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Standard Test Methods for Measurement of Physical Properties of Raw Cotton ~~Fibers by High Volume~~Cotton Classification Instruments[1]

This standard is issued under the fixed designation D5867; 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

~~1.1These test methods cover the color, trash content, micronaire, length, length uniformity, strength and elongation of cotton fibers using the Spinlab System HVI 900 SA or the Motion Control, Inc. Systems HVI 3500 and HVI 4000 that are a series of instruments connected to single dedicated programmed computers.~~

~~1.2These test methods are applicable to loose fibers taken from raw or partially processed cotton and some types of cotton waste.~~

~~1.3These test methods contain the following sections:~~

1.1 This test method covers the measurement of color, trash content, micronaire, upper half mean length (length), uniformity index and breaking tenacity (strength) of raw cotton for cotton marketing using a cotton classification instrument.

1.2 This test method is applicable to Upland and Extra Long Staple (ELS) raw cotton.

1.3 This test method is applicable to roller and saw ginned raw cottons.

1.4 This test method contains the following sections.

	Section
~~Color of Cotton~~	~~7~~ 15 Color
~~Trash Content of Samples of Cotton Fibers~~	~~16~~ 24 Trash Content
~~Micronaire Reading of Cotton Fibers~~	~~25~~ 33 Micronaire Reading
~~Length and Length Uniformity of Cotton Fibers~~	~~34~~ 42 Upper Half Mean Length (Length) and Uniformity Index
~~Breaking Tenacity and Elongation of Cotton Fibers~~	~~43~~ 51
~~Precision and Bias~~	~~52~~Breaking Tenacity (Strength)

~~1.4The~~1.5 The values stated in both inch-pound and SI units are to be regarded separately as the standard. The values given in parentheses are for information only.

~~1.5~~1.6 *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:*[2]

D123 Terminology Relating to Textiles ~~D1441~~

D1441 Practice for Sampling Cotton Fibers for Testing ~~D1445~~

D1445 Test Method for Breaking Strength and Elongation of Cotton Fibers (Flat Bundle Method) ~~D1447~~

D1447 Test Method for Length and Length Uniformity of Cotton Fibers by Photoelectric Measurement ~~D1448~~

D1448 Test Method for Micronaire Reading of Cotton Fibers ~~D1776~~

D1776 Practice for Conditioning and Testing Textiles ~~D2253~~

D2253 Test Method for Color of Raw Cotton Using the Nickerson-Hunter Cotton Colorimeter

[1] These test methods are under the jurisdiction of ASTM Committee D13 on Textiles and are the direct responsibility of Subcommittee D13.11 on Cotton Fibers.

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

D2812~~2~~2495 Test Method for Moisture in Cotton by Oven-Drying
D2812 Test Method for Non-Lint Content of Cotton ~~D3025~~
D3025 Practice for Standardizing Cotton Fiber Test Results by Use of Calibration Cotton Standards
D4848 Terminology Related to Force, Deformation and Related Properties of Textiles
D7139 ~~Terminology for Cotton Fibers~~ Terminology for Cotton Fibers
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

3. Terminology

3.1 For all terminology related to D13.11, refer to D7139

~~3.1.1The following terms are relevant to this standard: breaking tenacity, elongation at break, mean length, micronaire reading, particle count, percent area, span length, Rd and +b, strength, test beard, uniformity index, uniformity ratio, upper-half-mean length.~~ .

3.1.1 The following terms are relevant to this standard: micronaire reading, particle count (trash), percent area (trash), Rd (color reflectance) and +b (color yellowness), breaking tenacity (strength), uniformity index, upper-half-mean length.

3.2 For all other terminology related to textiles, refer to Terminology D123 and Terminology D4848.

4. Significance and Use—General

~~4.1These test methods are used in the trade and are considered satisfactory for acceptance testing of commercial shipments when the level of tests, of any one or several or all of the individual physical properties, in the laboratory of the purchaser and the laboratory of the supplier are controlled by the use of the same laboratory control samples.~~

~~4.1.1In case of dispute arising from differences in reported test results when using these test methods for acceptance testing of commercial shipments, the purchaser and the supplier should conduct comparative tests to determine if there is a statistical bias between their laboratories. Competent statistical assistance is recommended for the investigation of bias. As a minimum, the two parties should take a group of test specimens that are as homogeneous as possible and that are from a lot of material of the type in question. The test specimens should then be randomly assigned in equal numbers to each laboratory for testing average results from the two laboratories should be compared using Student's *t*-test for unpaired data and an acceptable probability level chosen by the two parties before testing is begun. If a bias is found, either its cause must be found and corrected or the purchaser and the supplier must agree to interpret future test results in the light with consideration to the known bias.~~

