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**Textiles — Determination of fabric  
propensity to surface fuzzing  
and to pilling —**

Part 2:  
**Modified Martindale method**

*Textiles — Détermination de la propension des étoffes à l'ébouriffage en  
surface et au boulochage —*

*Partie 2: Méthode Martindale modifié*



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ISO 12945-2:2000(E)

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 12945 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 12945-2 was prepared by Technical Committee ISO/TC 38, *Textiles*.

ISO 12945 consists of the following parts, under the general title *Textiles — Determination of fabric propensity to surface fuzzing and to pilling*:

- *Part 1: Pilling box method*
- *Part 2: Modified Martindale method*
- *Part 3: Determination using a random tumble method*

Annex A forms a normative part of this part of ISO 12945.

## Introduction

Pills are formed when fibres on a fabric surface “tease out” and become entangled during wear. Such surface deterioration is generally undesirable, but the degree of consumer tolerance for a given level of pilling will depend on the garment type and fabric end use.

Generally the level of pilling which develops is determined by the rates of the following parallel processes:

- a) fibre entanglement leading to pill formation;
- b) development of more surface fibre;
- c) fibre and pill wear-off.

The rates of these processes depend on the fibre, yarn and fabric properties. Examples of extreme situations are found in fabrics containing strong fibres versus fabric containing weak fibres. A consequence of the strong fibre is a rate of pill formation that exceeds the rate of wear-off. This results in an increase of pilling with an increase of wear. With a weak fibre the rate of pill formation competes with the rate of wear-off. This would result in a fluctuation of pilling with an increase of wear. There are other constructions that the surface fibre wear-off occurs before pill formation. Each of these examples demonstrates the complexity of evaluating the surface change on different types of fabric.

The ideal laboratory test would accelerate the wear processes a), b) and c) by exactly the same factor and would be universally applicable to all fibre, yarn and fabric types. No such test has been developed. However, a test procedure has been established in which fabrics can be ranked in the same order of fuzzing and pilling propensity as is likely to occur in end-use wear.

The modification to the very widely adopted Martindale abrasion testing machine on which this part of ISO 12945 is based is described in a publication by H. Knecht: *Neue Methode zur Prüfung der Pillingneigung* in *Wirkerei und Strickerei Technik*, **38** (1988), 12, p. 1309.



# Textiles — Determination of fabric propensity to surface fuzzing and to pilling —

## Part 2: Modified Martindale method

### 1 Scope

This part of ISO 12945 specifies a method for determination of the resistance to pilling and surface change of textile fabrics using a modified Martindale method.

### 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 12945. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 12945 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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

ISO 12947-1, *Textiles — Determination of the abrasion resistance of fabrics by the Martindale method — Part 1: Martindale abrasion testing apparatus.*

### 3 Terms and definitions

For the purposes of this part of ISO 12945 the following terms and definitions apply.

#### 3.1

##### **fuzzing**

roughing up of the surface fibres and/or teasing out of the fibres from the fabric, producing a visible surface change

NOTE This change can occur during washing, dry cleaning and/or wearing.

#### 3.2

##### **pills**

entangling of fibres into balls (pills) which stand proud of the fabric and are of such density that light will not penetrate and will cast a shadow

NOTE This change can occur during washing, dry cleaning and/or wearing.

#### 3.3

##### **pilling**

generation of pills over the surface of the fabric

### 3.4

#### **pilling rub**

one revolution of the two outer drives of the modified Martindale abrasion machine

### 3.5

#### **pilling cycle**

completion of the translational movements tracing a Lissajous figure comprising 16 rubs, i.e. 16 revolutions of the two outer drives and 15 revolutions of the inner drive of the Martindale abrasion tester

## 4 Principle

A circular test specimen is passed over a friction surface comprising the same fabric or, when relevant, a wool abradant fabric, at a defined force in the form of a Lissajous figure, with the test specimen able to rotate easily around an axis through its centre, perpendicular to the plane of the test specimen. Fuzzing and pilling are assessed visually after defined stages of rub testing.

