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

Part 3:
Random tumble pilling method

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

Partie 3: Méthode de boulochage par projections aléatoires dans une chambre cylindrique



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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.

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).

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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 38, *Textiles*, Subcommittee SC 24, *Conditioning atmospheres and physical tests for textile fabrics*.

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

- *Part 1: Pilling box method*
- *Part 2: Modified Martindale method*
- *Part 3: Random tumble pilling method*

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 where 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.

Particular attention is drawn to [Annex A](#) which gives advice on the maintenance and checking of the apparatus and liners. It is recommended that [Annex A](#) be studied prior to carrying out the procedure.

In Bibliography, some listed national standards have been taken into consideration as they refer to the use of the equipment, on which this part of ISO 12945 is based.

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

Part 3: Random tumble pilling method

1 Scope

This part of ISO 12945 describes a method for the determination of the resistance to pilling, fuzzing, and matting of textile fabrics using the random tumble pilling tester. This method is applicable to most of woven and knitted fabrics, including napped fabrics (fleeces, inlay fabrics).

This method is not applicable to fabrics which cannot tumble freely.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 48, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

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:

3.1

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.

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 1 to entry: 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

jamming, wedging, or entanglement

when specimens either become entangled on the impeller or lie on the side of the cylinder wall resulting in the fabric not tumbling in the required random action

3.5 matting

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

4 Principle

Specimens are tumbled randomly, under defined conditions, in a lined cylindrical test chamber. Fuzzing, pilling, and matting are assessed visually after a defined period of tumbling.

NOTE Any special treatment of the laboratory sample, i.e. washing, cleaning could be as agreed upon between the interested parties and be described in the test report.

5 Apparatus and auxiliary materials

5.1 Apparatus

The apparatus shall include:

5.1.1 Device, consisting of one or several cylindrical test chambers, horizontally positioned, with the inside dimensions of $(152,4 \pm 1,0)$ mm in depth and (146 ± 1) mm in diameter. In the centre of each chamber is a horizontal shaft with cross rods (impellers) which rotate at 1 200 rpm (see [Figure 2](#)). This device shall have a mean capable of sustaining a steady movement of the test specimens (thus, avoiding jamming during the test); this functionality can be set by either an air jet (which can blow onto the cylinder wall) or plastic blades (placed on the shaft, see [Figure 2](#), which can move physically jammed test specimens from the cylinder wall).

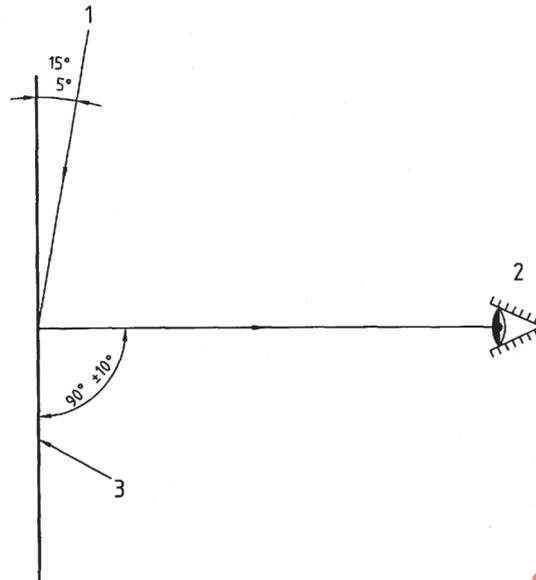
NOTE The use of either air jet device or plastic blades shall be reported.

5.1.2 Lining material, polychloroprene liner. The polychloroprene liner shall conform to the following criteria as described in [Table 1](#). Length and width of the polychloroprene liner shall be such that it fits securely in the test chamber without gaps or bulging.

Table 1 — Criteria for polychloroprene liner

Criteria	Units	Polychloroprene liner
Thickness	mm	$3,2 \pm 0,4$
Hardness	IRHD ^a	60 – 70
^a IRHD is an abbreviation for international rubber hardness degree and shall be checked according to ISO 48 (method N, i.e. normal test).		