~~4.2Being able to measure color, particle count of trash, micronaire, length, strength, and elongation using an integrated and dedicated system has the following benefits:~~

~~4.2.1The HVI measuring system can rapidly and objectively determine the color of cotton that is an important factor in determining the end use of cotton.~~

~~4.2.2The HVI system provides a particle count of the cotton trash that is directly related to textile processing waste.~~

~~4.2.3The HVI system determines micronaire, a factor that is correlated with cleaning efficiency, neppiness, the strength and uniformity of yarn, and dyeing of fibers, yarns, and fabrics.~~

~~4.2.4The HVI system provides a reproducible and economical procedure to measure length and length uniformity of fibers.~~

~~4.2.5The HVI system can determine various stress-strain parameters that are useful for research and for relating fiber characteristics to processing performance and quality of end products.~~

4.1 This test method is accepted for testing of bales of raw cotton in commercial shipments.

4.2 This test method describes acceptable practices for testing of raw cotton using cotton classification instruments that are capable of testing the fiber properties of micronaire reading, length, uniformity index, strength, Rd (color), +b (color), percent area (trash) and particle count (trash).

5. Sampling

5.1 ~~*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 D1441 for bales of fiber or containers of sliver. Consider shipping containers or bales to be the primary sample units.~~

~~NOTE1—An adequate specification or other agreement between the purchaser and the supplier requires taking into account the variability between sampling units, between laboratory samples within a sampling unit, and between test specimens within a laboratory sample 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*—For acceptance testing, randomly take material from each lot sampling unit, or original material, such as: loose fibers from one or more bolls, plants, or rows in a field; bales, mixes, or blends of cotton; or any consignment, shipment, or lot of cotton; of any size or mass to yield the required test specimen(s).~~

~~5.3*Test Specimens*—Take test specimens as directed in the description of individual test methods.~~ Bale Sample—For a bale sample, take a 4 oz (100 g) subsample of cotton from each of two opposite sides of the bale and combine the two subsamples into a single bale sample weighing 8 oz (200 g).

6. Conditioning

6.1Bring the laboratory samples to moisture equilibrium for testing in these test methods atmosphere for testing textiles. See Practice D1776.

6.1 Condition the cotton samples to the temperature and relative humidity levels of 21 ± 1°C (70 ± 2°F) and 65 ± 2 % until moisture equilibrium is reached.

6.2 Accelerated conditioning is an acceptable practice for this test method.

6.3 Moisture content (dry basis) measured by resistance technique referenced to oven method Test Method D2495 shall be within 6.75 to 8.25 %.

NOTE2—Cotton is normally received in the laboratory in a relative dry condition, making special preconditioning procedures unnecessary. Samples that are obviously damp should be preconditioned before being brought into the laboratory for conditioning. 1—This range covers the equilibrium moisture content range for all cottons.

NOTE3—If tests are not made for moisture equilibrium, it is recommended that the samples be conditioned for at least 12 h prior to testing.

COLOR OF RAW COTTON 2—Cotton is normally received in the laboratory in a relative dry condition, making special preconditioning procedures unnecessary. Samples that are obviously damp should be preconditioned before being brought into the laboratory for conditioning.

7. Scope

7.1This test method covers the comparison of the color of raw cotton with the official standards of the United States Department of Agriculture for Color Grade of cotton by means of a cotton colorimeter of the Nickerson-Hunter type. It can be used to measure the color of any type of raw cotton but is particularly applicable to Upland and American Pima cotton, for which official grade Standards have been established.

7.2The instrument employs the use of a programmable microprocessor with memory for controlling internal operations and performing required calibration, calculation, and data presentation.

NOTE4—For another method describing the measurement of the color of raw cotton, refer to Test Method D2253. Calibration

7.1 Follow instrument manufacturers' procedures for sample placement.

7.2 *Calibration of Rd (color reflectance) and +b (color yellowness)*:

7.2.1 For color calibration of Rd and +b, calibrate using USDA color materials in accordance with instrument manufacturers' recommendations to establish a testing level consistent with the industry accepted Universal HVI Rd/+b Cotton Color Standards.

7.3 *Calibration of Percent Area (trash) and Particle Count (trash)*:

7.3.1 For trash calibration of percent area and particle count calibrate using USDA trash materials in accordance with instrument manufacturers' recommendations.