## 5 Apparatus

**5.1 Martindale abrasion testing machine**, as described in ISO 12947-1, modified in accordance with 5.2.

The test apparatus consists of a base plate carrying the pilling tables and drive mechanism. The drive mechanism consists of two outer drives and an inner drive which cause the specimen holder guide plate to trace a Lissajous figure.

The specimen holder guide plate is moved horizontally by the drive mechanism in such a way that every point of the guide plate describes the same Lissajous figure.

The Lissajous movement changes from a circle to gradually narrowing ellipses, until it becomes a straight line, from which progressively widening ellipses develop in a diagonally opposite direction before the pattern is repeated.

The specimen holder guide plate is fitted with bearing housings and low friction bearings which carry the specimen holder guide spindles. The lower end of each specimen holder spindle is inserted into each corresponding specimen holder body. The specimen holder consists of a body, specimen holder ring and optional loading weight.

The apparatus is fitted with a pre-settable counting device which measures each revolution of one of the outer drives. Each revolution is taken as a pilling rub and sixteen revolutions as a complete Lissajous figure.

### 5.2 Drive and base plate attachments

#### 5.2.1 Drive

Movement of the specimen holder guide plate carrying the specimen holder bearing housings and bearings and consequently the specimen holders themselves is performed by the following units:

- a) two outer synchronised drive units with the distance of the axis of the drive units from their central axis of  $(12 \pm 0,25)$  mm;
- b) central drive unit, with the distance of the axis of the drive unit from its central axis of  $(12 \pm 0,25)$  mm.

The maximum stroke of the specimen holder guide plate in both the length and traverse directions is  $(24 \pm 0,5)$  mm.

**5.2.2 Counter**, for counting the pilling rubs and measures to an accuracy of 1 rub.



**5.2.3 Pilling tables**, each consisting of the following elements:

- a) pilling table (see Figure 1);
- b) clamping ring (see Figure 2);
- c) clamping mechanism to fasten the clamping ring.

**5.2.4 Specimen holder guide plate**, comprising a metal plate in which three guides engage the drive units. These interact so as to ensure a uniform, smooth and low vibration movement of the specimen holder guide plate.

The specimen holder guide spindles are located in bearing housings secured to the guide plate, central to each pilling table. Each bearing housing carries two bearings. The guide spindles shall be freely moving and free from play in the bearings.

**5.2.5 Specimen holder**, for every work station, comprising the following component parts:

- a) specimen holder (see Figure 3);
- b) specimen holder ring;
- c) specimen holder guide spindle.

The specimen holder complete with guide spindle and specimen holder ring shall have a mass of  $(155 \pm 1)$  g.

**5.2.6 Loading pieces**, comprising an additional loading piece in the form of a stainless steel disc which can be applied to the specimen holder (5.2.5) provided for each working station on the testing machine (see Figure 4). The mass of the disc is  $(260 \pm 1)$  g.

The mass of the complete specimen holder and stainless steel disc  $(415 \pm 2)$  g.

**5.2.7 Auxiliary device for specimen mounting**, required for mounting the test specimen without folds on the specimen holder (see Figure 5).

**5.2.8 Pilling table specimen mounting weight**, complete with handle, required for mounting the test specimen or abradant without folds or creases on the pilling table. The mounting weight mass is  $(2,5 \pm 0,5)$  kg and diameter  $(120 \pm 10)$  mm.

**5.3 Viewing cabinet**, illuminated by a white fluorescent tube or bulb to give uniform illumination over the width of the specimen(s) and masked in such a way that the observer does not look directly into the light. The illuminant shall be positioned at an angle between  $5^\circ$  and  $15^\circ$  to the plane of the specimen (see Figure 6). The distance between the eye and the specimen shall be between 30 cm and 50 cm for normal corrected vision.

