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Wool — Determination of fibre length distribution parameters — Capacitance method

Laine — Détermination des paramètres de distribution de longueur des fibres — Méthode capacitive

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 38, *Textiles,* Subcommittee SC 23, *Fibres and yarns*.

This second edition cancels and replaces the first edition (ISO 2648:1974), which has been technically revised.

The main changes compared to the previous edition are as follows:

— the title has been modified as "*Wool — Determination of fibre length distribution parameters — Capacitance method*";

— the content structure has been updated;

— in the scope, the text for "wool/synthetic blends" has been modified;

— the mandatory Clauses 2 and 3, "Normative references" and" Terms and definitions" respectively, have been added, and the subsequent clauses have been renumbered;

— Clause 4 "Principle" has been modified;

— in Clause 5, "measuring apparatus" has been modified and additional apparatus (5.2, 5.3and 5.4) for test specimen preparation have been included;

— the "Test specimen" clause has been deleted;

— Clause 6 "Conditioning and testing atmosphere" has been modified;

— a new Clause 7, "Sampling and preparation of laboratory sample" has been added;

— the former Clause 6, "Preparation of samples for testing" has been modified as 8.1 ""Preparation of test specimen";

— in Clause 8, the procedure for apparatus measuring has been added;

— a new subclause (9.2)on "Digital system" has been added;

— the former "Definition of the test on top sliver-notes on sampling" clause has been deleted;

— new Clauses 10 and 11, "Test report" and "Precision" respectively, have been added;

— the former Annexes A (Literature reference), Annex C (The Almeter), Annex D (Control of the machine), Annex E (Calibration check of the machine) and Annex F (Accuracy of the method) have been deleted;

— a new Annex A, "Preparation of top and sliver", has been added;

— former Annex B has been modified, and its title has been replaced with "Test specimen preparation";

— a new Annex C ,"The introduction of the precision of the method", has been added;

— the former Figures 1 to 4 have been deleted;

— new Figures A.1 to A.3 have been added;

— a Bibliography has been added.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Wool — Determination of fibre length distribution parameters — Capacitance method

1   Scope

This document specifies a method for the determination of fibre length distribution parameters (principally mean length, expressed as Hauteur or Barbe, and the coefficient of variation of the measurement) on slivers and rovings made from combed wool or combed synthetic fibres.

As the fibres of different chemical structure have different di-electric values, the method is not directly applicable to slivers made up of a blend of wool/synthetic fibres.

2   Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 139, *Textiles — Standard atmospheres for conditioning and testing*

3   Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

—   ISO Online browsing platform: available at https://www.iso.org/obp

—   IEC Electropedia: available at http://www.electropedia.org/

3.1
Hauteur
H
mean cross-section biased length of the test specimen

Note 1 to entry: It is expressed in millimetres (mm).

3.2
Barbe
B
mean weight-biased length of the test specimen

Note 1 to entry: It is expressed in millimetres (mm).

Note 2 to entry: Only Hauteur is certifiable.

3.3
total sample
total of the *laboratory samples* (3.4) taken to represent the lot

[SOURCE: ISO 137:2015, 3.2, modified — The definition has been slightly modified.]

3.4
laboratory sample
sample of sliver about 1,20 m long, twisted by 30 turns per metre if the test is not carried out within 4 h after it is taken for sampling

3.5
test specimen
sample of fibres aligned at one end made up of approximate 30 000 fibres

Note 1 to entry: It is sometimes referred to as "beard".

3.6
one measurement
result of an evaluation of the length distribution on both "left" and "right" ends of the sliver, in order to avoid the influence of any possible asymmetry between the two directions of the sliver

4 Principle

The capacitive sensor-based machine tests the length of textile fibres, using a test specimen of fibres made up with the aid of the mechanical grip.

The grip, fed with slivers or rovings, prepares a numerical specimen of fibres, where the number of fibres in each length class is represented in the same numerical proportion as in the original sliver.

This test specimen is arranged in the form of a draw of fibres, with all the fibres having one of their ends (their base) situated approximately on the same line, perpendicular to the direction of the fibres. The test specimen formed in this way is then transferred from the grip to the capacitive sensor-based apparatus, where it is inserted between two thin plastic sheets.

The carriage containing the test specimen is either moved at a constant speed through a measuring condenser, or the measuring condenser moves over a stable test specimen at a constant speed. The variation in capacitance so produced is due to the partial replacement of the dielectric "air" and fibres between the dielectric plates of the condenser. Knowing the formation of the sample, it can be shown that the measured signal (proportional to this increase in capacitance) is equivalent to a cumulative Hauteur (H) diagram, which is automatically traced.

The following length distribution parameters are calculated, Hauteur (H), coefficient of variation of hauteur (CV_H), Barbe (B), coefficient of variation of barbe (CV_B), L values and K values.

