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

This standard is issued under the fixed designation D1447; 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.

ε[1] NOTE—The terminology section was updated in July 2012.

1. Scope

1.1 This test method covers the measurement of the length and length uniformity of cotton fibers by use of photoelectric measurement. The test method is applicable to fibers taken from raw or partially processed cotton (up to card mat) or some types of cotton waste, but not to fibers from blends of cotton with other fibers or to fibers recovered from cotton yarns, fabrics or to 100 % synthetic fibers.

1.2 This test method is especially adapted for determining the length and length uniformity of cotton fibers by 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 D1447 in 1971 and previous editions.

NOTE 2—For other methods covering the measurement of the length of cotton fibers refer to Test Method D1440.

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:*[2]
D123 Terminology Relating to Textiles
D1440 Test Method for Length and Length Distribution of Cotton Fibers (Array Method)
D1441 Practice for Sampling Cotton Fibers for Testing
D1776 Practice for Conditioning and Testing Textiles

D3025 Practice for Standardizing Cotton Fiber Test Results by Use of Calibration Cotton Standards
D7139 Terminology for Cotton Fibers

3. Terminology

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

3.1.1 The following terms are relevant to this standard: fibrogram, mean length, uniformity index, upper-half-mean length.

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

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.

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. 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, ensure the test samples to be used are as homogeneous as possible, are drawn from the material from which the disparate test results were obtained, and are randomly assigned in equal numbers to each laboratory for testing. The test from the two laboratories should be compared using a statistical test for unpaired data, at a probability level chosen prior to the testing series. If a bias is
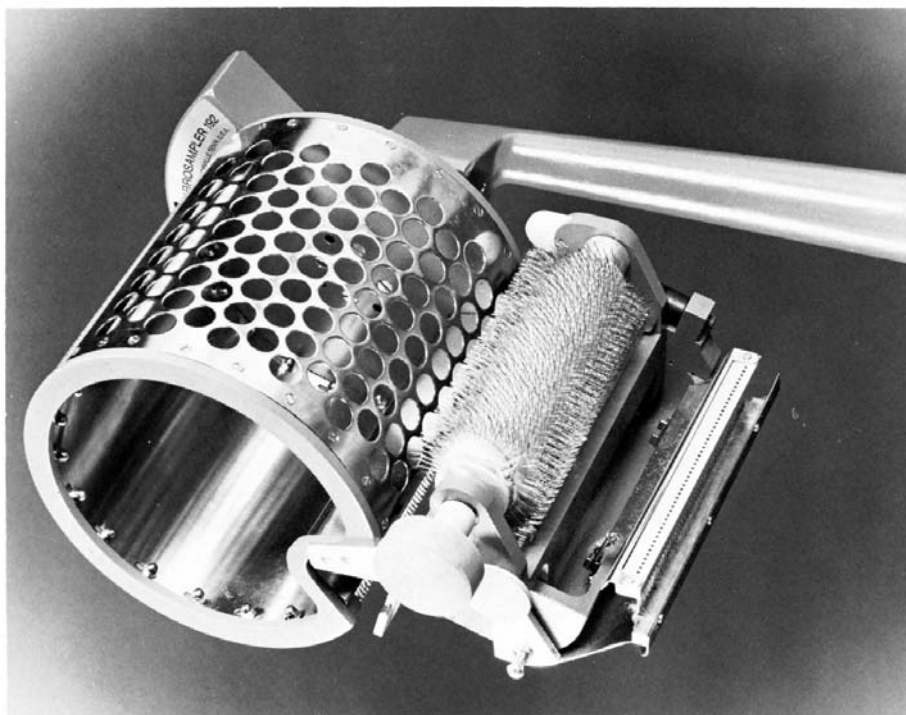

FIG. 1 Fibrosampler

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 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 randomly along its length.

6. Apparatus

6.1 *Fibrograph,*[3] digital model, with accessory equipment as shown in Fig. 2.

6.2 *Fibrosampler,* for the preparation of test specimens (required) as shown in Fig. 1.

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[3] Instruments and accessories meeting these requirements may be obtained from Uster Technologies, 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 D1441.