7.4 *Calibration of Micronaire*:

7.4.1 For calibration of micronaire, cotton calibration or orifice calibration methods are accepted practices within the industry.

7.4.2 For cotton calibration of micronaire, calibrate using Universal HVI Micronaire Calibration Cotton Standards in accordance with instrument manufacturers' recommendations.

7.4.3 For orifice calibration of micronaire, calibrate using USDA micronaire materials in accordance with instrument manufacturers' recommendations to establish a testing level consistent with the industry accepted Universal HVI Micronaire Calibration Cotton Standards.

7.5 *Calibration of Upper Half Mean Length, Uniformity Index and Breaking Tenacity (Strength)*:

7.5.1 For Upland saw ginned and roller ginned raw cotton testing, calibrate the instrument with Universal HVI Calibration Cotton Standards (Short/Weak and Long/Strong).

7.5.2 For ELS saw ginned and roller ginned raw cotton testing, calibrate the instrument with Universal HVI Short/Weak Calibration Cotton Standard and Extra Long Staple HVI Long/Strong Calibration Cotton Standard.

7.6 The calibration materials can be obtained from the USDA, AMS, Cotton Division's Standardization and Engineering Branch. The contact information is provided below:

USDA, AMS, Cotton Division
Standardization and Engineering Branch
3275 Appling Road, Room #5
Memphis, TN 38133 USA
http://www.ams.usda.gov/cotton/
phone: 901-384-3030 / fax: 901-384-3032

COLOR

8. Summary of Test Method

8.1A smooth representative surface of a cotton sample is placed over the colorimeter sample window and pressed flat. The instrument colorimeter is energized, and color values are displayed on the instrument's visual monitor in one or more of the following terms: the grayness and yellowness scale developed for cotton, the Rd and +b values, and the United States Department of Agriculture color grade code number. Scope

8.1 This section describes the measurements of Rd (color reflectance) and +b (color yellowness) for raw cotton. The Rd and +b measurements are based upon standards established by USDA.

9. Significance and Use

9.1Color is the primary factor of the color grade of cotton. Since cotton is graded by visual judgment, an instrument that measures color in terms that are highly correlated with visual judgement is a decided asset. Color measurements are even more important for use as an aid in reproducing copies of the official standards for color grade of cotton.

9.2Color is an element of cotton quality, and raw stock color measurements are useful in controlling the color of manufactured greige, bleached, or dyed yarns and fabrics. Summary of Test Method

9.1 A smooth representative surface of a cotton sample is placed in the color measurement area and pressed flat with a minimum force of 4 lb/in.^{2}(0.3 kg/cm^2).

10. Apparatus and Materials

10.1*Cotton Colorimeter*, HVI Model, with accessories.

10.2*Calibration Tile Standards*—A set of five working calibration tile standards of designated Rd and+b values.

10.3*Cotton Color Check Standards*. Significance and Use

10.1 Color is an element of cotton quality, and raw cotton color measurements are useful in controlling the color of manufactured greige, bleached, or dyed yarns and fabrics.

11. Preparation of Apparatus

11.1Allow the instrument to warm up for at least 4 h or until it becomes electronically stable.

11.2By keyboard entry, select the appropriate routine for calibration from the menu displayed on the monitor.

11.3Follow the displayed instructions requiring keyboard entry of the Rd and +b values of each calibration tile. As each tile is presented to the instrument, the programmed microprocessor will cause electronic circuitry to be automatically adjusted for agreement of displayed values with the designated values of the tiles.

11.4Perform measurements of the color check standards of cotton to verify calibration.

11.5If unacceptable results are obtained from the measurement of the color check standards of cotton, repeat the calibration tile procedure (see 11.3) until acceptable results are obtained. Procedure

11.1 One or more test replications shall be made on each subsample of the bale sample.

11.2 The surface of each subsample shall be large enough to completely cover the instrument's measurement area and thick enough to be opaque (no light transmitted through the sample). An uncompressed minimum thickness of 2 in. (50 cm) and a minimum surface area of 9 in.^{2}(58 cm^2) of each subsample are required.

11.3 For the bale sample, report the average Rd (color reflectance) of the test replications to the nearest one tenth of a unit.

11.4 For the bale sample, report the average +b (color yellowness) of the test replications to the nearest one tenth of a unit.

TRASH CONTENT

12. Test Specimens

12.1Test two specimens, one from each side of the laboratory sample.

12.2Select a smooth surface of the laboratory sample that is judged to be representative for color as the test specimen. The surface of the sample should be large enough to completely cover the instrument's viewing window and thick enough to be opaque (no light transmitted through the sample). From experience, a thickness of 50 cm (2 in.) or more has been found acceptable.