Dimensions in millimetres

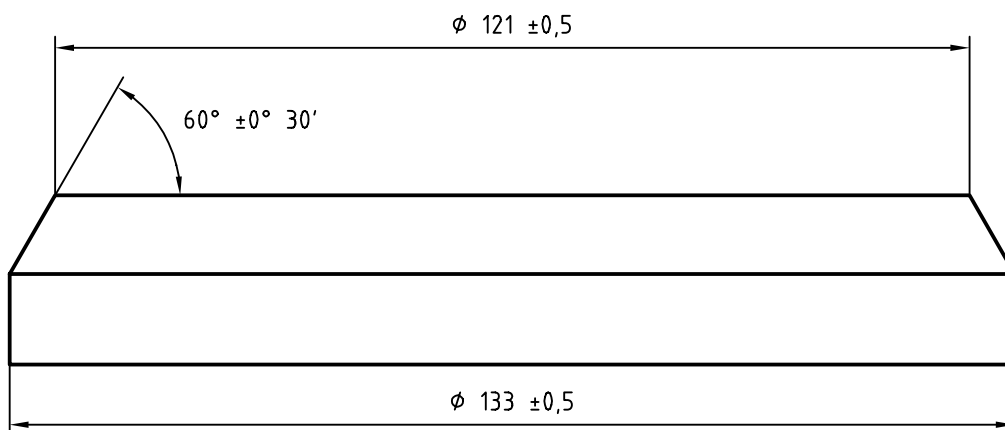


Figure 1 — Pilling table

Dimensions in millimetres