5.1.3 Viewing cabinet, illuminated by a white fluorescent tube or bulb (the colour temperature of the light source is not critical) to give uniform illumination over the surface of the specimen(s) and masked in such a way that the observer does not look directly into the light. The illuminant should be positioned at an angle between 5° and 15° to the plane of the specimen (see [Figure 1](#)). The distance between the eye and the specimen should be between 30 cm to 50 cm for normal corrected vision.

**Key**

- 1 light source
- 2 observer
- 3 specimen

Figure 1 — Illumination of specimens

5.2 Auxiliary materials

5.2.1 Glue, a white water-based all-purpose glue, for sealing the edges of the specimens.

NOTE Generally, this kind of glue is an emulsion of polyvinyl acetate.

5.2.2 Device for cutting, test specimens square or round to provide a test area $(100 \pm 2) \text{ cm}^2$.

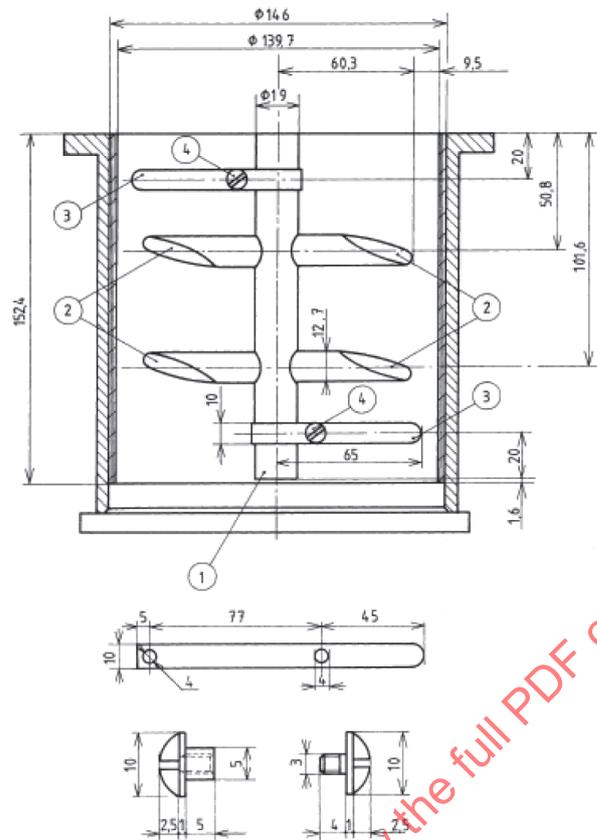
NOTE Studies have shown that the shape of the test specimens do not influence the test results.

5.2.3 Rating standards (optional), a set of five photographs numbered 1 to 5 illustrating varying degrees of pilling. The photographs shall be the same size as the test specimens.

5.2.4 Cork liner (optional), if agreed upon between the interested parties, cork liner can be used instead of the polychloroprene liner (see [5.1.2](#)).

NOTE The replacement of the polychloroprene liner by the cork liner will lead to increase two times the testing time as specified in [9.4](#).

5.2.5 Cotton linters (optional), if agreed upon between the interested parties, cotton linters can be used to highlight the possible occurrence of pills.



- Key**
- 1 axis of the impeller
 - 2 cross rods
 - 3 plastic blades (optional)
 - 4 cap screws

Figure 2 — View of the testing chamber and its components

6 Conditioning and testing atmosphere

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

NOTE It is recommended that the test specimens be conditioned for at least 16 h prior to testing.

7 Preparation of test specimens

7.1 Pretreatment

Samples can be washed or dry-cleaned before cutting the test specimens, using conditions appropriate for the fabric end use or conditions agreed upon between the interested parties.

NOTE 1 The procedures described in ISO 6330 or in a part of the series of ISO 3175 can be suitable (see Bibliography).

NOTE 2 It is recommended to launder or dry-clean test specimens in order to protect the friction surfaces of the polychloroprene liner and cross rods from lubricants or finishes which might cause inconsistent results.

If cleansing is carried out, assess the specimens before and after the pretreatment using the grading scheme described in [Clause 10](#).

7.2 Sampling

Cut specimens in squares 105 mm × 105 mm on the bias at an approximate 0,78 rad (45°) angle to the warp (wale) and weft (course) directions. Circles 100 cm² can be used as an alternative if agreed upon between the interested parties.

