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**Textiles — Determination of fabric  
propensity to surface pilling, fuzzing  
or matting —**

**Part 2:  
Modified Martindale method**

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

*Partie 2: Méthode du Martindale modifiée*

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# Contents

	Page
Foreword.....	iv
Introduction.....	v
<b>1 Scope.....</b>	<b>1</b>
<b>2 Normative references.....</b>	<b>1</b>
<b>3 Terms and definitions.....</b>	<b>1</b>
<b>4 Principle.....</b>	<b>2</b>
<b>5 Apparatus.....</b>	<b>2</b>
<b>6 Auxiliary materials.....</b>	<b>7</b>
<b>7 Preparation of test specimens.....</b>	<b>8</b>
7.1 Pretreatment of the laboratory sample.....	8
7.2 Sampling of test specimens.....	8
7.3 Number of test specimens.....	8
7.4 Marking the test specimens.....	9
<b>8 Conditioning and testing atmosphere.....</b>	<b>9</b>
<b>9 Procedure.....</b>	<b>9</b>
9.1 General.....	9
9.2 Mounting the test specimens.....	9
9.2.1 Mounting the test specimen in the test specimen holder.....	9
9.2.2 Mounting the test specimen on the pilling table.....	9
9.3 Pilling test.....	10
<b>10 Assessment of pilling, fuzzing and matting.....</b>	<b>10</b>
<b>11 Results.....</b>	<b>10</b>
<b>12 Test report.....</b>	<b>11</b>
<b>Annex A (normative) Categories of pilling test.....</b>	<b>12</b>
<b>Bibliography.....</b>	<b>13</b>

## 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.

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](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of 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 [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 38, *Textiles*, Subcommittee SC 24, *Conditioning atmospheres and physical tests for textile fabrics*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 248, *Textiles and textile products*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 12945-2:2000), which has been technically revised.

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

- in [Clause 9](#), visual assessment of pilling, fuzzing, and matting has been carried out according to ISO 12945-4.

A list of all parts in the ISO 12945 series can be found on the ISO website.

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](http://www.iso.org/members.html).

## 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 pilling, fuzzing, and matting propensity as is likely to occur in end-use wear.

The modification to the very widely adopted Martindale abrasion testing machine on which this document is based is described in Reference [8].

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# Textiles — Determination of fabric propensity to surface pilling, fuzzing or matting —

## Part 2: Modified Martindale method

### 1 Scope

This document specifies a method for the determination of the resistance to pilling, fuzzing, and matting of textile fabrics using a modified Martindale method.

### 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*

ISO 12945-4, *Textiles — Determination of fabric propensity to surface pilling, fuzzing or matting — Part 4: Assessment of pilling, fuzzing and matting by visual analysis*

ISO 12947-1:1998, *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 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

##### **pill**

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 1 to entry: This change can occur during washing, dry cleaning, and/or wearing.

[SOURCE: ISO 12945-4:2020, 3.1]

#### 3.2

##### **pilling**

generation of *pills* (3.1) over the surface of the fabric

[SOURCE: ISO 12945-4:2020, 3.2]

### 3.3

#### **fuzzing**

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

Note 1 to entry: This change can occur during washing, dry cleaning, and/or wearing.

[SOURCE: ISO 12945-4:2020, 3.3]

### 3.4

#### **matting**

disorientation of the raised fibres of a napped fabric, which produces a visible surface change

Note 1 to entry: This change can occur during washing, dry cleaning, and/or wearing.

[SOURCE: ISO 12945-4:2020, 3.4]

### 3.5

#### **pilling rub**

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

### 3.6

#### **pilling cycle**

completion of the translational movements tracing a Lissajous figure comprising 16 *pilling rubs* (3.5), 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, pilling, and matting 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 test specimen holder guide plate to trace a Lissajous figure.

The test 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 test specimen holder guide plate is fitted with bearing housings and low friction bearings which carry the test specimen holder guide spindles. The lower end of each test specimen holder spindle is inserted into each corresponding test specimen holder body. The test specimen holder consists of a body, test 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 16 revolutions as a complete Lissajous figure.