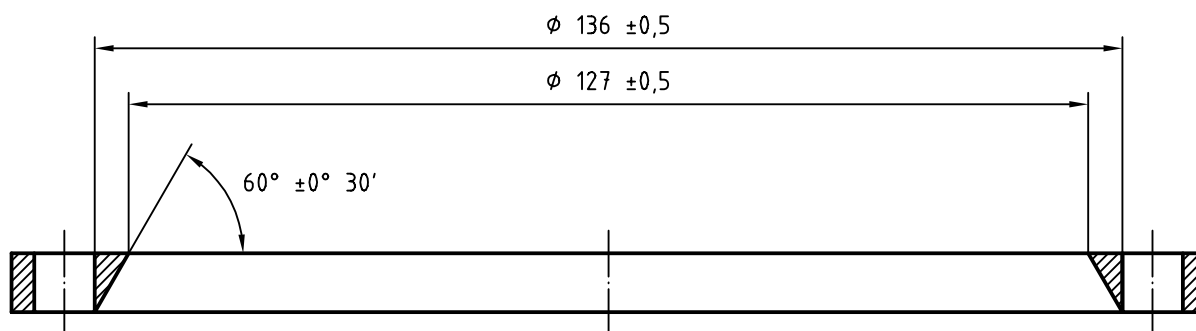


Figure 2 — Clamping ring

Dimensions in millimetres

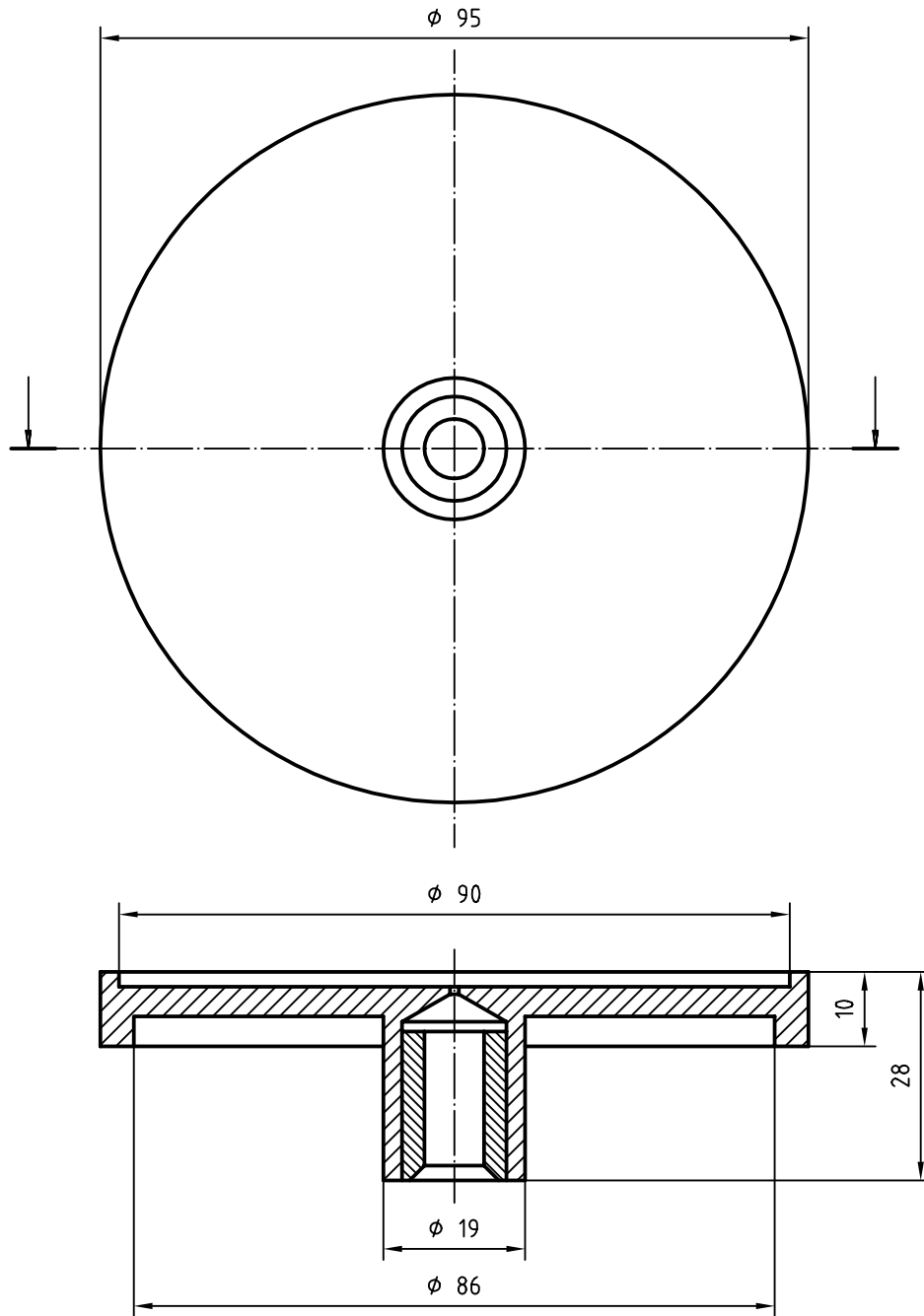