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 selvage than one-tenth the width of the fabric.

Handle the specimen by applying minimal tension to avoid stretching.

7.3 Fixation of specimen edges

In order to prevent fraying or de-knitting, apply a strip of glue to the edge of the specimen not exceeding 3 mm in width when dried. Allow the glue to dry completely before testing (at least for 2 h).

7.4 Number of specimens and marking

Prepare four specimens: three specimens for testing (and mark each of them with a number, from 1 to 3) and a fourth to serve as an untreated reference specimen for assessment. This fourth need not have the edges secured.

For the alternative method as described in [Annex B](#), six test specimens shall be prepared: five for testing and one for the assessment.

8 Preparation of apparatus

8.1 Polychloroprene liners

Both side of a polychloroprene liner can be used to carry out a test. After completion of the two testing, the polychloroprene liner shall be removed, and then cleaned and dried according to the procedure described in [A.2.1](#).

A new polychloroprene liner shall be run-in according to the procedure described in [A.2.2](#).

The polychloroprene liner shall be discarded as soon as its use leads to significant differences in results when testing an in-house standard reference fabric of known pilling, fuzzing, or matting resistance.

9 Procedure

9.1 Condition the test specimens and polychloroprene liners as specified in [Clause 6](#). Conduct all tests in the standard atmosphere for testing.

9.2 Place the polychloroprene liner securely and smoothly inside the chamber, so that the polychloroprene liner shall not rotate against the drum when in use.

9.3 Conduct individual test runs using three specimens from the same laboratory sample together in one test chamber.

9.4 Place the three prepared test specimens into the test chamber. Close the chamber door. Start the apparatus and run for the following total testing time (continue test time after each interval so that the total testing time is reached at each interval):

- step 1: total testing time: 5 min;
- step 2: total testing time: 15 min (10 min to be set up after the step 1);
- step 3: total testing time: 30 min (15 min to be set up after the step 2).

NOTE If total testing time of 45 min or 60 min is required, this has to be mentioned in the test report.

Ensure that no hang ups occur around the impeller during a test run.

9.5 At each inspection interval, remove each specimen from the chamber, firmly grasp the specimen and clean off any excess fibre that is not actually entangled in pills using an air jet blowing tangentially onto the surface.

9.6 Evaluate the specimens subjectively as described in [Clause 10](#).

9.7 Repeat [9.4](#) to [9.6](#) until the predetermined total testing time is completed.

10 Assessment of pilling and/or fuzzing and/or matting

10.1 The viewing cabinet shall be situated in a darkened room.

10.2 Place the tested specimen and a reference specimen (see [7.4](#)) (with or without pretreatment as appropriate) centrally in the specimen mount on the viewing cabinet (see [Figure 1](#)) with the length direction vertical. If necessary, use a piece of self-adhesive tape to ensure correct placement. Mount the tested specimen on the left and the reference specimen on the right.

10.3 View each specimen from just outside the viewing cabinet (see [5.5](#)) (to prevent glare from the light source) and directly in front of the specimen, as shown in [Figure 1](#).

10.4 Grade each specimen in accordance with the grading scheme given in [Table 2](#) (pilling), [Table 3](#) (fuzzing), or [Table 4](#) (matting). If the grading appears between 2 grades, report the "half" grading as, for example, 3-4.

10.5 The test result for each individual observer is the average of three specimen grades. 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 can be used to support the primary descriptive method of assessment, as agreed upon between the interested parties.

NOTE 3 A second assessment can be made by rotating the specimen to a position where the observed pilling is more severe. This assessment can 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 deterioration in surface appearance.