7.3 *Laboratory Sample*—As a laboratory sample for acceptance testing, select and prepare a 30 to 50 g subsample from each of the shipping containers in the lot sample, proceeding as directed in Practice D1441 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 (5 minutes),
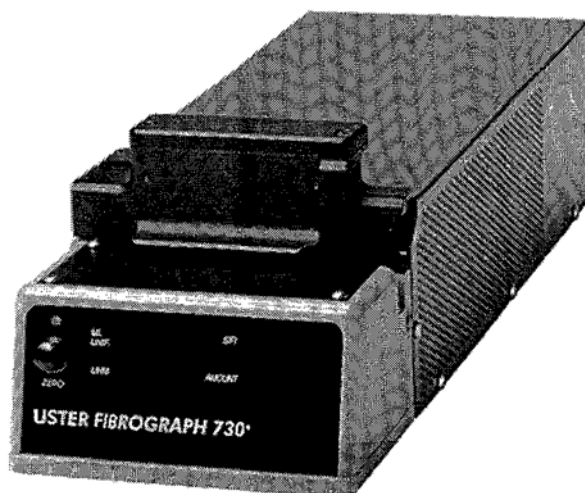
FIG. 2 Digital Fibrograph, Model 730

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 When the Fibrograph is first powered on, the LEDs on the front of the instrument will display the unit's system information. After the system information is displayed, the comb transport moves from the start to the stop position to zero the optics. Once the comb transport has returned to the start position, lift the door and adjust the optics by following the manufacturer's instruction.

8.3.2 The Fibrograph calibration should be checked once a week. During calibration check the calibration values are not changed. When a calibration is performed, the calibration values will be changed. A metal length standard with a known length value is supplied with the Fibrograph for calibration purposes. Follow the calibration procedures as directed in the manufacturer's instructions.

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, 3275 Appling Road, Memphis, TN 38133, 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 D3025.

NOTE 4—The Fibrograph length results obtained are affected by the amount of combing performed on the specimens. Operators quickly learn through practice the sampling process and the amount of brushing 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.
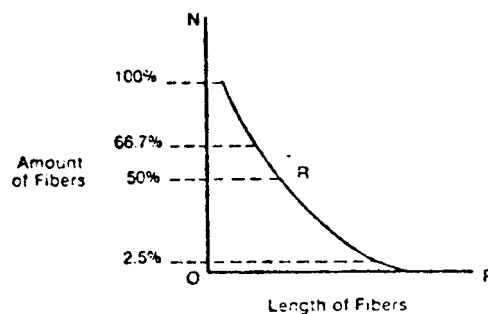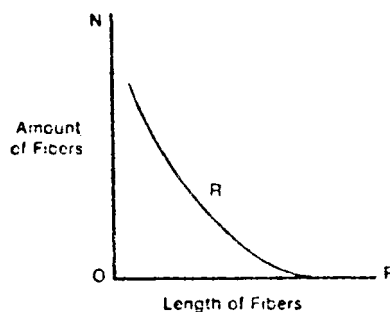

FIG. 3 Diagram Showing Digital Fibrograph Length Measurements

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 according to Practice D1776. Preconditioning is not necessary.

10. Preparation of Specimens

10.1 *Fibrosampler Method* (Fig. 1):

10.1.1 From a sample of fibers, select a subsample of approximately 25 grams or more (two handfuls). Place it in the Fibrosampler cylinder. Insert the comb into the Fibrosampler

TABLE 1 Mean Length

Material	Average, X̄	Repeatability Standard Deviation, s_r	Reproducibility Standard Deviation, s_R	Repeatability Limit, r	Reproducibility Limit, R
31	0.73166	0.01489	0.01820	0.04169	0.05095
32	0.75766	0.02080	0.02562	0.05825	0.07173
33	0.82322	0.01607	0.02076	0.04499	0.05813
34	0.84932	0.01333	0.02317	0.03733	0.06488
35	0.87984	0.01280	0.01514	0.03584	0.04240
36	0.89328	0.01246	0.01694	0.03488	0.04744
37	0.96546	0.01391	0.01505	0.03894	0.04215
38	0.98014	0.04077	0.04237	0.11416	0.11862
pima	1.08222	0.01668	0.02775	0.04671	0.07770

TABLE 2 Upper Half Mean Length

Material	Average, X̄	Repeatability Standard Deviation, s_r	Reproducibility Standard Deviation, s_R	Repeatability Limit, r	Reproducibility Limit, R
31	0.93258	0.01539	0.01874	0.04310	0.05246
32	0.96402	0.02624	0.02624	0.06281	0.07346
33	1.01490	0.01515	0.01998	0.04242	0.05593
34	1.04744	0.01394	0.02300	0.03902	0.06439
35	1.07026	0.01653	0.01876	0.04629	0.05252
36	1.09754	0.01684	0.01929	0.04714	0.05401
37	1.15114	0.01508	0.01906	0.04223	0.05337
38	1.17332	0.04057	0.04068	0.11358	0.11389
pima	1.28310	0.02200	0.03091	0.06160	0.08655