Figure 3 — Specimen holder body

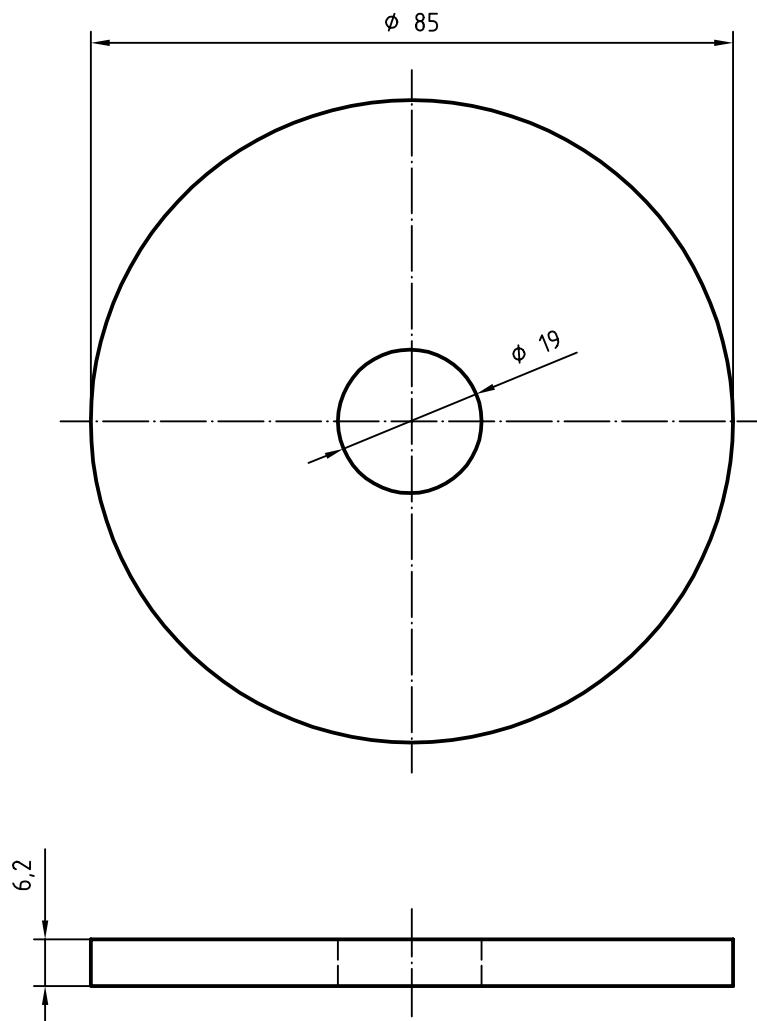


Figure 4 — Additional loading weight

