3) *CMRU Basis (commercial moisture regain with unscoured material)*—the mass of unscoured oven-dry fiber or

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 07.01.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 07.02.

<sup>4</sup> Available from the American Association of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle Park, NC 27709.

yarn plus the mass corresponding to its *commercial moisture regain*.

(4) *UN Basis (unadjusted net)*—the mass of unscoured fiber or yarn with no adjustment for the amount of moisture or finish, or both.

3.1.3 *commercial moisture regain, (CMR), n*—a formally adopted, arbitrary value, to be used with the oven-dried mass of textile fibers, when calculating the commercial mass of a shipment or delivery.

3.1.4 For definitions of the textile terms shipment and tare used in this test method, refer to Terminology D 4849.

3.1.5 For the terms laboratory sampling unit, moisture content, and oven-dry, refer to Terminology D 123.

3.1.6 For other textile terms used in this test method, refer to Terminology D 123, Terminology D 3888, Terminology D 3990, and Terminology D 4849.

## 4. Summary of Test Method

4.1 Representative specimens from a shipment are dried, weighed, and, in some cases, scoured and weighed again. From the net mass of the shipment and the masses of the specimens before and after treatment, commercial mass of the shipment is calculated using one of the following options:

4.1.1 *Option I*—CMRU basis treatment consists of drying only. Commercial mass includes finishes and a correction for commercial moisture regain.

4.1.2 *Option II*—CMRS basis treatment consists of scouring and drying. Commercial mass excludes scourables but includes a correction for commercial moisture regain.

4.1.3 *Option III*—CAS basis treatment consists of scouring and drying. Commercial mass includes a correction for commercial allowance.

4.1.4 *Option IV*—UN basis requires no samples and no treatment. Commercial mass equals the net mass of the shipment without adjustment for scourables or moisture.

## 5. Significance and Use

5.1 This test method is considered satisfactory as a referee method for acceptance testing of commercial shipments of yarn or manufactured staple fibers.

5.1.1 If there are differences of practical significance between reported test results for two laboratories (or more), comparative tests should be performed to determine if there is a statistical bias between them, using competent statistical assistance. As a minimum, use the samples for such a comparative test 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.

5.2 Option I is generally used to calculate the commercial mass of spun yarns, textured yarns, tops, and slivers. When materials are sold on a CMRU basis, the purchaser pays for the fiber lubricant or other removable processing aids.

5.3 Option II is generally used to calculate the commercial

mass of as-produced manufactured filament yarns (except some producer-textured yarns), manufactured staple fibers, and tows. This option is intended to reflect the mass of fiber remaining after fiber lubricants and processing aids are removed.

5.4 Option III is in common use in other countries, particularly in Europe.

5.5 Option IV is in common use with yarns made of wool or wool blends and some aramids.

5.6 When it can be shown that solvent extraction or another method of testing gives the same results, or results that have a constant ratio to those obtained by the scour procedure, that method may be used for routine testing of known production but should not be substituted for a scour on new or unknown material. For the determination of extractable matter, refer to Test Method D 2257.

5.6.1 When the finish is not removable by a water scour, a solvent extraction may be substituted on agreement between the purchaser and the supplier.

5.7 Under certain circumstances, samples taken from yarns and manufactured staple fibers and tows can change moisture content rapidly. For this reason, very careful planning and handling of samples are required to prevent major biases in commercial mass results.

## 6. Apparatus and Reagents

6.1 *Washing Machine*,<sup>4</sup> automatic home-type, of the make and model specified by the AATCC each year, or equivalent washing machine.

6.2 *Soft Water* (10 ppm or less calcium carbonate hardness) for hot setting of washer controlled for 60 to 65°C.

6.3 *Bags*,<sup>5</sup> made from polyester yarn, of a stable construction, such as a leno weave, which have been previously scoured and which have a known oven-dry mass. Each bag shall be large enough to permit the test specimen to be sufficiently porous to permit free access of the scouring solution to the specimen. The bag should have an adequate closure to prevent fiber loss.

6.4 *Automatic Dryer*,<sup>4</sup> automatic home-type, of the make and model specified by the AATCC each year, or equivalent, (optional).

