**Designation: D 1447 – 00**

# Standard Test Method for Length and Length Uniformity of Cotton Fibers by Fibrograph Measurement[1]

This standard is issued under the fixed designation D 1447; 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 covers the measurement of the length and length uniformity of cotton fibers by use of the Fibrograph. The test method is applicable to fibers taken from raw or partially processed cotton or some types of cotton waste, but not to fibers from blends of cotton with other fibers or to fibers recovered from cotton yarns or fabrics.

1.2 This test method covers procedures for all models of the Digital Fibrograph, hereafter referred to as Fibrograph.

NOTE 1—Instructions for the use of Manual and Servo Fibrograph Models were included in the text of Test Method D 1447 in 1971 and previous editions.

NOTE 2—For other methods covering the measurement of the length of cotton fibers refer to Test Method D 1440.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this 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 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 1440 Test Method for Length and Length Distribution of Cotton Fibers (Array Method)[2]

D 1441 Practice for Sampling Cotton Fibers for Testing[2]

D 1776 Practice for Conditioning and Testing Textiles[2]

D 3025 Practice for Standardizing Cotton Fiber Test Results by Use of Calibration Cotton Standards[2]

## 3. Terminology

3.1 *Definitions:*

3.1.1 *amount, n—cotton length testing with the Fibrograph*, *n*—a measure of the thickness, or optical density, of the test beard, proportional to the number of fibers present at various distances from the comb(s).

3.1.2 *fibrogram*, *n—in cotton length testing with the Fibrograph*, the curve representing the second cumulation of the length distribution of the fibers sensed by the length measuring instrument in scanning the fiber board.

3.1.3 *span length (Fibrograph)*, *n*—the distance spanned by a specified percentage of the fibers in the test beard, taking the amount reading at the starting point of the scanning as 100 %.

3.1.4 *test beard*, *n—in length testing of cotton*, the portion of the test specimen that has been combed and brushed into a "beard" which protrudes from the outside of the comb(s) or the clamp(s).

3.1.5 *test specimen (Fibrograph)*, *n*—the cotton fibers placed randomly on a Fibrograph comb(s) for fiber length measurements.

3.1.6 *uniformity ratio*, *n*—in cotton length testing with the Fibrograph, the ratio between two span lengths expressed as a percentage of the longer length.

3.1.6.1 *Discussion*—various span lengths and measures of length uniformity may be calculated from the results of the measured points, but the 2.5 and 50 % span lengths and the 50/2.5 uniformity ratio are usually used.

3.1.7 For definitions of other textile terms used in this method, refer to Terminology D 123.

## 4. Summary of Test Method

4.1 Fibers are placed on comb(s) in such a way that they are caught at random points along their lengths to form a beard. The beard is scanned photoelectrically from base to tip, the amount of light passing through the beard being used as a measure of the number of fibers that extend various distances from the comb(s).

4.2 The Fibrograph shows the amount and the length readings from the Fibrogram being sensed on separate dials. The instrument can show percent, the distance spanned by predetermined percentages of the cotton fibers in the beard.

## 5. Significance and Use

5.1 This test method is considered satisfactory for acceptance testing when the levels of the laboratories are controlled by the use of the same reference standard cotton samples because the current estimates of between-laboratory precision are acceptable under these conditions. In case of dispute, the statistical bias, if any, between the laboratory of the purchaser

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[1] This test method is under the jurisdiction of ASTM Committee D13 on Textiles, and is the direct responsibility of Subcommittee D13.11 on Cotton Fibers.

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


**FIG. 1 Digital Fibrograph, Model 530**

and the laboratory of the seller should be determined with each comparison being based on testing randomized specimens from one sample of material.

5.2 Fibrograph measurements provide a relatively fast method for determining the length and length uniformity of the fibers in a sample of cotton in a reproducible manner.

5.3 Results of the Fibrograph length tests do not necessarily agree with those obtained by other methods for measuring lengths of cotton fibers because of the effect of fiber crimp and other factors.

5.4 Fibrograph tests are more objective than commercial staple length classifications and also provide additional information on fiber length uniformity of cotton fibers. The cotton quality information provided by these results is used in research studies and quality surveys, in checking commercial staple length classifications, in assembling bales of cotton into uniform lots, and for other purposes.

5.5 Fibrograph measurements are based on the assumptions that a fiber is caught on the comb in proportion to its length as compared to total length of all fibers in the sample and that the point of catch for a fiber is at random along its length.

## 6. Apparatus

6.1 *Fibrograph*,[3] Digital model, with accessory equipment as shown in Fig. 1.