NOTE5—Laboratory samples usually consist of samples cut from sides of bales or taken by an automatic sampling device. Such samples come in layers, and different surfaces can be observed easily by opening the samples in a manner similar to turning pages in a book. The surface selected should be fairly smooth and free of lumps or folds which many cause dark shadows and produce erroneous results. Scope

12.1 This section describes the measurements of percent area (trash) and particle count (trash) for raw cotton. The percent area and the particle count measurements are based upon standards established by USDA.

13. Procedure

13.1By keyboard entry, select the appropriate routine for testing cotton from the menu displayed on the monitor.

NOTE6—The test routines are governed by software programs tailored for individual requirements, such as necessary for sample identification number and other identifier entries, number of tests per sample, choice of units of measure (such as millimetres or inches), selection of test parameters, necessary for statistical summary, need for hard copy printout, forwarding data to compatible external data handling systems and computers, and other parameters.

13.2Place the surface of the specimen to be measured over the sample window and energize the instrument by pressing the appropriate switch that will cause a plate to apply pressure to the specimen.

13.3Hold the specimen until the instrument, by display at the visual monitor, advises that the measurement is complete.

13.4Make one observation on each side of the specimen unless it is obviously nonuniform in color.

13.4.1If the specimen is nonuniform in color, make additional observations on it at different places in the specimen to obtain a measure of the full range of color. Summary of Test Method

13.1 A smooth representative surface of a cotton sample is placed in the trash measurement area and pressed flat with a minimum force of 4 lb/in.^{2}(0.3 kg/cm^2).

14. ~~Calculation~~

~~14.1All calculations are performed by the instrument's internal programmed microprocessor.~~ Significance and Use

14.1 Trash content is useful for: estimating the net amount of manufactured textile product obtainable from raw cotton, predicting the quality of cotton textile products, particularly their aesthetic properties, assembling and blending values in a mix on a trash content basis, adjusting ginning and textile processing machinery for maximum efficiency in removing trash from cotton, and relating trash content of cotton to processing efficiency and end-product quality.

15. ~~Report~~

~~15.1State that the samples were tested for color as directed in these test methods. Describe the material and the method of sampling used.~~

~~15.2Report the following information:~~

~~15.2.1The number of specimens tested for each sample.~~

~~15.2.2The average Rd value and the average +b value to the nearest 0.1 unit.~~

~~15.2.3The color code of the United States Department of Agriculture cotton color grade diagrams that shows the various color grades of cotton in relationship to the scale of Rd on the vertical axis and the +b on the horizontal axis.~~

~~TRASH CONTENT~~ Procedure

15.1 One or more test replications shall be made on each subsample of the bale sample.

15.2 The surface of each subsample shall be large enough to completely cover the instrument's measurement area and thick enough to be opaque (no light transmitted through the sample). An uncompressed minimum thickness of 2 in. (50 cm) and a minimum surface area of 9 in.^{2}(58 cm^2) of each subsample are required.

15.3 For the bale sample, report the average percent area (trash) of the test replications to the nearest one hundredth of a unit.

15.4 For the bale sample, report the average particle count (trash) of the test replications to the nearest whole number.

MICRONAIRE READING

16. ~~Scope~~

~~16.1This test method describes the measurement of the amount of trash as seen by a video camera focused on the surface of a test specimen of cotton pressed against a glass window.~~

~~NOTE7—For another method describing the measurement of trash or non-lint content of cotton, refer to Test Method D2812.~~

~~16.2The instrument may be incorporated within the space occupied by and adjacent to the apparatus to measure color of raw cotton (see Sections 7-15), thus permitting simultaneous measurement of color and trash on the same test specimen.~~ Scope

16.1 This section describes the measurement of the micronaire of raw cotton that is based upon standards established by USDA.

17. Summary of Test Method

~~17.1A smooth representative surface of a test specimen of cotton is placed over the colorimeter/trashmeter sample window, the specimen is pressed flat. The trash meter is energized, and test values are read directly from instrument's visual monitor trashmeter.~~

17.1 A predetermined mass of raw cotton is placed in the measurement area and compressed. The resistance to air flow through the cotton using constant air pressure is measured.