Dimensions in millimetres

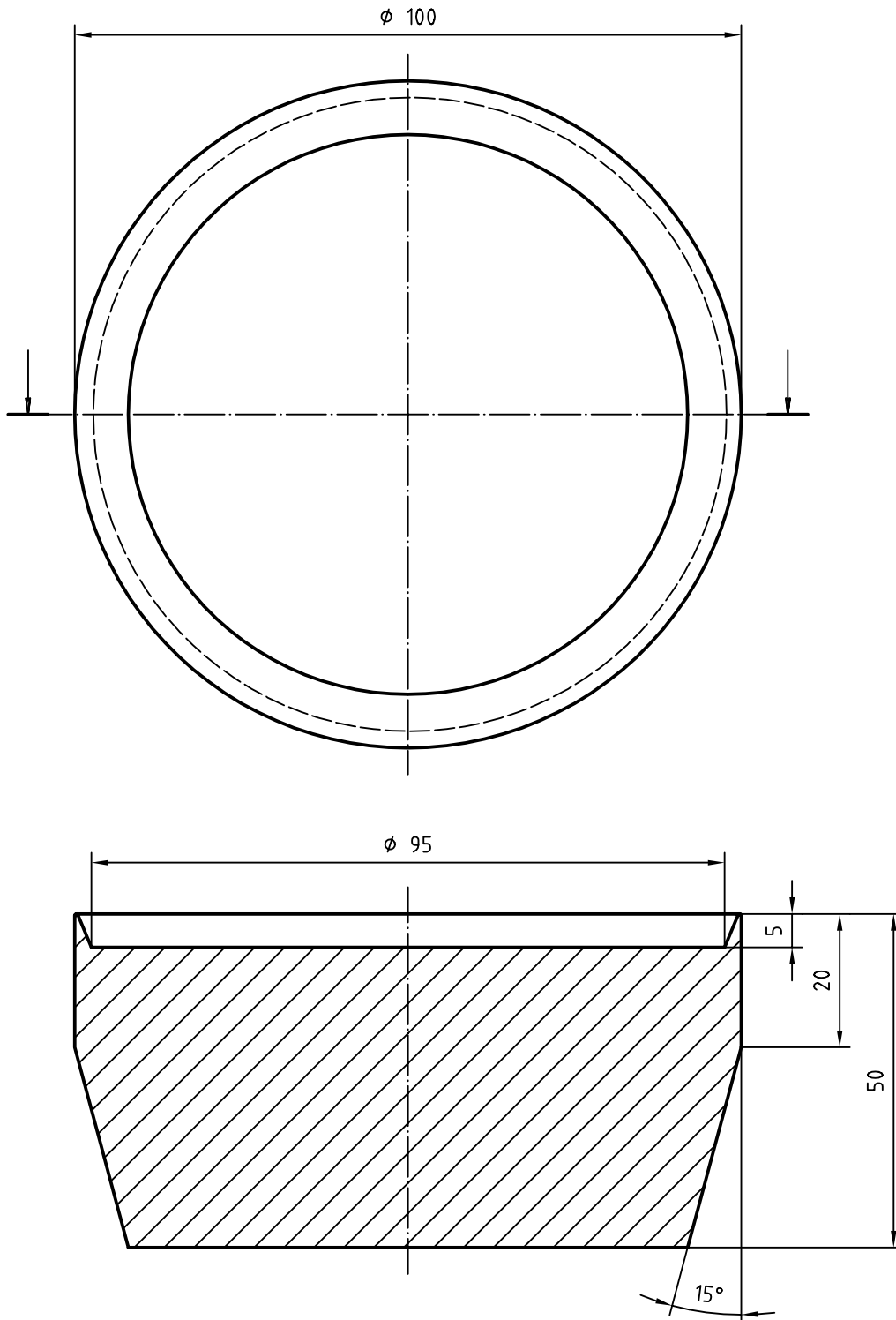
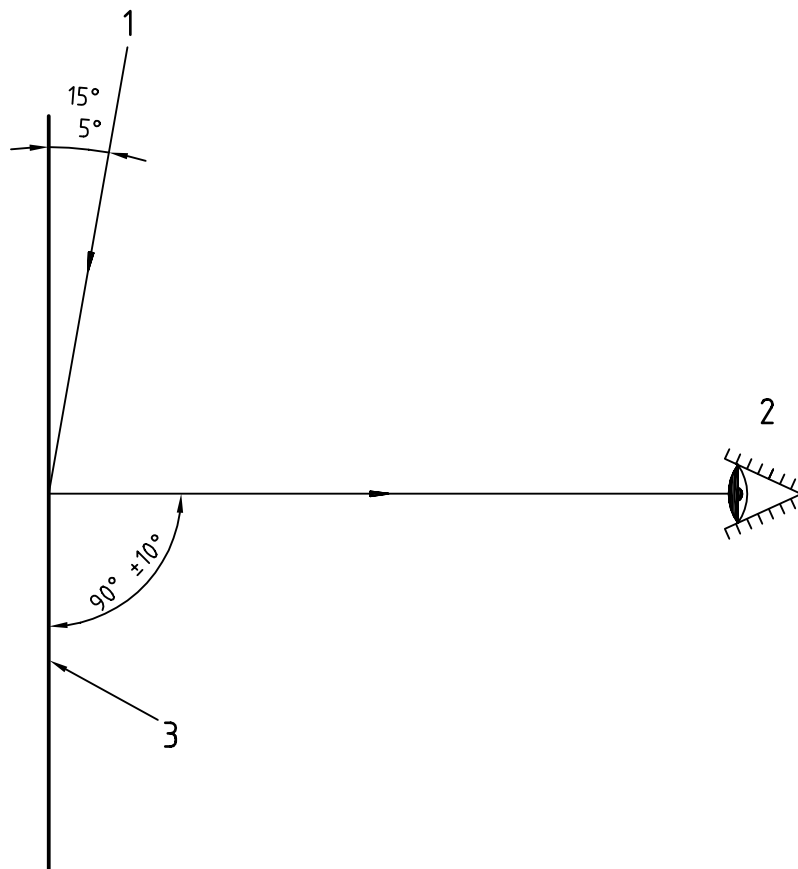