## 5.2 Drive and base plate attachments

### 5.2.1 Drive

Movement of the test specimen holder guide plate carrying the test specimen holder bearing housings and bearings and consequently the test 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 test 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 0,01.

**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 Test 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 test specimen holder guide plate.

The test 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 Test specimen holder**, for every work station, comprising the following component parts:

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

The test specimen holder complete with guide spindle and test 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 test 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 test specimen holder and stainless-steel disc  $(415 \pm 2)$  g.

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

**5.2.8 Pilling table test specimen mounting weight**, complete with handle, required for mounting the test specimen or abrasant 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.

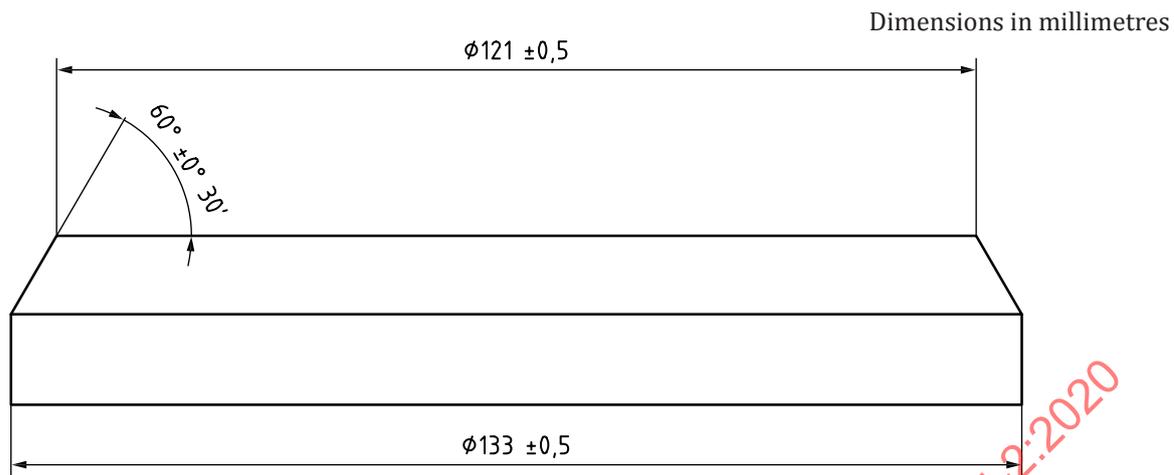


Figure 1 — Pilling table

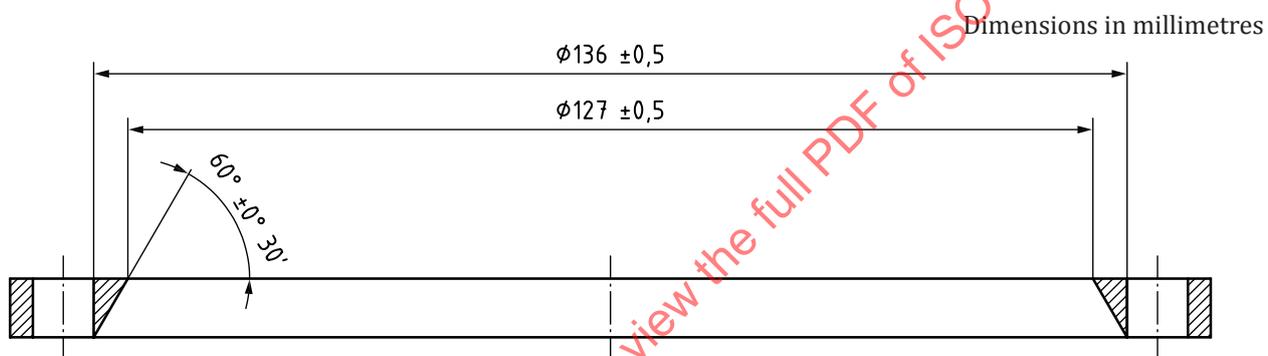


Figure 2 — Clamping ring

Dimensions in millimetres

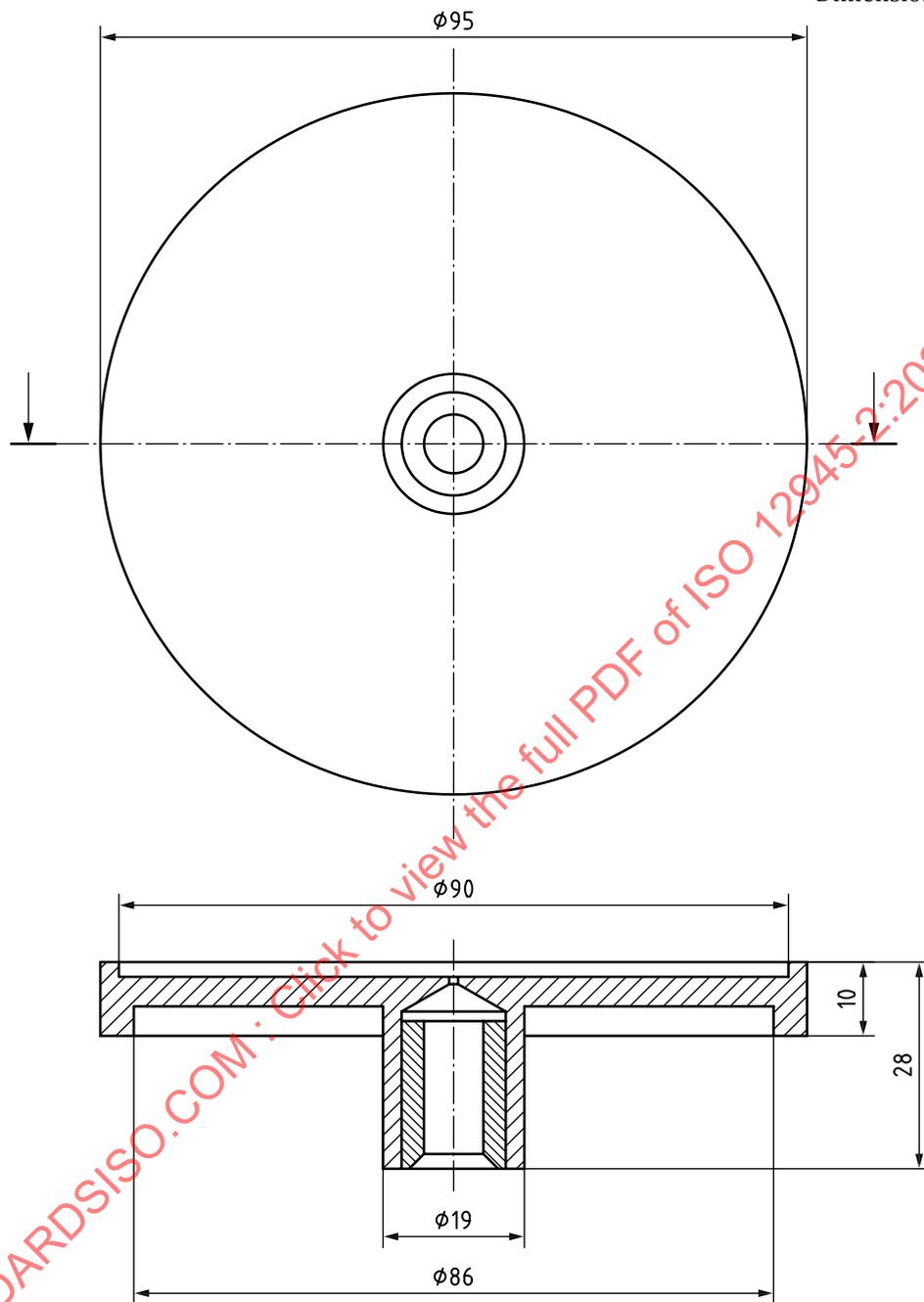


Figure 3 — Test specimen holder body

Dimensions in millimetres

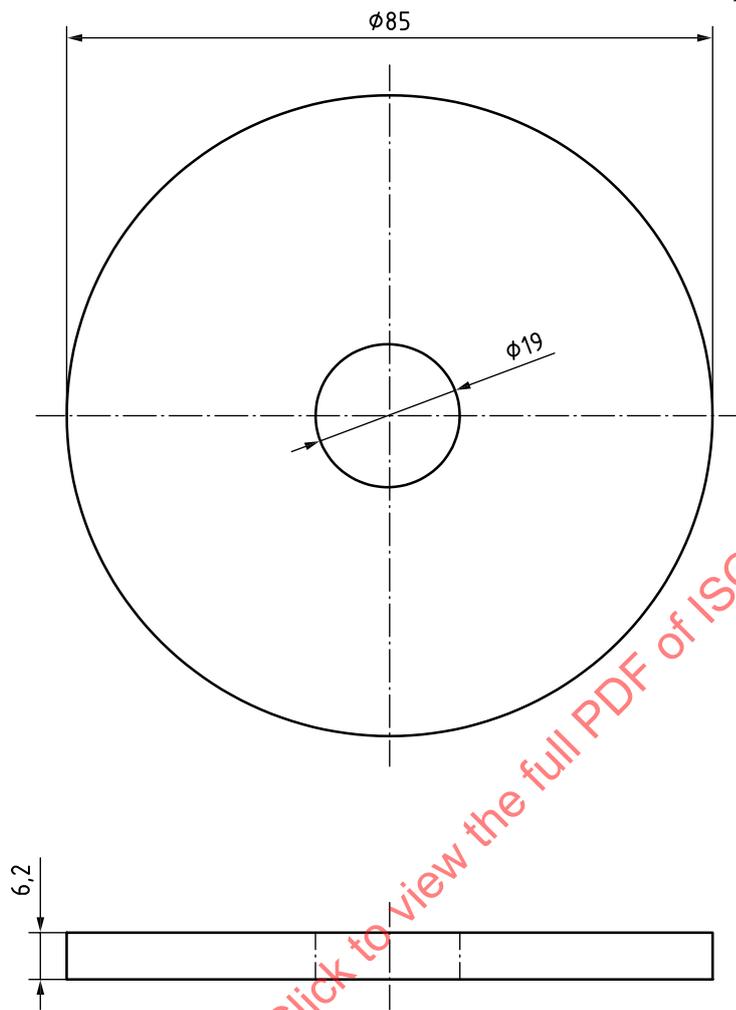


Figure 4 — Additional loading weight

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Dimensions in millimetres

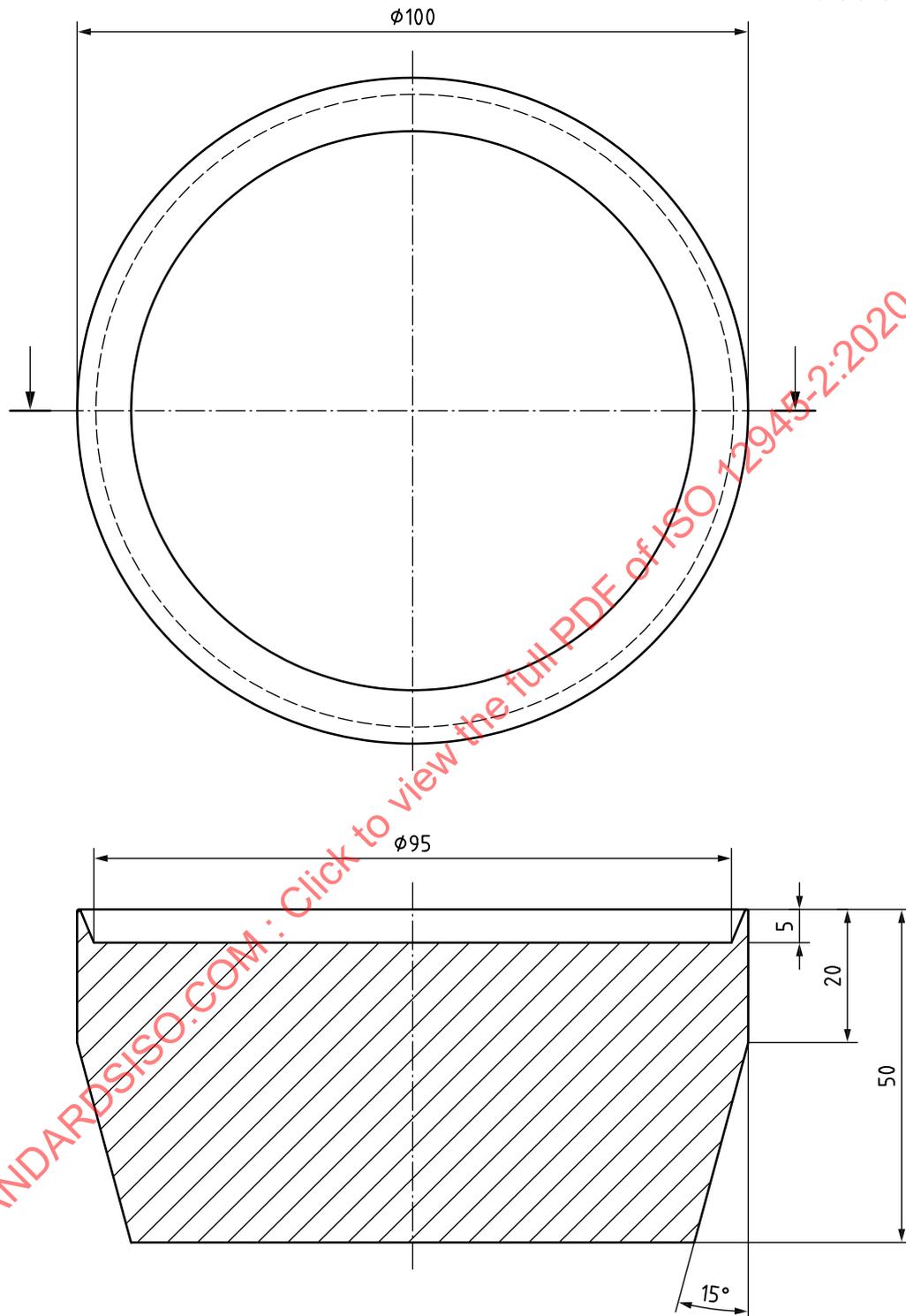


Figure 5 — Auxiliary device for test specimen mounting

## 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 test specimens. They have the following dimensions:

- a) top (test specimen holder):  $(90 \pm 1)$  mm diameter;