6.5 *Drying Oven*, ventilated and capable of controlling the temperature in the range of 105 ± 3°C. The oven shall be supplied with a current of air sufficient to change the air once every 4 min. The specimens shall be protected from direct radiation of the heating units. Air supplied to the oven shall be at standard atmospheric conditions for testing textiles. The oven may be provided with facilities for cutting off the air current and weighing the specimens without removing them from the oven.

6.6 *Scale*, with a capacity and sensitivity sufficient to weigh beams, bales, cases, or other shipping units within 0.1 % of their gross mass and maintained according to National Institute

<sup>5</sup> The sole source of supply of the apparatus known to the committee at this time is Mar Mac Manufacturing Co., P.O. Box 278, McBee, SC 29101. If you are aware of alternative suppliers, please provide this information to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,<sup>1</sup> which you may attend.

of Standards and Technology (NIST) criteria.<sup>6</sup>

6.7 *Balance*, having a sensitivity of 0.1 % of the mass of the specimens being tested and maintained according to NIST criteria.<sup>6</sup> These requirements apply both to balances built into ovens and to free-standing devices.

6.8 *Weighing Cans*, with tight-fitting lids of sufficient size to hold the bag and specimen (required only if weighings are made outside the oven).

6.9 *Desiccator(s)*, of sufficient size to hold the weighing cans (required only if weighings are made outside the oven).

6.10 *Desiccant*, silica gel or equivalent, if desiccators are used.

6.11 *High Cloud Point Nonionic Detergent*,<sup>7</sup> as agreed upon between the purchaser and the supplier.

## 7. Procedure

7.1 *Shipment Mass*—Weigh, intact, each shipping unit (bale or case) in the shipment to the nearest 0.1 % of its mass.

NOTE 2—The gross mass and the tare mass should be obtained on materials at equilibrium with the same ambient conditions, which are often not the standard atmosphere for testing textiles. Also, for this procedure, the tare should be determined from actual weighings and not from values supplied by the supplier.

7.2 *Lot Sample*—Take a lot sample as directed in the applicable material specifications, or as agreed upon between the purchaser and the supplier, or in their absence as directed in Practice D 2258 for yarn or Practice D 3333 for staple fiber. Treat sliver (or top) and tow as staple for lot sampling. The same units selected for product samples will also be used for tare samples. The lot sample must be representative of the shipment and must be taken at random from the various shipping units.

NOTE 3—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.

7.3 *Laboratory Samples*—Take laboratory samples representative of the shipment as directed as follows. Save all loose packaging materials (wrappings, strappings, and separators) from each lot sample unit for tare weighing. Sample the lot as quickly as possible to reflect accurately the moisture level in the lot. Place samples in airtight containers for subsequent weighing.

7.3.1 *Yarn*—Take at least 20 unit packages from random places within the different shipping units forming the lot sample as directed in Practice D 2258. Use a prearranged plan for random sampling to save time in taking the packages from the shipping units. Enclose each unit package in a separate airtight container until the specimens are removed.

7.3.1.1 Sampling beams of yarn for verification of commercial mass presents unique problems which are left to the agreement of the purchaser and the supplier.

7.3.2 *Staple, Sliver or Top, and Tow*—Take laboratory samples from each laboratory sampling unit as directed in Practice D 3333.

7.4 *External Tare*—Collect, without delay, all packaging materials which were part of the lot sample and which were associated with the shipping units. Supports for individual packages will be dealt with in 7.6. Weigh the external tare material for each lot sample unit to 0.1 % of its mass. (See Note 3).

7.5 *Specimens*—Without delay, prepare specimens as directed in 7.5.1 or 7.5.2. Save all yarn supports which were part of the laboratory sample.

7.5.1 *Yarn*—Take two 5-g bits of yarn from each of at least 20 packages that form the laboratory sample. Immediately put each bit into one of two airtight containers and close the container after obtaining each bit. (Each container will contain bits from 20 packages.) With the exception of lots shipped on beams, take the yarn from random locations within the packages. Prepare representative specimens each weighing approximately 100 g. Do not wind or reel yarn being taken for specimens. Keep the hands dry and handle the yarn (both packages and specimens) as little as possible. Select one of the specimens for testing; set the other aside for any confirmatory tests which may be required.