TABLE 3 Uniformity Index

Material	Average, X̄	Repeatability Standard Deviation, s_r	Reproducibility Standard Deviation, s_R	Repeatability Limit, r	Reproducibility Limit, R
31	78.462	0.709	0.805	1.985	2.255
32	78.576	0.830	1.039	2.324	2.908
33	81.108	0.739	0.923	2.070	2.586
34	81.078	0.708	1.040	1.984	2.913
35	82.216	0.813	1.012	2.276	2.835
36	81.402	0.671	0.878	1.878	2.458
37	83.872	0.738	0.897	2.068	2.511
38	83.514	0.946	1.114	2.648	3.120
pima	84.354	1.215	1.452	3.401	4.067

TABLE 4 Short Fiber Index

Material	Average, X̄	Repeatability Standard Deviation, s_r	Reproducibility Standard Deviation, s_R	Repeatability Limit, r	Reproducibility Limit, R
31	15.044	1.025	1.156	2.870	3.236
32	14.872	1.849	1.872	5.176	5.242
33	9.792	0.793	0.995	2.222	2.787
34	10.592	0.800	1.047	2.241	2.931
35	8.902	0.760	0.832	2.128	2.329
36	9.758	0.587	0.699	1.643	1.958
37	7.384	0.378	0.530	1.058	1.484
38	7.786	0.431	0.521	1.207	1.458
pima	8.024	0.406	0.483	1.137	1.352

combholder. With a circular motion of the left hand, press the fibers so they protrude through holes of the sample plate, maintaining and evenly distributed pressure over the surface. Then relax the pressure of the left hand so the fibers can be easily pulled through the plate holes by the teeth of the comb. 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.

10.1.2 Clean the card clothing on the Fibrosampler each time you change samples. This will avoid having the cotton that has built up on the card cloth contaminate the new sample

and possibly skewing the test results. Cotton should also be removed from the cleaning brush as required. To do this, use the cleaning brush provided with the equipment.

11. Procedure

11.1 After the Fibrograph is in proper operating condition (see 8.3) and the correct sampling 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. It is important that each sample is brushed properly so that consistent test results can be achieved.

11.2 Lower the lens assembly (close the door) The comb transport will move the sample across the optics to measure the sample.

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 upper-half-meanlength values in millimetres directly from the LED display of the Fibrograph.

11.5 Read the uniformity index in percent directly from the LED display of the Fibrograph. A switch in the back of the instrument allows choosing which value is displayed on the LED display.

11.6 Read the short fiber index (SFI) value in percent directly from the LED display on the Fibrograph.

12. Report

12.1 State that the specimens were tested as directed in Test Method D1447. State the number of specimens tested for each subsample.

12.2 Report the following information:

12.2.1 Designation of the length and uniformity index values reported, such as upper-half-mean length (UHML), mean length (ML), uniformity index (ML/UHML) and short fiber index (SFI).

12.2.2 The average length, uniformity index and short fiber index.

12.2.3 The source of the cotton fibers taken for testing, such as raw or partially processed cotton (up to card mat) or type of cotton waste.

13. Precision and Bias

13.1 The precision of this test method is based on an Interlaboratory study of Test Method D1447 conducted in 2007. Each of ten laboratories tested nine materials (five replicates each) covering four analyses to determine the intralaboratory and interlaboratory precision of Test Method D1447.[4]

13.1.1 *Repeatability*—Two test results obtained within one laboratory shall be judged not equivalent if they differ by more than the "*r*" value for that material; "*r*" is the interval representing the critical difference between two test results for the same material, obtained by the same operator using the same equipment on the same day in the same laboratory.

13.1.2 *Reproducibility*—Two test results should be judged not equivalent if they differ by more than the "*R*" value for that material; "*R*" is the interval representing the difference between two test results for the same material, obtained by different operators using different equipment in different laboratories.

13.1.3 Any judgment in accordance with statements 13.1.1 or 13.1.2 would have an approximate 95 % probability of being correct.

13.2 *Bias*—At the time of the study, there was no accepted reference material suitable for determining the bias for this test method, therefore no statement on bias can be made.

14. Keywords

14.1 cotton; length