b) bottom (pilling table):  $(140^{+5}_0)$  mm diameter.

If the felt exhibits a change in mass and/or thickness such that it no longer meets the requirements of ISO 12947-1:1998, Table 2 then it shall be replaced.

The felt shall not show any visible surface changes like thin or thick places.

**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  $(140^{+5}_0)$  mm in diameter or  $(150 \pm 2)$  mm in length and width are mounted on each abrading table.

## 7 Preparation of test specimens

### 7.1 Pretreatment of the laboratory sample

Laboratory samples may be pretreated by washing or dry-cleaning before cutting the test specimens, using conditions appropriate for the fabric end use or conditions agreed upon between the interested parties. When pretreated, the evaluation of the tested specimen from the pretreated laboratory sample is done in comparison with that laboratory sample.

If there is no specific pretreatment agreed upon between the interested parties, the test specimen is tested as received.

Regardless of the pretreatment, samples shall be conditioned according to [Clause 8](#) prior to testing.

NOTE The procedures of the pretreatment described in ISO 6330 or in the respective part of ISO 3175 can be suitable.

### 7.2 Sampling of test specimens

Take specimens from areas evenly spaced across the width of the fabric or from three different panels of a garment. Stagger specimens in such a manner that no two specimens contain the same yarns. Avoid areas with wrinkles and other distortions. Unless otherwise specified, do not cut specimens nearer to the selvedge than one-tenth the width of the fabric.

Handle the specimen by applying minimal tension to avoid stretching.