5 Apparatus

5.1 Measuring apparatus.

5.1.1 Mechanical grip.

The mechanical grip works in the same way as the nip of a rectilinear comb. At each cycle, it takes from the sliver a numerical draw or sample containing all the fibres whose heads lie in a short length of the sliver, between 2 cross-sections of the sliver about 2,5 mm (automatic preparer) to 3,7 mm (manual preparer) apart. The complete test specimen is made up of a collection of about 6 to 10 of these samples.

5.1.2 Main capacitive sensor-based instrument, consists of two parts, assembled within one chassis:

1) a device, measuring the local mass of the fibre test specimen;

2) a computer, automatically evaluating the length distribution parameters during the test.

The device for measuring the local mass is made up of a special condenser in the form of a greatly elongated rectangle, 1,8 mm × 175 mm. The small dimension (1,8 mm) of the condenser in the direction

of the fibres provides for a detailed examination of the local mass from the end of the sample up to the line of the common origin of the fibres.

A carriage automatically carries the test specimen at a constant speed between the electrodes of the measuring condenser, or conversely the condenser moves over the test specimen.

5.1.3   Recorder.

In the analogue system, the record is a galvanometric recorder, which automatically traces the cumulative Hauteur diagram on squared paper during measurement.

In the digital system, the data are captured by a computer which is capable of outputting the results to either the screen or to a printer. The diagram ordinate gives the percentage of fibres (biased by cross-section) of length greater than the length indicated on the corresponding abscissa. (The percentage by cross-section is very close to the percentage by number).

5.2   Test specimen holder.

5.3   Extractor system.

5.4   Restraining strip.

6   Conditioning and testing atmosphere

6.1   Conditioning atmosphere

6.1.1   General

The sample, kept in the form of a twisted hank, is exposed to the conditioning atmosphere for a minimum period as indicated below. This period can vary according to the type of the material and the sampling conditions.

Generally, regardless of the origin of the sample of sliver, the preliminary conditioning period is 24 h in the standard atmosphere for testing as defined in ISO 139.

In order to standardize the procedure, this period of 24 h may be adopted for all cases where no urgency exists.

6.1.2   For slivers coming from a process involving soaking, drying or oiling, a conditioning period of 24 h in standard atmosphere is to be observed.

6.1.3   For tops sampled in the normal way at a passage following combing, and drawing slivers and rovings sampled from a machine where fibre lubricant is not applied, the period of conditioning in standard atmosphere can be reduced to a minimum of 4 h.

6.1.4   In some cases, this period can be reduced still further; for instance, if a rapid conditioning enclosure is available in which the sample hank can be placed for 30 min followed by a further 30 min in the standard atmosphere.

6.1.5   The conditioning period may be omitted or reduced to a precautionary 30 min when a combination of the following conditions occurs.

a)   Sampling has taken place approximately within the 4 h prior to the test during processing or from balls stored in a satisfactory atmosphere.

b)   The sample hank has been transported in a sufficient airtight plastic bag, avoiding any excessive heat or cold.

6.2   Testing atmosphere

The test is to be performed in the standard atmosphere for testing as defined in ISO 139.

7   Sampling and preparation of laboratory sample

7.1   Sampling

Samples shall be taken from bales distributed equally throughout a lot. Only one sample shall be taken from a bale, unless the lot is smaller than 5 bales when an equal number of samples shall be taken from each bale.

To characterize a lot, take at least one sample from each of 5 homogeneous portions of the lot to form the total sample. For masses greater than 5 000 kg, at least one sample shall be added per 5 000 kg portion.

NOTE   Homogeneous portion of the lot is a ball or bump of sliver, a can of drawing sliver, a roving bobbin, a sliver or roving taken directly from a finisher.

Samples shall not be taken for measurement from the disturbed outer layer, or immediately next to the core of a package. Slivers having adventitious thickness faults (especially abnormal thick or thin places) are to be discarded. Slivers taken directly from a comb, cut or chopped slivers and those containing fibre bundles are also unsuitable. In such cases, the variation in fibre length between successive samplings is likely to be very large, potentially giving rise to significant errors.

7.2   Preparation of laboratory sample

7.2.1   General

To obtain a suitable laboratory sample, fibres shall be under semi-relaxed state. To achieve this form, pre-treat laboratory samples according to Annex A.

7.2.2   Slivers of combed wool weighing between 15 g/m and 30 g/m

For slivers of combed wool weighing between 15 g/m and 30 g/m, a length of about 1,2 m is broken off from the homogeneous portion of the lot. Immediately after sampling, the sample held under slight tension is given 36 turns of twist (30 turns/m); held taut in this condition, it is doubled at its centre and its ends are brought together and held. See Annex A for details.

In this form, the sample can be stored indefinitely and can easily be sent by post in a plastic bag, or held fast on a tube of approximate diameter 40 mm in the twisted state, to the testing laboratory.

For in-mill management, the operation of twisting may be omitted only when the ball of combed sliver or of roving is available at the moment of testing and if the test is going to be carried out within 4 h of sampling.