Figure 5 — Auxiliary device for specimen mounting



**Key**

- 1 Light source
- 2 Observer
- 3 Specimen

**Figure 6 — Illumination of specimens**

**6 Auxiliary materials**

**6.1 Felt**, in the form of circles as specified in ISO 12947-1, serving as a support material for the two specimens. They have the following dimensions:

- a) top (test specimen holder):  $(90 \pm 1)$  mm diameter;
- b) bottom (pilling table):  $(140 \begin{smallmatrix} +5 \\ 0 \end{smallmatrix})$  mm diameter.

**6.2 Abradant**, against which the test specimen is abraded, normally the same as the fabric under test. Under certain circumstances, e.g. upholstery fabrics, the wool abradant fabric specified in ISO 12947-1 is used. The choice of abradant shall be stated in the test report.

Circles of the abrading fabric measuring  $(140 \begin{smallmatrix} +5 \\ 0 \end{smallmatrix})$  mm in diameter or  $(150 \pm 2)$  mm in length and width are mounted on each abrading table.

## 7 Conditioning and testing atmosphere

The standard temperate atmosphere for conditioning and testing textiles as defined in ISO 139 shall be used, i.e. a temperature  $(20 \pm 2)$  °C and a relative humidity of  $(65 \pm 2)$  %.

## 8 Preparation of test specimens

### 8.1 Pre-treatment

Unless otherwise agreed, launder or dry clean the sample using a method agreed upon by the interested parties.

NOTE The procedures described in ISO 6330 or ISO 3175-1 or ISO 3175-2 may be suitable.

### 8.2 Sampling

NOTE Test specimens should be randomly placed with none of the test specimens having common warp or weft threads.

The test specimen for the specimen holder is a disc of  $(140 \text{ }^{+5}_0)$  mm diameter. The test specimen for the pilling table can optionally be  $(140 \text{ }^{+5}_0)$  mm in diameter or  $(150 \pm 2)$  mm in both the length and width.

Throughout sampling and specimen preparation particular care shall be taken that during handling the absolute minimum of tension is applied to avoid any abnormal elongation of the textile fabric.

### 8.3 Number of test specimens

At least three sets of specimens are required where one complete set comprises one test specimen for the specimen holder and one for the pilling table. Where the wool abradant fabric is used on the pilling table, at least three specimens of the fabric under test are required for the specimen holders. If testing more than three specimens, an odd number of specimens shall be used. A further specimen cut is necessary for comparative assessment against the tested specimen.

### 8.4 Marking the test specimens

Before sampling, mark each test specimen, at the same point, on the back of the fabric to be assessed. This ensures that the test specimens are aligned in the same thread direction in the assessment. The mark shall not influence the test in any way.

## 9 Procedure

### 9.1 General

Check the Martindale abrasion testing machine for correctness in accordance with ISO 12947-1. Assess the specimen support materials after every pilling test and replace in the event of soiling or wear.

### 9.2 Mounting the test specimens

With lightweight knitted fabrics, particular care shall be taken that the test specimens are not visibly extended.

#### 9.2.1 Mounting the test specimen in the specimen holder

Remove the specimen holder ring and guide spindle from each specimen holder. Place the auxiliary device for specimen mounting (5.2.7), small diameter uppermost on a bench or table top. Position a specimen holder ring on the angled surface of the auxiliary device, roll ring down until it is located on the large parallel diameter at the base.

Invert a specimen holder and place a  $(90 \pm 1)$  mm diameter disc of felt centrally in the recessed face. Place a  $(140^{+5}_0)$  mm diameter specimen face up centrally over the felt and allow excess material to drape over the specimen holder edge. Ensure the specimen fully covers the groove in which the specimen holder ring locates.

Carefully bring together the specimen holder carrying the felt and specimen and the large diameter end of the auxiliary device so that the specimen holder locates in the recess of the auxiliary device. Whilst holding the specimen holder and auxiliary device firmly together, roll the specimen holder ring on to the specimen holder so that it locates in the specimen holder groove, thus retaining the specimen and felt.

Repeat the procedure for the remaining specimen holders. Place the loading piece (5.2.6) when required, over the specimen holder guide spindle bush and locate in the recess of the specimen holder.

### 9.2.2 Mounting the test specimen on the pilling table

Place a  $(140^{+5}_0)$  mm diameter piece of felt [6.1b)] on the pilling table. Place the bottom test specimen or, when relevant, the wool abradant with the surface to be rubbed facing upwards, on the felt. Load with the mounting weight (5.2.8) and secure with the clamping ring.

### 9.3 Pilling test

Run the test until the end of the first rubbing stage is reached (see annex A). Carry out the first assessment in accordance with clause 10 without removing the test specimen from the specimen holder and without clearing away parts of the surface for the purpose of assessment.

Following assessment, replace the specimen holders in the testing position from which they were taken. As required, continue the test, assessing at each rubbing stage until the end of the final rubbing stage is reached as described in annex A.

## 10 Assessment of fuzzing and/or pilling

The viewing cabinet shall be situated in a darkened room.