7.5.1.1 Preparation of specimens from beams is left to the agreement of the purchaser and the supplier.

7.5.2 *Staple, Sliver, Top, Tow*—Treat each of the laboratory samples as a specimen. Select one of each pair of specimens for testing and set the other aside for confirmatory testing, if required.

7.6 *Internal Tare*—Collect, without delay, all yarn supports which were part of the laboratory sample and weigh each to 0.1 % of its mass.

7.7 *Specimen Mass, M*—Without delay, weigh each specimen to the nearest 0.1 % of its mass, after removing from the container.

7.8 *Bagging*—Place the specimens in the bags and close the bags securely.

7.9 *Drying and Weighing*—Dry and weigh the specimens (N) to determine the dry mass as directed in 7.9.1 or 7.9.2.

7.9.1 *Oven Equipped with Balance*—Place the bags containing the specimens in the drying oven. Dry each specimen at  $105 \pm 3^\circ\text{C}$  until it loses no more than 0.1 % of its mass when heated for 30-min intervals.

7.9.2 *Oven Not Equipped with Balance*—Place the bagged specimens and tared weighing cans in the oven. Dry each specimen at  $105 \pm 3^\circ\text{C}$  for 60 min. Quickly place the specimen in its weighing can and close the can. Transfer to desiccator and cool to room temperature. Remove the can from the desiccator and crack open the can momentarily to equalize air pressure and reseal before weighing. Weigh the specimen to the nearest 0.01 g. Continue drying, cooling, and weighing until the specimen loses no more than 0.1 % of its mass.

NOTE 4—Do not dry the bagged specimens in the weighing cans or leave the covers on the cans in the oven.

<sup>6</sup> "Specifications, Tolerances and Other Technical Requirements for Commercial Weighing Devices," *NBS Handbook No. 44*, 1977, may be obtained from the National Institute of Standards and Technology, Washington, DC 20234.

<sup>7</sup> Detergents Tergitol 15-S-12, available from Union Carbide, Old Ridgebury Road, SCTNC-2, Danbury, CT 06817, and Mergol HCS, available from Dupont Chemicals and Pigments, 1007 Market St., Wilmington, DE 19898, or their equivalent, have been found satisfactory.

NOTE 5—Drying and weighing the specimen before scouring is not needed for the calculation of the commercial mass but the drying is specified to provide data that can be used to calculate independently the loss due to drying and the loss due to scouring or to facilitate analysis of discrepancies observed between tests.

NOTE 6—Acrylic fibers can decompose during heating; therefore, it must be established that continued mass loss is due only to moisture.

7.10 *Scouring* (Options II and III Only)—Fill the washing machine with hot water to heat machine before starting the test. Drain. Place the individually bagged specimens in the washing machine and fill with water at 60 to 65°C. The bath must have a mass of at least 25 times that of the specimens being scoured. Operate the washing machine under the most severe washing cycle, that is, soft, hot water wash with 0.5-g/L nonionic detergent, and rinse with hot water for the maximum time permitted by the washer.

7.11 *Pre-Drying* (Options II and III Only)—Dry in an automatic home dryer or by other means until the specimens are dry to the touch. Do not heat the specimens above 105°C.

7.12 *Drying and Weighing* (Options II and III Only)—Dry and weigh the specimens (*D*) as directed in 7.9.

7.13 *Efficacy of Scour* (Options II and III Only)—Prepare four specimens of yarn by reeling skeins of yarn and dividing them into replicates by cutting across all turns (strands) of the skein. For staple fiber, prepare four specimens as directed in 7.3.2 or by dividing sliver of the fiber or fiber blend under test. For tow, cut four adjacent segments. Test replicate specimens by running two specimens through a normal treatment (7.8-7.12) and another two specimens through a double-scour treatment (7.8-7.10, repeat 7.10 and follow with 7.11 and 7.12). Calculate the commercial mass for each specimen, and the average commercial mass for the single scour and for the double scour. If the difference between the two averages exceeds 0.1 % of the average mass, take a new laboratory sample and use the double-scour procedure on all subsequent samples of similar material.