NOTE   This twisting operation is absolutely essential in order to obtain accurate test results.

7.2.3   Rovings or slivers weighing less than 15 g/m

In the case of rovings or slivers weighing less than 15 g/m, sufficient 1,2 m lengths of sliver are successively drawn to build up, by overlaying, a sliver which weight per metre is about 22 g (30 g maximum). At the time of the overlaying, the slivers shall always be laid in the same direction (for example, the leading end as delivered by the mill machine always to the left).

Then, without any delay, this built up sliver is subjected to the twisting and hanking operation described in 7.2.2.

7.2.4   Rovings or slivers weighing more than 30 g/m

In the case of rovings or slivers weighing more than 30 g/m, a length of approximately 1,2 m is broken off from the homogeneous portion of the lot. The sample is then carefully separated along its length into 2 approximately equal portions of similar weight. At random, one portion is discarded, and without any delay, the remaining portion is then subjected to the twisting and hanking operation described in 7.2.2.

8   Procedure

8.1   Preparation of test specimen

8.1.1   The laboratory sample, kept in the form of a twisted hank, is untwisted immediately before the start of testing. The sliver, held with one end in each hand, is then straightened by putting it under slight tension and subjecting it to gentle shaking.

When testing balls of sliver or bobbins of roving, the 1,2 m long sample can be taken immediately before making the measurement, after unwinding a few outer turns that have lower tension.

Bump strings shall be cut immediately prior to testing and samples shall be taken from sliver/roving that does not contain pressure creases.

8.1.2   Take a certain number of successive fibre draws from a sliver sample, parallel fibres from one original base line to form the test specimen. These draws are made by using the semi-automatic grip or an automatic mechanical grip. The number of draws is determined by experience, normally approximately 6 to 10 draws are suitable to make up a test specimen, made up of approximately 30 000 fibres. Two test specimens are measured from each laboratory sample.

8.1.3   Top sliver is slightly asymmetrical because of the presence of fibre hooks in unequal proportions in the 2 directions. In the case of semi-automatic grip, carry out a single test on the left–hand end of the sliver sample and a single test on the right-hand end.

8.1.4   In the case of automatic motorised grip, introduce the sliver sample into the mechanical grip with a doubled condition, as described in Annex B, and take draws simultaneously from both ends of the sliver sample. The result of the single test is made on the both ends.

8.2   Measurement

8.2.1   Switch on the machine and warm up for at least 10 min.

8.2.2   Select the desired material range and the fibre length measurement range.

8.2.3   Check the plastic transport sheet and make it clear of fibres, soil or dust and free from grease and static charges.

8.2.4   If needed, carry out the calibration check for ensuring the accuracy of the tests, by using the plastic trapeziums as described in operation manual.

8.2.5   If needed, carry out the zero-setting for the instrument.

8.2.6   Transfer the test specimen, assembled in a test specimen holder, on the plastic transport sheet of the test specimen carriage. Take great care not to displace the test specimen during the operation. And start the measurement.

9   Calculation and expression of results

9.1   Analogue system

After carrying out the measurement and after recording the micro-ammeter readings l_1 with the "FUNCTION" switch in the first integral and then l_2 with the switch in the double integral position, the values of Hauteur (H), Barbe (B) and the coefficient of variation are calculated for each single test on the left-hand end or on the right-hand.

The arithmetic mean of the results defined as "one measurement" obtained on both ends of one sliver sample for H, B and the coefficient of variation, etc. is calculated.

NOTE   In the analogue system, one test corresponds to one test specimen.

9.1.1   Calculation of Hauteur (H) and Barbe (B)

The Hauteur (H), expressed in mm, is equal to the reading l_1 multiplied by a coefficient α according to Formula (1). The coefficient α depends on the range used, as shown in Table 1.

$$H = l_1 \cdot \alpha \tag{1}$$

The Barber (B), expressed in mm, is equal to the reading l_2 divided by l_1 and multiplied by a coefficient β according to Formula (2). The coefficient β depends on the range used, as shown in Table 1.

$$B = (l_2 / l_1) \cdot \beta \tag{2}$$

Table 1 — Values of coefficients α and β used to calculate H and B

Range	α	β
1	$\dfrac{1}{2}$	75
2	$\dfrac{2}{3}$	100
3	1	150
4	$\dfrac{4}{3}$	200

9.1.2   Calculation of coefficient of variation of Hauteur CV_H

The coefficient of CV_H is given by Formula (3):

$$CV_\mathrm{H} = \sqrt{\frac{B-H}{H}} \tag{3}$$

or, expressed in % as Formula (4):

$$CV_\mathrm{H} = \sqrt{\frac{B-H}{H}} \times 100 \tag{4}$$

9.1.3 Percentage of short fibres

The percentage of fibres shorter or longer than a given length may be estimated either from the diagram traced by the recorder or directly on the instrument by reading the graduated scale.

