International Standard

ISO 13997

Protective clothing — Mechanical properties — Determination of resistance to cutting by sharp objects

Habillement de protection — Propriétés mécaniques — Détermination de la résistance à la coupure par des objets tranchants

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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 document 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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This document was prepared by Technical Committee ISO/TC 94, *Personal safety — Personal protective equipment*, Subcommittee SC 13, *Protective clothing*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 162, *Protective clothing including hand and arm protection and lifejackets,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 13997:2023), of which it constitutes a minor revision.

The main changes are as follows:

— Figure 7 a) was replaced;

— Footnote 2 was moved to the Figure 7 title;

— the Excel file that can be downloaded using the link in the note to Table B.2 was replaced (there was a correction because in few specific cases Excel did not work as planned).

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.

Introduction

Although textiles, composites, leather, rubbers and reinforced materials may resist cutting by sharp edges in different ways, a test method for evaluating the resistance to cut of materials in protective clothing should be applicable to all materials. The test described in this document provides a method that allows calculations of the downwards (normal) force required to cause a blade drawn across the sample for a fixed distance to cut through the specimen.

The performance of protective clothing materials may be classified using the numerical values obtained from this test.

Protective clothing — Mechanical properties — Determination of resistance to cutting by sharp objects

1 Scope

This document specifies a tomodynamometer cut test method and related calculations, for use on materials and assemblies designed for protective clothing, including gloves. The test determines resistance to cutting by sharp edges, such as knives, sheet metal parts, swarf, glass, bladed tools and castings.

When this document is cited as a test method in a material or product requirement standard, that standard contains the necessary information to permit the application of this document to the particular product.

This test does not provide data on the resistance to penetration by pointed objects such as needles and thorns, or the point of sharp-edged blades. The test described in this document is not considered suitable for testing materials made from chain mail and metal plates. The text of this document does not include provisions for the safeguard of the operator.

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 34-1, *Rubber, vulcanized or thermoplastic — Determination of tear strength — Part 1: Trouser, angle and crescent test pieces*

ISO 37, *Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties*

ISO 48-4, *Rubber, vulcanized or thermoplastic — Determination of hardness — Part 4: Indentation hardness by durometer method (Shore hardness)*

ISO 2781, *Rubber, vulcanized or thermoplastic — Determination of density*

ISO 11610, *Protective clothing — Vocabulary*

ISO 23388:2018, *Protective gloves against mechanical risks*

ISO 23529, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11610 and the following 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 https://www.electropedia.org/

3.1
cut-through
event which has occurred when the blade edge first contacts the conducting material below the test specimen

3.2
cutting force
calculated force that would be required to be applied to a blade of standard sharpness to cut through a material in a blade stroke of length 20 mm

3.3
cutting stroke length
distance the cutting-edge travels before *cut-through* (3.1) occurs

4 Sampling

4.1 General

Unless otherwise specified, specimen dimensions should not be less than 25 mm by 100 mm as this allows for several cuts on the same sample (see 5.2.4 and 5.2.5). If this specimen size is not possible, the smallest specimen on which single cuts are made shall not be less than 25 mm by 25 mm.

NOTE The test requires at least 15 cuts therefore at least two specimens are necessary.

4.2 Textiles and other materials

Specimens shall be taken from regions of the sample product representative of the range of construction present in protective areas or as defined in product requirement standard. In the case of an irregular design, the test specimen shall be taken from the area where the least protection is expected.

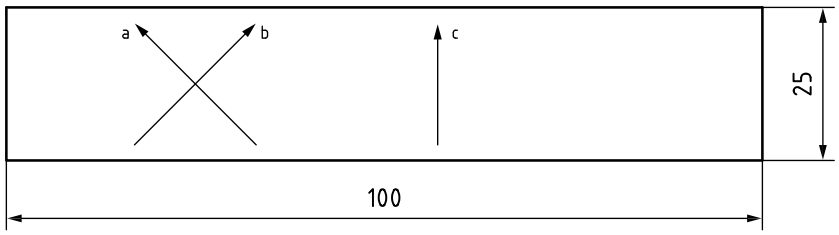
Specimens from textile materials shall be prepared so that test cuts are made at an angle of (45 ± 5)° to the warp and weft direction as defined in Figure 1. Only one result (cutting force, see 5.4.4.2) shall be reported.

Materials that have no clear orientation shall be tested in two directions at 90° to each other and both cutting forces (see 5.4.4.2) shall be reported and the final result is the lowest one.

If the material is known to have homogenous properties in all directions, only one result (cutting force see 5.4.4.2) needs to be reported.

NOTE Materials that have no clear orientation are for example, unoriented materials, or those in which the machine direction either does not exist or is uncertain such as some non-woven.

Dimensions in millimetres



a Warp or longitudinal direction.
b Weft or transversal direction.
c Cut test direction.

Figure 1 — Control specimen dimensions and cut direction for garments

4.3 Gloves

For gloves, take the specimen from the palm area cut on the bias such that the size of the specimen is adequate but at an angle as close as possible to 45° as shown in Figure 2.