NOTE 7—In the double scour, drying is omitted between scourings because of possible effects on the yarns or fiber.

## 8. Calculation

8.1 *Gross Mass of Shipment, W*—Add together the masses of the shipment units obtained in 7.1.

8.2 *Gross Mass of Tare, T*—Compute by adding together the gross mass of the external tare and the gross mass of the internal tare as determined as follows:

8.2.1 Calculate the gross mass of the external tare by adding the external tares of the lot sample units and adjusting for the number of units in the shipment.

8.2.2 Calculate the gross mass of the internal tare by adding the internal tares of the laboratory samples and adjusting for the number of individual packages in the shipment.

8.3 Calculate the commercial mass of the shipment for each specimen using Eq 1, Eq 2, Eq 3, or Eq 4.

$$\text{Option I, commercial mass, } CMRU = (W - T) (N/M) \times [(100 + R)/100] \quad (1)$$

$$\text{Option II, commercial mass, } CMRS = (W - T) (D/M) \times [(100 + R)/100] \quad (2)$$

$$\text{Option III, commercial mass, } CAS = (W - T) (D/M) \times [(100 + F)/100] \quad (3)$$

$$\text{Option IV, commercial mass, } UN = W - T \quad (4)$$

where:

- W* = gross mass of the shipment, obtained in 8.1,
- T* = gross tare for the empty containers, boxes, wrapping papers, spools, or cone cores obtained, 8.2,
- M* = original mass of the test specimen,
- N* = moisture-free mass of the unscoured specimen,
- D* = moisture-free mass of the scoured specimen,
- R* = commercial regain for the fiber as listed in Table D1909, and
- F* = agreed-upon commercial allowance for moisture and finish.

8.4 Calculate the mean commercial mass of the shipment.

8.5 If the yarn or staple fiber is blended from two or more fibers that have different commercial regains or commercial allowances, calculate the applicable moisture regain using Eq 5 or Eq 6.

$$R = AR_a + BR_b + \text{etc.} \quad (5)$$

$$F = AF_a + BF_b + \text{etc.} \quad (6)$$

where:

- A* = amount of Fiber A, expressed as a decimal fraction of the mass,
- B* = amount of Fiber B, expressed as a decimal fraction of the mass,
- R<sub>a</sub>* = commercial regain for Fiber A, %,
- F<sub>a</sub>* = commercial allowance for Fiber A, %,
- R<sub>b</sub>* = commercial regain for Fiber B, %, and
- F<sub>b</sub>* = commercial allowance for Fiber B, %, etc.

8.6 Calculate the coefficient of variation or standard deviation, or both, for the lot if requested.

NOTE 8—*A* and *B* in Eq 5 may be determined using Test Methods D 629.

8.7 When required to convert from moisture content or moisture regain, or vice versa, use Eq 7 or Eq 8, as applicable:

$$R = [M/100 - M] \times 100 \quad (7)$$

$$M = [R/100 + R] \times 100 \quad (8)$$

where:

- R* = moisture regain, % and,
- M* = moisture content, %

## 9. Report

9.1 State that the specimens were tested as directed in ASTM Test Method D 2494. Describe the product of material sampled and the method of sampling used.

9.2 Report the following information:

9.2.1 The invoiced mass of the shipment and the number of containers in the lot,

**TABLE 1 Components of Variance as Standard Deviations, Percent Weight Loss Due to Extractables and Moisture as Percentage Points**

	Single-Operator Component	Within-Laboratory Component	Between-Laboratory Component
Spun cotton yarn	0.137	0.000	0.057
Polyester filament yarn	0.047	0.056	0.080
Nylon staple	0.068	0.045	0.138
Spun rayon yarn	0.256	0.354	0.130



- 9.2.2 Gross mass of the shipment,
- 9.2.3 Adjusted tare for the shipment,
- 9.2.4 Net mass of the shipment,
- 9.2.5 Average commercial mass of the shipment,
- 9.2.6 Optional procedure(s) employed,
- 9.2.7 Value of commercial moisture regain or commercial allowances used in calculations,
- 9.2.8 Number of specimens tested, and
- 9.2.9 The coefficient of variation or standard deviation, or both, for the lot if calculated.