9.1.4 Use of the nomograms

A set of nomograms is supplied with each instrument, enabling the Hauteur(H), Barbe (B) and coefficient of variation to be calculated very easily. There is a nomogram for each measuring range.

9.1.4.1 Calculation of Hauteur (H)

Select the nomogram corresponding to the measuring range used, then mark the value of the first integral (l_1) on scale C and read the Hauteur on scale B opposite the mark.

9.1.4.2 Calculation of Barbe (B)

Mark the value of the first integral (l_1) on scale C. Mark the value of the second integral (l_2) on scale F. Join these two points and the intersection with the axis of the Barbes give the value of the Barbe.

9.1.4.3 Calculation of the coefficient of variation of Hauteur CV_H

Mark the value of the first integral (l_1) on scale A. Mark the value of the second integral (l_2) on scale F. Join these two points, and the intersection with scale CV gives the coefficient of variation of Hauteur CV_H.

9.2 Digital system

9.2.1 General

The averaged parameters on both ends of one sliver sample Hauteur (H), CV_H, Barbe (B), CV_B are available without external calculation, through either

1) the integral keypad (with 16 keys) and the display, or

2) the PC printer.

NOTE   In the digital system, one test corresponds to the mean from a specified number of test specimens (normally 2 from each laboratory sample), which is set at the start of the operations.

9.2.2 Calculation of Hauteur (H)

9.2.2.1 Hauteur diagram

The horizontal (x-axis) gives the fibre length in mm. The y-axis gives the percentage of fibres, biased by cross-section (this would be number-biased if all the fibres had the same cross-section), whose length is equal or greater than the fibre length given as abscissa (x-axis). The origin represents the common base of the test specimen and is normalized to equal 100 %. The Hauteur diagram is a direct representation of the fibre length distribution in the test specimen.

9.2.2.2 Hauteur histogram

The ordinate (y-axis) gives the percentage of fibres, whose length falls within the length class group given on the abscissa (x-axis). The scale used is decided by the instrument.

9.2.3 Calculation of the coefficient of variation of Hauteur, CV_H

The coefficient of variation of Hauteur CV_H is calculated by the classical formula using squares of deviation of values of the H diagram at every 0,25 mm.

9.2.4 Calculation of Barbe (B)

9.2.4.1 Barbe diagram

The ordinate (y-axis) gives the percentage of fibre, biased by weight, whose length is equal or longer than the value given as abscissa (x-axis).

9.2.4.2 Barbe histogram

The ordinate (y-axis) gives the percentage of fibre, biased by weight, whose length falls within the length class group given on the abscissa (x-axis).

9.2.5 Calculation of the coefficient of variation of Barbe, CV_B

The coefficient of variation of Barbe, CV_B, is calculated by the classical formula using squares of deviation of values of the B diagram at every 0,25 mm.

9.2.6 Tuft diagram

The ordinate (y-axis) gives the percentage of fibres lying across 2 cross-section along a sliver, whose separation is equal to the length group given on the abscissa (x-axis). The scales and class groups used are the same as used for the Hauteur diagram.

The mathematical definition of this Tuft function is given by the integral over L of the Hauteur diagram divided by the Hauteur, as Formula (5):

$$T = \frac{1}{H} \int_l^L H(L) \cdot dl \qquad (5)$$

The physical interpretation for slivers with Poisson fibre distribution is as follows.

If the sliver is gripped at a line across its width, each fibre held consists of 2 segments, one on either side of the gripping line. If the Hauteur for these segments was determined, this would give the Tuft diagram.

9.2.7 Fibre length attributes (L values and K values)

The following numerical results are also provided as part of the length distribution parameters for both Hauteur and Barbe:

L values: Lengths in mm exceeded by x% of the fibres, are given for percentage of 95, 90, 75, 50, 25, 10, 5, 2,5, and 1.

K values: percentage of fibres shorter than a given length (x mm) are given for length of:

a)   10 mm to 50 mm in 5 mm steps for the LONG setting;

b)   5 mm to 25 mm in 2,5 mm steps for the SHORT setting.

To ensure conformity of reporting, in shorthand form, the following convention should be followed.

Distribution values:

—   L values (length of fibres at x %)

—   K values (% fibres < x mm)

Describe the "length parameter" L or K; add the category, e.g. 5 %; and the measurement type *H* for Hauteur or *B* for Barbe.

EXAMPLE 1   L5H: the length (mm) of 5 % of fibres as measured from the Hauteur distribution.

EXAMPLE 2   K25B: the % fibres < 25 mm from the Barbe distribution.

This convention applies to all the distribution categories for the different "length distribution" measurements.

10 Test report

10.1 General

a)   a reference to this document including its year of publication, i.e. ISO 2648:2020;

b)   all the details necessary for the identification of the sample tested (including the method of preparation, if applicable);

c)   the test conditions;

d)   the test system used (analogue or digital);

e)   the number of test specimens;

f)   the test results obtained in accordance with Clause 9, Hauteur to the nearest 0,1 mm, CV_H to the nearest 0,1 %, Barbe to the nearest 0,1 mm, CV_B to the nearest 0,1 %;

g)   any deviation from the given procedure;

h)   any unusual features observed;

i)   the date of the test.