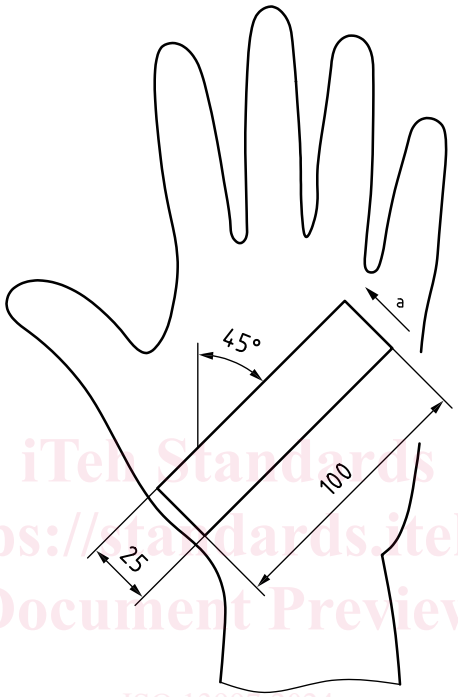
In the case of an irregular design of the palm, the test specimen shall be taken from the palm area where the least protection is expected.

If reinforcement(s) does not uniformly cover the palm area, either the specimen shall be taken without reinforcement or the specimen shall be provided without reinforcement.

If cut protection is claimed for back of the hand or cuff and the materials are different from the palm, they shall be tested and reported.

NOTE There is no tolerance to the angle for the glove as this depends on the size of the glove and its construction to take the correct angle that best represents a 45° angle.

Dimensions in millimetres



[a] Cut test direction.

Figure 2 — Glove sample and cut direction

4.4 Conditioning

Specimens shall be conditioned as defined in product requirement standard or in the following conditioning atmosphere:

— Temperature (23 ± 2) °C and relative Humidity (50 ± 5) %.

Alternatively, the following conditioning should be used, and shall be reported in the test report.

— Temperature (20 ± 2) °C and relative Humidity (65 ± 5) %.

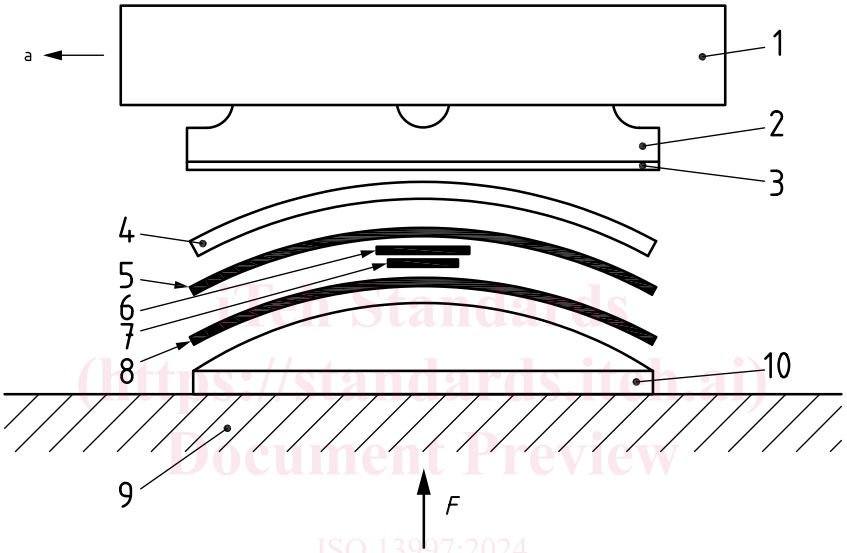
The period of conditioning is at least 24 h. Testing shall be carried out in the conditioning environment or within 30 min of withdrawing the specimens from the conditioning environment.

5 Test method

5.1 Principle

The cut resistance of a material is its ability to resist being cut-through by a blade. This is measured in a machine in which a sharp blade is drawn across a specimen. The cuts are achieved in blade movements of 5,0 mm to 50,0 mm length when a range of forces are applied to the blade normal to the specimen surface. The cut resistance of a sample material is expressed as the cutting force that is required to be applied to a blade of standard sharpness to just cut through the material in a 20,0 mm blade stroke. The value of the cutting force may be used to classify materials.

The cut test apparatus consists of the following primary components (see Figure 3): blade holder (key item 1) with a straight line mechanism that holds a blade (key item 2), having a cutting edge (key item 3), a specimen (key item 5) with a paper sheet (key item 6) and conductive strip (key item 7) and double-sided adhesive tape(key item 8) mounted to a specimen holder (key item 10) attached to the specimen holder mount (key item 9) to which the force, *F*, is applied.



Key

1	blade holder	7	conductive strip
2	blade	8	double-sided adhesive tape
3	cutting edge of blade	9	specimen holder mount
4	specimen securing clamp (optional)	10	specimen holder
5	specimen	*F*	applied force
6	paper sheet	a	Cut direction.

Figure 3 — Schematic of the cutting part of a cut test apparatus

Any apparatus can be used that can maintain a constant force between the cutting edge and the specimen and can accurately measure the distance the blade travels to cut through the specimen. The testing apparatus shall also allow the test to be performed in the conditions specified in the test method, for instance in terms of displacement rate of the blade and geometry of the specimen holder (see 5.2).