18. Significance and Use

~~18.1Trash content is an element in determining the quality or use value of raw cotton. Trash is the primary factor of the leaf grade of cotton. Since cotton is usually graded by visual judgement, an instrument that measures trash in terms that are highly correlated with visual judgement is a decided asset.~~

~~18.2Trash content is useful for: estimating the net amount of manufactured textile product obtainable from raw cotton, predicting the quality of cotton textile products, particularly their aesthetic properties, assembling and blending values in a mix on a trash content basis, adjusting ginning and textile processing machinery for maximum efficiency in removing trash from cotton, and relating trash content of cotton to processing efficiency and end-product quality.~~

18.1 The micronaire reading of raw cotton is a function of both fineness and maturity and is related to environmental conditions during the growth of cotton, variety of cotton, mill processing performance, and to the quality of end products. Factors correlated with micronaire include cleaning efficiency, neppiness, the strength and uniformity of yarn, and dyeing of fibers, yarns, and fabrics.

19. ~~Apparatus and Materials~~

~~19.1*Trashmeter*, HVI model.~~

~~19.2*Calibration Tile Standards*—A set of working calibration tile standards of designated value for use in instrument calibration.~~ Procedure

19.1 Take one specimen from the bale sample and place the specimen into the instrument's micronaire measurement area for testing.

19.2 The specimen can be taken from either subsample or a portion can be taken and combined from each subsample.

19.3 For the bale sample, report the micronaire reading to the nearest one hundredth of a unit.

UPPER HALF MEAN LENGTH (LENGTH) AND UNIFORMITY INDEX

20. ~~Preparation of Apparatus~~

~~20.1Allow the instrument to warm up for at least 1 h or until it becomes electronically stable.~~

~~20.2By keyboard entry, select the appropriate routine for calibration from the menu displayed on the monitor.~~

~~20.3Follow the displayed instructions requiring keyboard entry of the calibration tile values for number of pieces of trash and percent area. The programmed microprocessor will cause electronic circuitry to be automatically adjusted in order that displayed values will agree with designated values of the tiles.~~

~~20.4Perform measurements of the tiles to verify calibration.~~ Scope

20.1 This section describes the measurement of the upper half mean length (length) and uniformity index of raw cotton that is based upon standards established by USDA.

21. ~~Test Specimens~~

~~21.1The test specimen is the surface of the laboratory sample that is placed over the sample window.~~ Summary of Test Method

21.1 The measurements of length and uniformity index of cotton fibers in a tapered beard are derived from the measured length distribution of cotton fibers. Fibers are caught at random along their lengths to form a tapered beard. The tapered beard is scanned from base to tip to form the fiber length distribution.

22. ~~Procedure~~

~~22.1By keyboard entry, select the appropriate routine for testing cotton from the menu display on monitor (see Note 6).~~

~~22.2Place the surface of the specimen to be measured over the sample window and energize the instrument by pressing the appropriate switch that will cause a plate to apply pressure to the specimen.~~

~~22.3Hold the specimen until the instrument, by display at the visual monitor, advises that the measurement is completed.~~

~~22.4Present to the sample window at least four different surface areas of the sample since trash within cotton is not uniformly distributed.~~ Significance and Use

22.1 The length and uniformity index of cotton is related to environmental conditions during the growth of cotton, variety of cotton, ginning of cotton, mill processing performance, and to the quality of end products.

23. ~~Calculation~~

~~23.1Perform all calculations by the instrument's internal programmed microprocessor.~~ Procedure

23.1 Take one specimen from each subsample of the bale sample for Upland saw ginned raw cotton and place the specimen into the instrument's length measurement area.

23.2 Take two specimens from each subsample of the bale sample for ELS or roller ginned Upland raw cottons.

23.3 For the bale sample, report the average of the specimens for upper half mean length to the nearest one thousandth of an inch (one hundredth of a millimeter).

23.4 For the bale sample, report the average of the specimens for uniformity index to the nearest one tenth of a unit.

BREAKING TENACITY (STRENGTH)

24. ~~Report~~

~~24.1State that the samples were tested for trash as directed in these test methods. Describe the material and the method of sampling used.~~

~~24.2Report the following information:~~

~~24.2.1The number of specimens tested for each sample, and~~

~~24.2.2The average percent area to the nearest 0.1 unit place and the average number of pieces of trash.~~

~~MICRONAIRE READING~~ Scope

24.1 This section describes the measurement of the breaking tenacity (strength) of raw cotton that is based upon standards established by USDA.

25. ~~Scope~~

~~25.1This test method describes the determination of the micronaire of loose cotton by measuring the resistance of a plug of cotton to air flow under prescribed conditions. The instrument employs a programmed microprocessor with memory for controlling internal operation and performing required calibration, adjustments, calculations, and data presentation.~~