10.2 The following results may also be reported under "Additional information":

a)   L values (length of fibres at x %) to the nearest 0,1 mm;

b)   K values (% fibres < x mm) to the nearest 0,1 %;

c)   Length diagram and table of cumulative percentages, including short (K) and long (L) fibre parameters;

d)   Barbe diagram and table of cumulative percentages, including short (K) and long (L) fibre parameters.

11 Precision

11.1 Precision of the method

Detailed information on the precision of the method is detailed in Annex C.

11.2 Within and between laboratory variation for Hauteur and Barbe

The values of CV_0 and CV_1 given in Table 2 are data for one measurement; i.e. arising from 2 test specimens and thus 2 readings for the manual preparer; but arising from a single test specimen with a single reading for the automatic preparer.

Table 2 — Within and between laboratory variation for Hauteur and Barbe

	Variation within-laboratory CV_0 %		Variation between laboratories CV_1 %	
	Automatic grip	Manual grip	Automatic grip	Manual grip
Hauteur	1,80	1,80	1,30	1,59
Barbe	1,36	1,36	1,08	1,53

11.3 95 % confidence intervals for Hauteur and Barbe

The confidence interval (CI), given in Table 3, is calculated from the within-laboratory coefficient of variation CV_0 (see Annex C). It takes into account the variance of the test equipment, of the testing within one laboratory and the variation of the length distribution along a sample from a ball of top. It does not cover the variation in a lot during manufacture (for example from ball to ball), or the variation between laboratories.

Table 3 — 95 % confidence intervals for Hauteur and Barbe

Number of measurement (k)	CI[a]			
	Hauteur		Barbe	
	automatic grip	manual grip	automatic grip	manual grip
1	3,60	3,60	2,72	2,72
2	2,54	2,54	1,92	1,92
3	2,08	2,08	1,57	1,57
4	1,80	1,80	1,36	1,36
5	1,61	—	1,22	—
6	1,47	—	1,11	—
7	1,36	—	1,03	—
8	1,27	—	0,96	—
[a] $CI = \pm \dfrac{2cv_0}{\sqrt{k}}$.				

11.4 MPD% values for Hauteur and Barbe based on k measurements

The maximum probable difference (MPD%) given in Table 4, expresses the difference to be expected between the results (mean of k measurements) from 2 laboratories testing samples taken from the same ball. This difference calculated at a 95 % level of probability will on average be exceeded only 5 times out of 100.

The maximum probable difference (MPD%) thus takes into account the variance within a laboratory and the variance between laboratories testing the same ball. It does not cover possible variation throughout the lot, from ball to ball.

Table 4 — MPD% values for Hauteur and Barbe based on k measurements

Number of measurement (k)	MPD%[a]			
	Hauteur		Barbe	
	automatic grip	manual grip	automatic grip	manual grip
1	6,28	6,79	4,91	5,79
2	5,15	5,76	4,09	5,11
3	4,71	5,37	3,78	4,86
4	4,47	5,17	3,61	4,73
5	4,32	—	3,51	—
6	4,22	—	3,43	—
7	4,15	—	3,38	—
8	4,09	—	3,34	—
[a] $\quad \text{MPD\%} = 2 \cdot \left[2 \cdot \left(CV_1^2 + \dfrac{cv_0^2}{k} \right) \right]^{\frac{1}{2}}.$				

Annex A
(normative)

Preparation of top and sliver

A.1 Preparation by twisting

Select the required laboratory sample length (normally 1,2 m) from the ball or bump, fix one end and twist the other under light tension until 30 twists per metre have been inserted. (That is 36 turns for a 1,2 m length.) This operation shall be carried out within 30 min of taking a sample.

NOTE   It has been shown by experiment that this number of turns is optimum.

Place the two ends of the sliver together without releasing the twist, while holding the length of sliver at its middle.

Tie the two ends firmly together (this can be effectively done with an elastic band) and gently allow the twist to balance out while holding the two ends. The sample so formed shall look like the sample shown in Figure A.1.

Incorrectly prepared sample as shown in Figure A.2 shall be released and reprepared.

Figure A.1 — Correct prepared sample

Figure A.2 — Incorrect prepared sample

A.2 Preparation by winding on to tubes

A.2.1 Select the sample required, insert approximately 30 turns per metre, then wind under a medium tension directly onto suitable tube as shown in Figure A.3.