The test apparatus may have limitations in testing materials with a thickness greater than 12 mm (see 5.2.7). When using the specimen securing clamp (key item 4), the maximum thickness may be less than that (see 5.2.5).

NOTE For each of the required measurements performed in accordance with this document, a corresponding estimate of the uncertainty of measurement is evaluated. One of the following approaches is used:

— a statistical method, e.g. that given in ISO 5725-2[2];

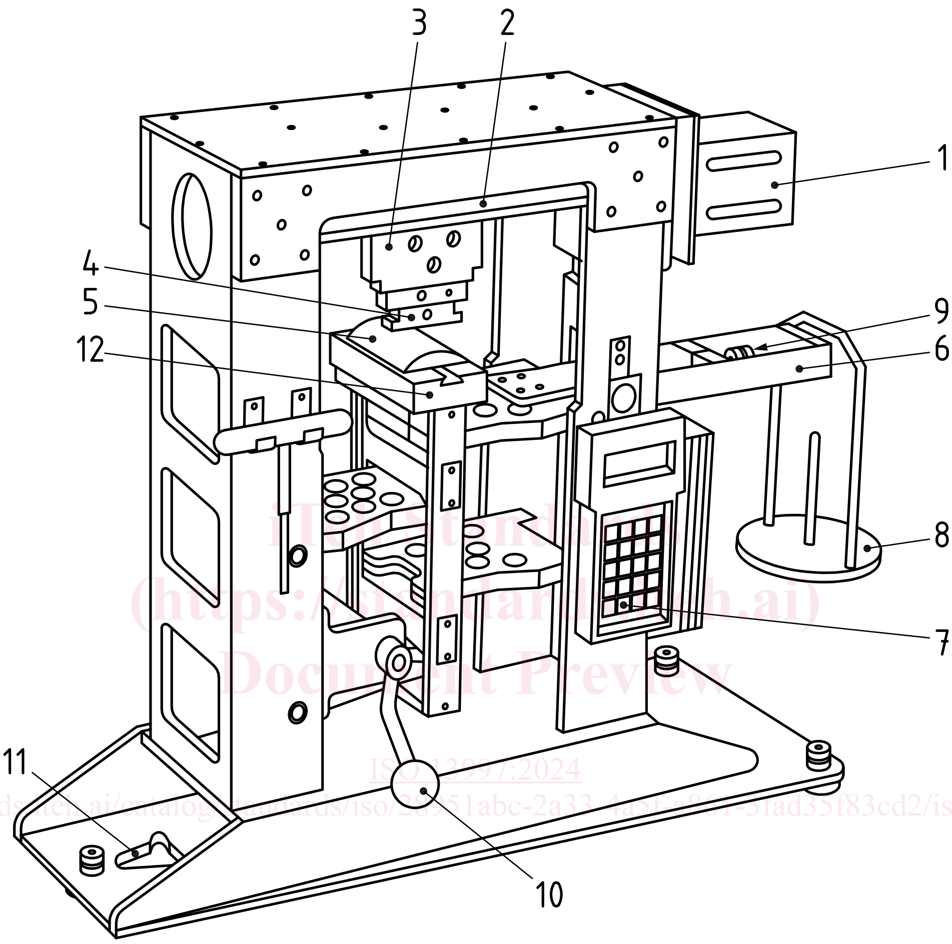
— a mathematical method, e.g. that given in ISO/IEC Guide 98-3[3];

— uncertainty and conformity assessment as given in ISO/IEC Guide 98-4[4];

— JCGM 100:2008[5].

5.2 Test apparatus

The apparatus shall have the following components (see Figure 4 for the general aspect of the cut testing device).



Key

1	motor and gearhead	5	specimen holder and specimen securing clamp	9	calibration weights
2	slide system	6	beam	10	loading/unloading handle
3	blade support/clamp mechanism	7	controller keypad with distance meter	11	level indicator
4	blade	8	loading device	12	specimen holder mount

Figure 4 — Example of apparatus[1)]

1) An apparatus known as the tomodynamometer embodying these principles is available from a number of suppliers such as: (1) TDM-100 from RGI Industrial Products, Inc., 755 Pierre Caisse, St-Jean-sur Richelieu, Quebec, Canada J3B 7Y5 (www.rgicanada.com), (2) STM610 from SATRA, Wyndham Way, Telford Way, Kettering, Northamptonshire, NN16 8SD, United Kingdom (www.satra.com), (3) LINEAR CUT RESISTANCE TESTER 3394B from Mesdan, Via Masserino, 6 - 25080 Puegnago del Garda (BS) Italy (www.saviotechnologies.com), and (4) PROCOUPE from EMI Developpement, Rue Alexandre Yersin, Zone Artisanale Coulmet, 10450 Breviandes France (www.emi-developpement.com). This information is given for the convenience of user of this International Standard and does not constitute an endorsement by ISO of this product. Equivalent products may be used if they can be shown to lead to the same results.