6.2 *Fibrosampler*, for the preparation of test specimens (optional) as shown in Fig. 2.

[3] Instruments and accessories meeting these requirements may be obtained from Zellweger Uster, Inc., 456 Troy Circle, P. O. Box 51270, Knoxville, TN 37919-1270.

## 7. Sampling

7.1 *Division into Lots*—For acceptance testing purposes, the purchaser and the supplier shall agree on what material constitutes a lot.

7.2 *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 D 1441.

7.3 *Laboratory Sample*—As a laboratory sample for acceptance testing, select and prepare a 30 to 225 g (1 to 8 oz) subsample from each of the shipping containers in the lot sample, proceeding as directed in Practice D 1441 using either the blended sample procedure or the subsample procedure as agreed between the purchaser and the supplier.

7.4 *Test Specimens*—As directed in Section 10, prepare either two or four specimens from each subsample in the laboratory sample. For acceptance testing, test either two or four specimens from each subsample in the laboratory sample as agreed between the purchaser and the supplier.

## 8. Preparation and Adjustment of Apparatus

8.1 Set up the Fibrograph and adjust it as directed in the manufacturer's instructions for the model being used.

8.2 Set up and adjust the Fibrosampler as directed in the manufacturer's instructions.

8.3 Before making Fibrograph length tests, allow the instrument to warm up until it is electronically stable, then carefully check it both electronically and mechanically by using the methods listed in 8.3.1-8.3.4 for specific items.

8.3.1 Check the length and sensitivity controls according to

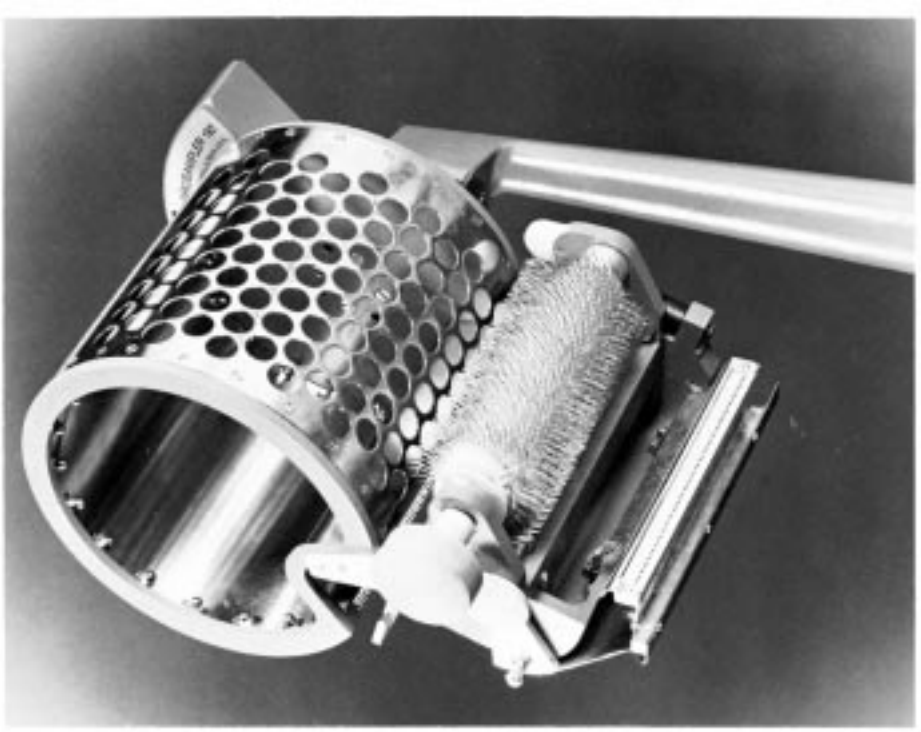

**FIG. 2 Fibrosampler**

the manufacturer's instructions and recommendations for the model being used. Compare the instrument measurement of the length of a card or similar item to its known length to check the correctness of the length indicator.

8.3.2 Compare the instrument measurement of light passage through different varying numbers of cellophane sheets to check the linearity or optical calibration.

8.3.3 Measure specimens of cotton fibers from a laboratory control sample with established length values (Note 3). Each technician must measure separate specimens prepared from a laboratory control sample and obtain acceptable length results before performing similar measurements on specimens from unknown samples. When unacceptable results are obtained from the laboratory control sample, recheck the instrument adjustments and the testing techniques until acceptable results are obtained (Note 4).