## 10. Precision and Bias

10.1 *Summary*—In comparing two averages of two determinations each, the difference should not exceed the following amounts in 95 out of 100 cases when all of the determinations are taken 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.

Spun cotton yarns	0.27 percentage points
Polyester filament yarn	0.09 percentage points
Nylon staple	0.13 percentage points
Spun rayon yarn	0.50 percentage points

The procedure in this test method has no known bias and is generally accepted as a referee method. Paragraphs 10.2-10.4 explain the basis for this summary and for evaluations made under other conditions.

10.2 *Interlaboratory Test Data*<sup>8</sup>—An interlaboratory test was run in 1982 in which randomly drawn specimens of four materials were tested in each of four laboratories. Each laboratory used two operators, each of whom tested two specimens of each material. The materials were a spun cotton yarn, a polyester filament yarn, a nylon staple, and a spun rayon yarn. The components of variance expressed as standard deviations were calculated to the value listed in Table 1.

NOTE 9—The square roots of the components of variance are being reported so that variability is expressed in the appropriate units of measure rather than as the square of those units of measure.

NOTE 10—The standard deviations of test results in Table 1 can be converted to the standard deviations of the ratio,  $N/M$  in Eq 1 by dividing the above values by 100.

10.2.1 The components of variance reported in 10.2 are for percent weight loss due to extractables and moisture which is not used directly in Eq 1. Instead  $N/M$ , the ratio of the moisture-free mass of the unscoured specimen to the original mass of the test specimen is used in calculating commercial mass under Option 1. This ratio can be calculated using Eq 9:

$$N/M = (100 - C)/100 \quad (9)$$

<sup>8</sup> Supporting data are available from ASTM Headquarters. Request RR: D13-1037.

where:

$C$  = percent moisture content.

10.3 *Precision*—For the components of variance reported in 10.2, two averages should be considered significantly different at the 95 % probability level if the difference equals or exceeds the critical differences listed in Table 2.

NOTE 11—Since the interlaboratory test included only four laboratories, estimates of between-laboratory precision should be used with special caution.

NOTE 12—The tabulated values of the critical differences should be considered to be a general statement, particularly with respect to between-laboratory precision. Before a meaningful statement can be made about two specific laboratories, the amount of statistical bias, if any, between them must be established with each comparison being based on recent data obtained on specimens from a lot of material of the type being evaluated so as to be as homogeneous as possible and then randomly assigned in equal numbers to each of the laboratories.

10.4 *Bias*—The procedure in this test method has no bias because the true value of a commercial mass can be defined only in terms of a test method.

## 11. Keywords

11.1 commercial mass; textile fibers; textile strand; yarn

**TABLE 2 Critical Differences for the Conditions Noted, 95 % Probability Level, Percent Weight Loss Due to Extractables and Moisture in Percentage Points<sup>A</sup>**

Number of Determinations in Each Average	Single-Operator Precision	Within-Laboratory Precision	Between-Laboratory Precision
Spun Cotton Yarn			
1	0.38	0.38	0.41
2	0.27	0.27	0.32
4	0.19	0.19	0.25
8	0.14	0.14	0.21
16	0.10	0.10	0.19
Polyester Filament Yarn			
1	0.13	0.20	0.30
2	0.09	0.18	0.29
4	0.07	0.17	0.28
8	0.05	0.16	0.27
16	0.03	0.16	0.27
Nylon Staple			
1	0.19	0.23	0.44
2	0.13	0.18	0.42
4	0.13	0.16	0.41
8	0.07	0.14	0.41
16	0.05	0.13	0.41
Spun Rayon Yarn			
1	0.71	1.21	1.26
2	0.50	1.10	1.16
4	0.35	1.04	1.10
8	0.25	1.01	1.07
16	0.18	1.00	1.06

<sup>A</sup> The critical differences were calculated using  $z = 1.960$ .



## D 2494 – 02

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