Place the tested specimen and a piece of the original sample (with or without pretreatment) centrally on the lectern in the viewing cabinet (see Figure 6) with the length direction vertical. If necessary use a piece of self adhesive PVC tape to ensure correct placement. The tested specimen shall be mounted on the left and the original sample on the right.

View each specimen from just outside the viewing cabinet (5.3) (to prevent glare from the light source) and directly in front of the specimen, as shown in Figure 6.

Grade each specimen in accordance with the grading scheme given in Table 1. If the grading appears between two grades, report the "half" grading as, e.g., 3-4.

The test result for each individual observer is the average of the specimen grades used. The test result for the laboratory sample is the average of the observer grades.

NOTE 1 Due to the subjective nature of the assessment, it is recommended that more than one observer assess the specimens.

NOTE 2 Photographic assessment may be used to support the primary descriptive method of assessment, as agreed between interested parties.

NOTE 3 A second assessment may be made by rotating the specimen to a position where the observed pilling is more severe. This assessment may be used to provide data for an "extreme" condition, e.g. where a surface is being viewed along the plane of the surface.

NOTE 4 Report any other aspect which shows the deterioration in surface appearance.



Table 1 —Visual Assessment

Grade	Description
5	No change.
4	Slight surface fuzzing and/or partially formed pills.
3	Moderate surface fuzzing and/or moderate pilling. Pills of varying size and density partially covering the specimen surface.
2	Distinct surface fuzzing and/or distinct pilling. Pills of varying size and density covering a large proportion of the specimen surface.
1	Dense surface fuzzing and/or severe pilling. Pills of varying size and density covering the whole of the specimen surface.

## 11 Results

Record the grading for each specimen and calculate the mean result for all assessments carried out as described in Clause 10. If the mean result is not a whole number, round the result to the nearest half grade. The variation in the result based on the mean of the test specimens should be no more than half a grade. If this variation is more than half a grade, the grading of each specimen shall be reported.

## 12 Test report

The test report shall include the following information:

- a) reference to this part of ISO 12945, i.e. ISO 12945-2;
- b) a description of the laboratory sample;
- c) where applicable details of pretreatment of the laboratory sample;
- d) the number of test specimens and number of observers;
- e) the abrasant used;
- f) the loading mass;
- g) the number of rubs and respective pilling grade at each stage;
- h) the date of test;
- i) the final grade assessed and whether it relates to fuzzing or pilling or both;
- j) details of any deviation from the procedure.

## Annex A (normative)

### Categories of pilling test

Unless otherwise specified the categories for different types of textiles shall be as in Table A.1.

**Table A.1 — Categories of pilling test**

Category	Textile type	Abradant type	Loading weight g	Assessment stage	Number of rubs
1	Upholstery	Wool abradant fabric	415 ± 2	1	500
				2	1 000
				3	2 000
				4	5 000
2 <sup>a</sup>	Woven fabrics (except upholstery fabrics)	Woven fabric under test (face/face) or wool fabric	415 ± 2	1	125
				2	500
				3	1 000
				4	2 000
				5	5 000
				6	7 000
3 <sup>a</sup>	Knitted fabrics (except upholstery fabrics)	Knitted fabric under test (face/face) or wool fabric	155 ± 1	1	125
				2	500
				3	1 000
				4	2 000
				5	5 000
				6	7 000
<sup>a</sup> For categories 2 and 3 the minimum test duration is 2 000 pilling rubs. The test may be terminated before 7 000 pilling rubs if grade 4-5 or better is observed at an agreed assessment stage.					
<b>NOTE</b> Trials have shown that better correlation occurs between the test and wear performance by continuing to 7 000 rubs on the grounds that pills which are present at 2 000 rubs may be removed by 7 000 rubs.					

## Bibliography

- [1] ISO 3175-1, *Textiles — Dry-cleaning and finishing — Part 1: Method for assessing the cleanability of textiles and garments.*
- [2] ISO 3175-2, *Textiles — Dry-cleaning and finishing — Part 2: Procedures for tetrachloroethene.*
- [3] ISO 6330, *Textiles — Domestic washing and drying procedures for textile testing.*

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