NOTE 3—Standard calibration cotton samples for Fibrograph length tests are available from the Cotton Division, Agricultural Marketing Service, U. S. Department of Agriculture, 4841 Summer Ave., Memphis, TN 38122, or other cottons may be used for routine calibration after extensive tests in comparison with USDA calibration samples have established the test values and the uniformity of the material. See Practice D 3025.

NOTE 4—The Fibrograph length results obtained are affected by the amount of combing performed on the specimens. Operators quickly learn through practice the amount of combing required to obtain acceptable results for the tests on the laboratory control samples for the instrument being used.

8.3.4 Make additional length measurements of specimens taken from the laboratory control sample at least every 2 h during the day to maintain a continuing check on the level of results.

## 9. Conditioning

9.1 Before preparing the specimens, bring the laboratory sample from the prevailing atmosphere to moisture equilibrium for testing in the standard atmosphere for testing textiles. Exposure to moving air for a period of at least 4 h is usually required, and a longer conditioning period is essential for large samples and for moist samples. Preconditioning is not necessary.

## 10. Preparation of Specimens

10.1 *Hand Combing Method*:

10.1.1 Place a portion of the conditioned laboratory sample on a pair of Fibrograph combs. Distribute the fibers evenly across the width of the combs while placing the fibers randomly along their lengths on the teeth of the combs. Place sufficient cotton on the combs for each test specimen to produce amount readings of 1.200 to 1.600.

NOTE 5—The exact amount of cotton within these limits does not affect the length values obtained, and operators can quickly learn through practice the amount of fibers required for the instrument being used.

10.1.2 Untangle and parallelize the beard of fibers protruding from the outer side of the teeth of the combs by holding one comb in each hand and gently combing the fibers from each comb with the teeth of the other comb. Transfer the fibers from one comb to the other and repeat the combing operation if desirable to obtain a uniform distribution of fibers on the combs.

10.1.3 Check to see if there is an approximately uniform distribution of fibers on each comb by holding the comb toward the light. When the distribution is not satisfactory, transfer fibers from the denser to the lighter areas of each comb. Do this

by continuing the combing action as directed in 10.1.2 while slightly tilting the teeth of the comb with the lighter area to transfer fibers from the denser area until a fairly uniform distribution is obtained on each comb.

10.2 *Fibrosampler Method* (*Fig. 2*):

10.2.1 Place the Fibrosampler comb in the combholder with the teeth uppermost. Place the laboratory sample in the cylinder and press it against the curved and perforated sample plate. Rotate the pivot arm for one complete counterclockwise revolution while maintaining evenly distributed pressure over the surface of the sample to load and comb the specimen of cotton fibers. Take the loaded comb from the Fibrosampler, turn the sample around to present a new surface to the perforated plate. If a second comb is required, repeat the load procedure described above.

10.2.2 Clean the card clothing on the Fibrosampler periodically to maintain effective combing action. To do this, raise the release button to put the doffer in the cleaning position, rotate the doffer one-half revolution clockwise to clean the clothing sector, and return it counterclockwise one-half revolution to clean the doffer.

## 11. Procedure

11.1 After the Fibrograph is in proper operating condition (see 8.3) and the correct combing procedure has been established, insert the loaded comb(s) into the combholder of the Fibrograph with the beard of fibers pointing downward. Brush the fibers with firm strokes of the Fibrograph brush to remove loose fibers, to straighten the other fibers without disturbing their distribution in the teeth of the comb(s), and thus complete preparation of the specimen.

11.2 Lower the lens assembly and manipulate the controls of the instrument to scan the fibers in accordance with the manufacturer's instructions for the model being used.

11.3 Test either two or four specimens from each subsample in the laboratory sample, depending on the precision desired, and if possible have two technicians participate with each one testing one half the number of specimens.

11.4 Read the span length values in inches or millimetres directly from the dials digital display of the Fibrograph for selected points in the length-frequency distribution for the desired span lengths (Fig. 3).

## 12. Calculation

12.1 For the span lengths measured, average the results for all specimens in inches to two decimal places or in millimeters to one decimal place.

12.2 Calculate the uniformity ratio by dividing the average of the shorter span lengths by the average of the longer span lengths. Multiply the ratio by 100 to convert it to a percentage and round it off to a whole number.

## 13. Report

13.1 State that the specimens were tested as directed in ASTM Test Method D 1447. State the method of preparing specimens used, such as hand combing or by the Fibrosampler, and the number of specimens tested for each subsample.