NOTE   Small lengths of cardboard tubes of approximately 40 mm diameter have been found suitable.
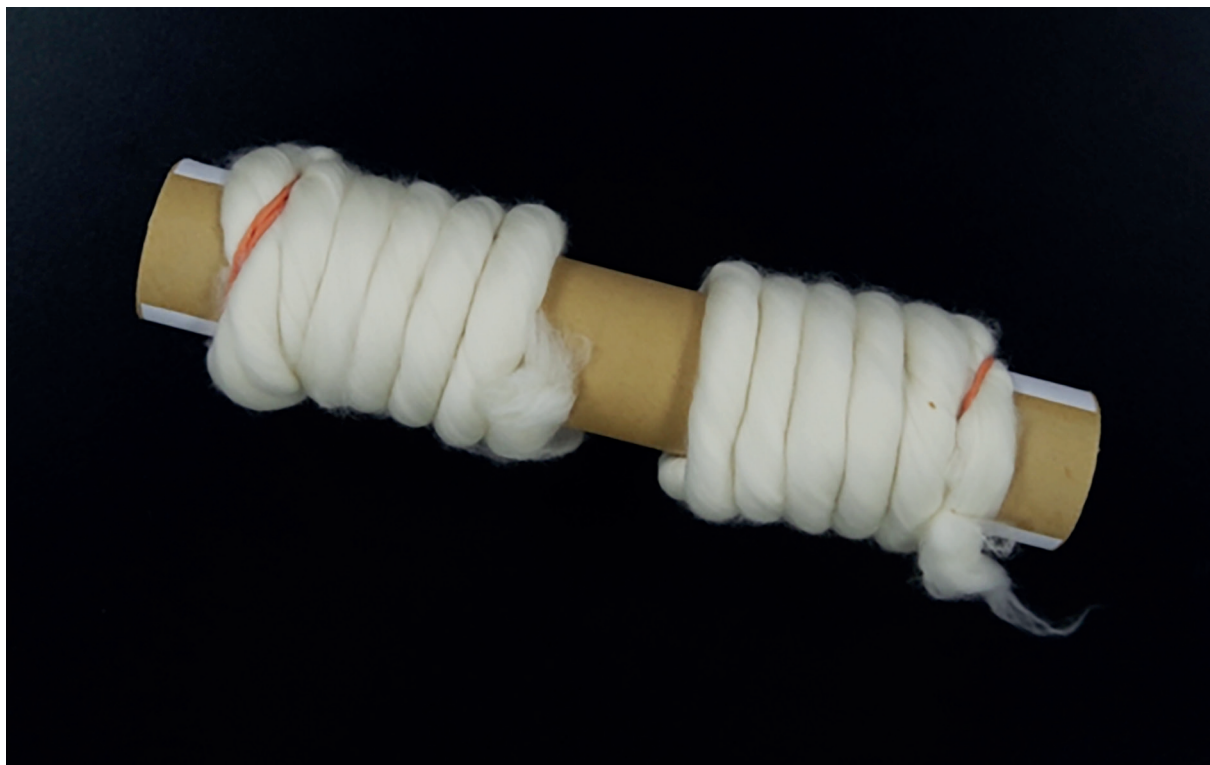
Figure A.3 — Sample winding onto tubes

A.2.2   Trapping the ends of the sliver in slits formed in the ends of the tube and make sure that the ends of the sliver are firmly held.

A.3   Partial recovery procedures

Re-twist the sliver under tension when the samples have been incorrectly prepared.

Fix the sliver sample at one end and twist re-inserted described in A.1. Maintain the sliver sample in that state for at least 4 h, preferably 24 h.

Annex B
(normative)

Test specimen preparation

B.1 General

The test specimen shall be made up of a specified number of successive draws, extracted from a sliver of parallel fibres, and aligned along the same base line. The number of draws is determined by experience as the main capacitive sensor-based instrument will not read results if there is too much or too little sample. Under normal circumstances approximately 6 to 10 draws are suitable to make up a sample.

The draws are assembled so as to make a test specimen of sufficient size, representative of the lot under test and weighing about 1 g. This test specimen is placed in a device, called a "test specimen holder", consisting of a series of pinned fallers held between 2 aluminium frames, which form handles.

The draws are assembled by both superposition and juxtaposition. For instance, in the case of wool, the test specimen is on average made up of 5 to 10 draws, takes from each end of the sliver simultaneously, superimposed and placed side by side.

B.2 Preparation of a test specimen

B.2.1 Insertion of the sliver

Pass the sliver/roving under the feed roller and embed the sliver/ roving in the mechanic grip pin with 20 mm to 30 mm overhanging the front.

If the sliver or roving has been cut, it shall first be hand broken (pulled) before embedding in the mechanic grip, at a distance from the cut end equivalent to the length of the longest fibres to ensure no cut fibres are present to bias the sample.

B.2.2 Squaring the sample

Square the sample by hand, by removing fairly large tufts of fibres from the end of the sliver by successive draws to obtain an even edged sample for measurement.

Carefully, taking small amounts of fibres, hand square the sample back to 10 mm. Make sure this leading edge is as square as possible.

Start the mechanic pin and take about 20 draws or more until a perfectly squared base line is obtained, these draws are then discarded.