The test specimen for the test specimen holder is a disc of  $(140^{+5}_0)$  mm diameter. If necessary, in order to prevent the loosening of the fibres/yarns that can interfere in the zone of friction with the specimen, leading to pilling, the edges of the test specimens may be secured (e.g. by gluing, with adhesive tape).

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

### 7.3 Number of test specimens

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

## 7.4 Marking the test specimens

Before sampling, mark each test specimen and the laboratory sample (including the reference 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.

## 8 Conditioning and testing atmosphere

The standard atmosphere for conditioning and testing textiles as defined in ISO 139 shall be used.

The test specimens and abradant (when used) should be conditioned for at least 16 h prior to testing.

## 9 Procedure

### 9.1 General

Check the Martindale abrasion testing machine for correctness in accordance with ISO 12947-1.

Assess the felts (6.1), serving as a support material, after every pilling test and replace in the event of soiling or wear.

In the case of the use of a wool abradant fabric during the pilling test, it should be changed after every test.

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

### 9.2 Mounting the test specimens

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

Remove the test specimen holder ring and guide spindle from each test specimen holder. Place the auxiliary device for test specimen mounting (5.2.7), small diameter uppermost on a bench or table top. Position a test 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 test 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 test specimen face up centrally over the felt and allow excess material to drape over the test specimen holder edge. Ensure the test specimen fully covers the groove in which the test specimen holder ring locates.

Place the large diameter end of the auxiliary device on top of the face of the specimen holder containing the felt and the specimen. The mass of the auxiliary device and its overhang over the edge of the face of the specimen holder act to equalize tension across the specimen surface. Roll the specimen holder ring onto the specimen holder so that it locates in the specimen holder groove, thus retaining the specimen and felt under equal tension.

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

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

Place a  $(140^{+5}_0)$  mm diameter piece of felt [6.1 b)] 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 test specimen holder, clear away loose parts of the surface for the purpose of assessment.

Following assessment, replace the test 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](#).

Gently remove loose fibres or debris from the surface of the abradant.

Sometimes, test specimens cannot be assessed because there is a binding in the friction zone between the fibres of both top and bottom test specimens. In this case, it shall be reported the results up to that stage and that “due to binding between fabrics, the test specimen cannot be assessed”.

**10 Assessment of pilling, fuzzing and matting**

The visual assessment of pilling, fuzzing and matting, respectively, shall be carried out according to ISO 12945-4.

If agreed between interested parties, the assessment may be additionally carried out according to instrumental assessment.

**11 Results**

For each surface appearance (i.e. pilling, fuzzing, and matting), record the grade for each test specimen.

Calculate the mean result for all tested specimens for each surface appearance separately: for pilling, for fuzzing and for matting 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 three test specimens should be no more than half a grade. If this variation is more than half a grade, the grading of each test specimen shall be reported.

[Table 1](#) shows an example of presentation of the results.

**Table 1 — Example of a table with results at each assessment stage**

Number of pilling rubs	Pilling				Fuzzing				Matting			
	result 1	result 2	result 3	Average	result 1	result 2	result 3	Average	result 1	result 2	result 3	Average
125 rev.	grade	grade	grade	<b>grade</b>	grade	grade	grade	<b>grade</b>	grade	grade	grade	<b>grade</b>
500 rev.	grade	grade	grade	<b>grade</b>	grade	grade	grade	<b>grade</b>	grade	grade	grade	<b>grade</b>
1 000 rev.	grade	grade	grade	<b>grade</b>	grade	grade	grade	<b>grade</b>	grade	grade	grade	<b>grade</b>
2 000 rev.	grade	grade	grade	<b>grade</b>	grade	grade	grade	<b>grade</b>	grade	grade	grade	<b>grade</b>
5 000 rev.	grade	grade	grade	<b>grade</b>	grade	grade	grade	<b>grade</b>	grade	grade	grade	<b>grade</b>
7 000 rev.	grade	grade	grade	<b>grade</b>	grade	grade	grade	<b>grade</b>	grade	grade	grade	<b>grade</b>