13.2 Report the following information:

13.2.1 Designation of the length and uniformity ratio values

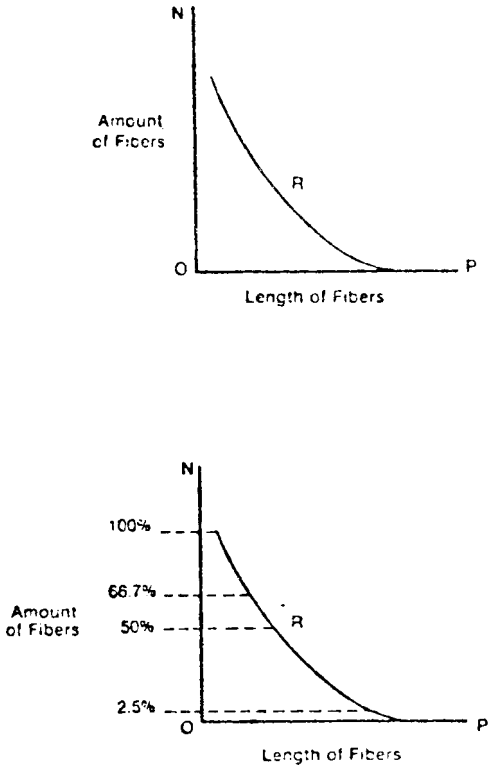


**FIG. 3 Diagram Showing Digital Fibrograph Length Measurements**

reported, such as 2.5 % span length, 50 % span length, and 50/2.5 ratio.

13.2.2 The average length and uniformity ratio.

13.2.3 The source of the cotton fibers taken for testing, such as raw cotton, card sliver, or waste.

## 14. Precision and Bias

14.1 *Interlaboratory Test Data*[4]—An interlaboratory test was carried out in 1969 in which two operators in each of three laboratories performed fiber length tests by Fibrograph measurement. Both operators tested two specimens from each of five subsamples from each cotton to establish standard values for each of five different cottons. Each of the subsamples were coded with a different number and the results were decoded after the tests were completed. The operators performing these tests had better than average skill and extensive experience. The levels of the participating laboratories were controlled by the use of the same group of control cottons. The components of variance calculated from the results of these tests and expressed as standard deviations are listed in Table 1.

14.2 *Precision*—For the components of variance above, the averages of observed values for both the four specimen and the two specimen tests should be considered significantly different at the 95 % probability level if the differences equal or exceed the critical differences in Table 2.

NOTE 6—The tabulated values for 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

[4] ASTM Research Report No. D-13-1008. A copy is available on loan from ASTM Headquarters.

**TABLE 1 Components of Variance Calculated from Test Results and Expressed as Standard Deviations**

| Test Item | Single Operator | Within Laboratory | Between Laboratory |
|---|---|---|---|
| 2.5 % Span length, in. (mm) | 0.01163(0.295402) | 0.00003(0.000762) | 0.00360(0.09144) |
| 50 % Span length, in. (mm) | 0.01028(0.261112) | 0.00137(0.034798) | 0.00834(0.211836) |
| 50/2.5 uniformity ratio, percentage points | 1.270 | 0.117 | 0.973 |

**TABLE 2 Critical Differences Between Two Means in Cotton Fiber Length Tests by the Fibrograph Measurement for the Conditions Noted[A]**

| Number of Specimens in Test and Item[A] | Single Operator | Within Laboratory | Between Laboratory |
|---|---|---|---|
| Four-specimen test: | | | |
| 2.5 % span length, in. (mm) | 0.016(0.4064) | 0.016(0.4064) | 0.019(0.4826) |
| 50 % span length, in. (mm) | 0.014(0.3556) | 0.015(0.381) | 0.027(0.6858) |
| 50/2.5 uniformity ratio, percentage points | 1.8 | 1.8 | 3.2 |
| Two-specimen test: | | | |
| 2.5 % span length, in. (mm) | 0.023(0.5842) | 0.023(0.5842) | 0.025(0.635) |
| 50 % span length, in. (mm) | 0.020(0.508) | 0.021(0.5334) | 0.031(0.7874) |
| 50/2.5 uniformity ratio, percentage points | 2.5 | 2.5 | 3.7 |

[A] The values for the critical differences listed in Table 1 were calculated using $t = 1.960$ which is based on an infinite number of degrees of freedom. These values are applicable only when the tests are performed by skilled operators in laboratories which control the level of results by use of standard calibration cottons.

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 randomized specimens from one sample of the material to be tested.

14.3 *Bias*—No justifiable statement on the accuracy of Test Method D 1447 for Fibrograph data can be made since the true value of the properties can be defined only in terms of observations made by a specific test method when controlled to a standard level by the use of calibration cottons.

## 15. Keywords

15.1 cotton; length