B.2.3 Drawing and formation of the test specimen

Set the machine to the number of draws required, under normal circumstances approximately 6 to 10 draws, to make up a test specimen. For the second test specimen discard the next 20 draws before drawing this test specimen. Remove the test specimen holder from the machine when the required number of draws has been reached.

B.2.4   Transfer of the test specimen

Transfer the test specimen onto the plastic sheet of the sample carriage as follows.

a)   Insert the test specimen holder above the lower sheet of the slide with the pins facing downwards and the base of the test specimen (aligned ends of the fibres) towards the operator. Insert the two locating studs on the side of test specimen holder in the corresponding locators in the 2 sides of the carriage.

Take care not to piece the plastic sheet with the pins of the test specimen holder as this affects the measurement.

b)   Insert the extractor system consisting of parallel steel rods between the fallers of the test specimen holder with only one rod in front of the first faller on the side of the operator.

c)   Push the extractor fully downwards to extract the test specimen from the pin and deposit it on the lower sheet.

d)   Against the first rod, lower the restraining strip, a small stainless-steel strip of 215 mm × 30 mm, as a precautionary measure, until it rests on the sheet, its forepart clamping the aligned ends of the fibres.

e)   Remove the test specimen holder and extractor, first lift the front at a small angle and slide back about 1 cm before lifting so as to ensure all fibres remain undisturbed.

f)   Remove the restraining strip, with taking great care not to displace the test specimen during this operation.

g)   Lower the upper sheet rapidly at first, until it is about 2 cm above the lower sheet, then lower it very slowly avoiding spreading out the test specimen. Apply light pressure to the upper sheet to ensure that closure is complete.

Annex C
(informative)

Precision of the method

C.1 General

An interlaboratory experiment, involving 32 participants in 5 countries, comprising 5 official or research laboratories and 27 mill laboratories, allowed the determination of confidence intervals for length measurements in normal industrial usage. The results were analysed for 26 manual sampling grips and 11 automatic grips, some participants having performed tests with both types.

For each of 5 commercial lots that had not been subjected to any special treatment and covering a range of Hauteur between 46 mm and 94 mm, samples drawn from a single ball of top were distributed to the participants.

The coefficient of variation of tests within a laboratory (CV_0) and between laboratories (CV_1) for each of the five lots examined was obtained by an analysis of variance.

The values obtained take into account not only the variance due to apparatus (which is generally negligible within a laboratory) but also the variance of the distribution of length within a ball of top sliver. However, the variance of the distribution of length distribution during the production of a lot, which is translated into an inter-ball variance, is not included.

In order to summarize the results of the five commercial lots used (selected randomly from the ordinary production of two combing establishments) and also to take account of cases corresponding to lots more heterogeneous within a ball than those used in the experiment, it was assumed that the five lots examined were regarded as coming from a population of lots of normal distribution as far as the variation of the measurements is concerned, and the variation for a limit lot corresponding to a probability threshold of 10 % has been calculated.

These values given in Table 2, Table 3 and Table 4 have therefore been calculated in this way from the experiment results obtained from the five lots. Consequently, they give an estimate of the maximum values that will be obtained from the coefficients of variation CV_0 and CV_1, and also for confidence limits and maximum probable differences (MPD) between laboratories, in the case of samples drawn from a single ball of top.

The CV_0 and CV_1 values in Table 2 are given for "one measurement", and thus for two test specimens and two readings in the case of the manual grip, and a single test specimen with a single reading in the case of the automatic grip.

Similarly, the values of the confidence interval (CI) and the maximum probable differences (MPD) are given in Table 3 and Table 4 as a function of the number of "one measurement", and thus corresponding in each case to twice the number of test specimens and twice the number of readings for the manual grip.

The variance within a laboratory is characterized by the coefficient of variation CV_0. It is practically the same for a single (folded) test specimen with a single run, using automatic grip, as for the mean of two test specimens (left and right), with two runs, using the manual grip.

The variance between laboratories is characterized by the coefficient of variation CV_1. This is less for a single test specimen drawn from a folded sample with the automatic grip than that obtained with two test specimens and two readings using the manual grip.

C.2 Individual result precision-AL 100/AL 2000 signal

The values provided in Table C.1 for the AL 100 and AL 2000 relate to a signal test for the instrument signal variation only. Sampling variation has been removed from these estimates. These values are provided to illustrate the precision of the measuring head signals for the AL 100 and AL 2000.

Table C.1 — Individual result precision-AL 100/AL 2000 signal

Attribute	Hauteur		*CV* Hauteur		Barbe	
Instrument	AL 100	AL 2000	AL 100	AL 2000	AL 100	AL 2000
Mean variance	0,644 1	0,939 9	1,026 1	1,489 87	0,361 7	1,999 3
95 % CL	1,57 mm	1,90 mm	1,98 %	2,40 %	1,71 mm	2,77 mm
NOTE The sample variation has been removed.						