Table 2 — Pilling grading scheme

Grade	Description
5	No change
4	Partially formed pills
3	Moderate pilling — pills of varying size and density partially covering the specimen surface
2	Distinct pilling — pills of varying size and density covering a large proportion of the specimen
1	Severe pilling — pills of varying size and density covering the whole of the specimen surface

Table 3 — Fuzzing grading scheme

Grade	Description
5	No change
4	Slight surface fuzzing
3	Moderate surface fuzzing
2	Distinct surface fuzzing
1	Dense surface fuzzing

Table 4 — Matting grading scheme

Grade	Description
5	No change
4	Slight surface matting
3	Moderate surface matting
2	Distinct surface matting
1	Dense surface matting

11 Results

By type of surface appearance (when relevant), record the grade 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 three 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 give the following information:

- a) reference to this part of ISO 12945 (i.e. ISO 12945-3);
- b) description of the laboratory sample;
- c) where applicable, method of pretreatment of the laboratory sample ;
- d) number of specimens;
- e) whether specimens were square or round;
- f) test time carried out;
- g) number of observers;

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- h) when relevant, individual specimen pilling grades, fuzzing grades, or matting grades, at each total testing time (i.e. at 5 min, 15 min, and 30 min);
- i) other observation of surface changes or fabric behaviour (e.g. curl);
- j) the rounded mean grade assessed in relation to the type of the surface change(s) - i.e. pilling, fuzzing or matting - (to the nearest half grade), at each total testing time (i.e. at 5 min, 15 min, and 30 min);
- k) date of the test;
- l) type of used lining;
- m) if air injection or plastic blades were used, this should be stated;
- n) if applicable, the photographic rating standards used;
- o) any deviation from the given procedure.

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Annex A (normative)

Checking of apparatus and preparation of liners

A.1 Checking of apparatus

A.1.1 Checking of test apparatus can be done in-house or by the service department of the equipment supplier. Check timer, tension of belt transmission, rotor revolutions. In case of the chamber with air injection, check the air pressure.

A.1.2 For checking of the function of the apparatus, use an in-house standard reference fabric of known pilling resistance. Apply test requirements to be used for this test.

A.1.3 The frequency of checking the apparatus depends on the frequency of use. If used daily, check monthly. If used infrequently, check before the start of a new test series.

A.2 Preparation of liners

A.2.1 Cleaning and drying of polychloroprene liners

Prepare the cleaning paste, by mixing IEC reference detergent A (non-phosphate detergent with optical brightener and with enzymes, described as "reference detergent 2" in ISO 6330) with lukewarm water at 70:100 to 80:100 by weight (ratio: water/detergent).

Brush polychloroprene liners carefully with a polyamide hairbrush and with the cleaning paste and lukewarm water.

Rinse thoroughly with water.

Repeat this procedure three times for new polychloroprene liners before the running-in procedure according to [A.2.2](#).

After running-in or after use for testing of each side of the polychloroprene liner, perform this operation of cleaning and drying once before reusing the polychloroprene liner.

Let polychloroprene liners dry in ambient atmosphere and condition in the standard atmosphere for testing.

A.2.2 Running-in of new polychloroprene liners

Perform a blank test with three test specimens of the standard reference in-house fabric, preferably a desized and scoured or bleached cotton twill fabric (a mass per unit area of 150 g/m² has been found suitable). The test should be run for 3 h without interruption. At the end of the test, clean and dry the polychloroprene liners once according to [A.2.1](#).

Annex B (informative)

Alternative procedure

B.1 Principle

The procedure described in [Clause 9](#) leads to run the testing always with the same three test specimens, and leads to take out the three test specimens to assess them and place them again in the testing chamber and run again. In order to optimize the testing time, the alternative procedure is intended to replace one tested test specimen by a new one at each stage.

B.2 Number of specimens and marking

Prepare six specimens, five specimens for testing (and mark each of them with numbers, from 1 to 5) and a sixth to serve as an untreated reference specimen for assessment. This sixth does not need having the edges secured.

B.3 Alternative procedure

Proceed as described in [Clause 9](#), but placing the following test specimens according to the [Table B.1](#).

Table B.1 — Alternative procedure

Stages	Total testing time (min)	Number of the test specimens
1st step	5	1, 2, and 3
2nd step	15	2, 3, and 4 (1 is out and 4 is in)
3rd step	30	3, 4, and 5 (2 is out and 5 is in)

The five test specimens shall be assessed according to [Clause 10](#), but no mean calculation is required.

The subsequent assessments represent the evolution of the pilling/fuzzing/matting in relation to the duration of the testing time.

Table B.2 — Duration of the testing time

Number of the test specimen	Duration of the testing time (min)
1	5
2	15
3	30
4	25
5	15