C.3 Components of variance and estimates of precision

Table C.2 show estimates of precision determined from the 1970 round trail. Precision is shown for the combination of results from up to 8 laboratory samples, based on the within and between laboratory components of variance.

The result from each laboratory sample comprises the average of one measurement on each of two test specimens.

The precision values quoted include the variation that occurs between laboratory samples from the same ball, but do not cover the variation in a lot during manufacture (for example from ball to ball).

The estimates shown in Tables C.2, Table C.3, Table C.4, and Table C.5 have been derived from the published values of the components of variance obtained from measurements undertaken on the 5 tops used in the trial. Precision values for Hauteur, Barbe and L5H showed level-dependency, and consequently the values for these parameters are tabulated for a range of levels based on linear regression of the measured components of variance (expressed as SD values) against the grand means of the appropriate parameters. The within-laboratory components of variance have been calculated for the mean of two test specimens drawn from a single laboratory sample. And only the results from the automatic grip were analysed.

95 % confidence limits are calculated according to Formula (C.1):

$$95\ \%\ \text{confidence limit} = 1,96 \cdot \sqrt{(\sigma^2_{between} + \sigma^2_{within} / n)} \tag{C.1}$$

where

$\sigma_{between}$ and σ_{within} are the components of variance;

n is the number of laboratory samples measured.

Table C.2 — Components of variance and estimates of precision (Mean Hauteur)

Mean Hauteur (mm)	Components of variance expressed as SD (mm)		95 % confidence limits (mm)							
			Number of laboratory samples							
Range	Between	Within	1	2	3	4	5	6	7	8
			Number of test specimens							
			2	4	6	8	10	12	14	16
Less than 50,0	0,069	0,258	0,5	0,4	0,3	0,3	0,2	0,2	0,2	0,2
50,0 to 59,9	0,253	0,430	1,0	0,8	0,7	0,7	0,6	0,6	0,6	0,6
60,0 to 69,9	0,437	0,603	1,5	1,2	1,1	1,0	1,0	1,0	1,0	1,0
70,0 to 79,9	0,621	0,775	1,9	1,6	1,5	1,4	1,4	1,4	1,3	1,3
80,0 to 89,9	0,805	0,948	2,4	2,1	1,9	1,8	1,8	1,7	1,7	1,7
90,0 and above	0,989	1,121	2,9	2,5	2,3	2,2	2,2	2,1	2,1	2,1

Table C.3 — Components of variance and estimates of precision (Length distribution)

Length distribution	Components of variance expressed as SD (%)		95 % confidence limits (%)							
			Number of laboratory samples							
Range	Between	Within	1	2	3	4	5	6	7	8
			Number of test specimens							
			2	4	6	8	10	12	14	16
CV_H	1,060	0,841	2,7	2,4	2,3	2,2	2,2	2,2	2,2	2,2
K25H	0,390	0,450	1,2	1,0	0,9	0,9	0,9	0,8	0,8	0,8
K40H	0,628	0,823	2,0	1,7	1,5	1,5	1,4	1,4	1,4	1,4

Table C.4 — Components of variance and estimates of precision (Mean L5H)

Mean L5H	Components of variance expressed as SD (mm)		95 % confidence limits (mm)							
			Number of laboratory samples							
Range	Between	Within	1	2	3	4	5	6	7	8
			Number of test specimens							
			2	4	6	8	10	12	14	16
Less than 90,0	0,159	0,501	1,0	0,8	0,6	0,6	0,5	0,5	0,5	0,5
90,0 to 119,9	0,690	0,686	1,9	1,7	1,6	1,5	1,5	1,5	1,4	1,4
120,0 to 149,9	1,221	0,871	2,9	2,7	2,6	2,5	2,5	2,5	2,5	2,5
150,0 to 179,9	1,752	1,055	4,0	3,7	3,6	3,6	3,6	3,5	3,5	3,5
180,0 and above	2,283	1,240	5,1	4,8	4,7	4,6	4,6	4,6	4,6	4,6

Table C.5 — Components of variance and estimates of precision (Mean Barbe)

Mean Barbe (mm)	Components of variance expressed as SD (mm)		95 % confidence limits (mm)							
			Number of laboratory samples							
Range	Between	Within	1	2	3	4	5	6	7	8
			Number of test specimens							
			2	4	6	8	10	12	14	16
Less than 60,0	0,314	0,296	0,8	0,7	0,7	0,7	0,7	0,7	0,7	0,6
60,0 to 79,9	0,526	0,470	1,4	1,2	1,2	1,1	1,1	1,1	1,1	1,1
80,0 to 99,9	0,738	0,644	1,9	1,7	1,6	1,6	1,6	1,5	1,5	1,5
100,0 to 119,9	0,950	0,818	2,5	2,2	2,1	2,0	2,0	2,0	2,0	1,9
120,0 and above	1,162	0,992	3,0	2,7	2,5	2,5	2,4	2,4	2,4	2,4

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