
Protective gloves against thermal risks (heat and/or fire)

Gants de protection contre les risques thermiques (chaleur et/ou feu)

*Перчатки защитные от термических рисков (тепла и/или
пламени)*

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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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).

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.

This document was prepared by Technical Committee ISO/TC 94, *Personal safety — Personal protective equipment*, Subcommittee SC 13, *Protective clothing*.

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

This document has been developed to cover all type of personal protective equipment protecting the hand, a part of the hand or a part of the arm against thermal risks, no matter where they are used (professional use, consumer, domestic use...). This document is the adoption of the European Standard EN 407.

The document is adopted using fast-track procedure in line with the decision to adopt the European standard without changes and propose that any comments would be incorporated during the next revision schedule five years after the publication date. The intent for the next revision is to have a combined EN ISO standard whichever the EN or ISO standard is revised first.

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Protective gloves against thermal risks (heat and/or fire)

1 Scope

This document specifies requirements, test methods, marking and information for protective gloves and other hand protective equipment against thermal risks for professional use, consumer, domestic use.

This document is also applicable to arm protective equipment.

It is used for all gloves and other hand protective equipment which protect the hands or part of the hand against heat and/or fire in one or more of the following forms: flame, contact heat, convective heat, radiant heat, small splashes or large quantities of molten metal.

This document is only applicable in conjunction with ISO 21420:2020.

This document does not apply to gloves for fire-fighters or welding that have their own standards.

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 6942:2002, *Protective clothing — Protection against heat and fire — Method of test: Evaluation of materials and material assemblies when exposed to a source of radiant heat*

ISO 7500-1:2018, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system*

ISO 9150:1988, *Protective clothing — Determination of behaviour of materials on impact of small splashes of molten metal*

ISO 9151:2016, *Protective clothing against heat and flame — Determination of heat transmission on exposure to flame*

ISO 9185:2007, *Protective clothing — Assessment of resistance of materials to molten metal splash*

ISO 12127-1:2015, *Clothing for protection against heat and flame — Determination of contact heat transmission through protective clothing or constituent materials — Part 1: Contact heat produced by heating cylinder*

ISO 15025:2016, *Protective clothing — Protection against flame — Method of test for limited flame spread*

ISO 21420:2020, *Protective gloves — General requirements and test methods*

EN 659:2003+A1:2008, *Protective gloves for firefighters*

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:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1
after flame time

length of time for which a material continues to flame, under the specified test conditions, after the ignition source has been removed

3.2
afterglow time

time for which a material continues to afterglow, under specified test conditions after cessation of after flaming or after removal of the ignition source

3.3
back of the glove

back of hand, excluding fingers

3.4
cuff

part of the glove that extends beyond the opening of glove body to cover the wrist area and sometimes part of the forearm

3.5
debris

material separating from the specimen during the test procedure and falling from the specimen without flaming

3.6
dripping

detachment of molten droplets during the melting process

3.7
flaming debris

material separating from the specimen during the test procedure and igniting the filter paper

3.8
hands protective equipment against thermal risks

equipment which protect hand and/or areas of the hand intended to be exposed to thermal risks

Note 1 to entry: See examples in [Annex A](#)

3.9
high thermal resistant gloves

gloves which claimed at least level 3 for one of the following properties: convective heat, contact heat, radiant heat, small metal splashes, large quantities of molten metal

3.10
hole

opening, break, or discontinuity of any size in the original structure of the test specimen's material caused by application of the test flame

3.11
melting

liquefaction of the material under the influence of heat

3.12
innermost layer

layer closest to the wearer's skin

3.13
reinforcement

additional layer which does not cover the full area where the protection is claimed

Note 1 to entry: Most of the time, this area has a limited surface to preserve comfort and dexterity of the gloves.

4 General requirements

4.1 General

Where protection against other than thermal risk is needed the specific standard shall be used.

The protective gloves according to this document shall meet all the applicable requirements of ISO 21420:2020.

When parts of the glove are made from dissimilar materials, these dissimilar materials shall be tested separately, except if another way is specified in the standard. The results of each material shall comply with the requirements given in 4.5.

In those circumstances when the sample size is significantly larger than the particular part of the glove or hands protective equipment against thermal risks being tested, then the manufacturer shall be requested to supply samples of identical material.

4.2 Cleaning

All tests required in this document shall be performed on unused gloves or hand protective equipment unless otherwise specified.

If care instructions are provided, the relevant tests shall be performed on the gloves or hand protective equipment, before and after they have been subjected to the procedure described in the care instruction, including the maximum recommended number of cleaning cycles. The levels of performance and the mechanical strength (see 4.3) are given by the lowest of the 2 results obtained before and after cleaning.

NOTE Manufacturer's instructions typically indicate one or several of the various methods and processes of ISO 6330, ISO 15797 or equivalent as standardized processes for cleaning.

4.3 Mechanical strength

The glove material(s) shall be tested according to 6.8. The tear strength resistance shall have at least a value of 10 N.

4.4 Sizes and dimensions

4.4.1 Gloves

The gloves shall correspond to the relevant requirements of ISO 21420:2020, 5.1.

If according to the intended use, the hand protector needs to be taken off quickly, the protective gloves of performance levels 3 and 4 as specified in 4.5.2 to 4.5.7 shall be manufactured so that they can easily be removed in case of an emergency. The test shall be performed according to EN 659:2003 + A1:2008, 3.15 using the same requirement. This property shall be justified and explained in a warning included in the manufacturer's information.

The removal test shall be carried out only in the dry state if the manufacturer's information states that the glove is not intended for use in wet conditions.

If protection against metal splashes as described in 4.5.6 and/or 4.5.7 is claimed, the minimal length of the glove shall correspond to the requirements of Table 1.

Table 1 — Minimal length of the glove

Size of the hand	5	6	7	8	9	10	11	12	13
Minimal length of glove mm	290	300	310	320	330	340	350	360	370

4.4.2 Hand protective equipment

Hand protective equipment against thermal risks shall have a sufficient dimension to fully cover the part of the hand intended to be protected against thermal risk. The property shall be verified by visual inspection.

The manufacturer information shall contain precise information about how to use the hand protective equipment and which part of the hand is protected.

4.5 Thermal performances

4.5.1 General

For each of the following test methods the defined performance level depends upon the intended field of application of the glove or hand protective equipment. Only the tests which are relevant to the risks in the intended end-use application shall be carried out.

For the choice of relevant testing, examples are given in [Annex B](#).

4.5.2 Limited flame spread

Using test method [6.2](#) the glove and other hand protective equipment, as well as all outer materials shall correspond to the requirements of [Table 2](#). Surface of the innermost layer of the glove shall be inspected, it shall show no sign of melting. No hole shall appear on all layers of the tested area. The seam shall not come apart after the ignition time.

For high thermal resistant gloves (level 3 or 4), all outer materials different to the finger area shall be tested according to ISO 15025:2016, method A and comply at least with level 3 of [Table 2](#). Seams and outer accessories with a surface area greater than 10 cm² shall also be tested.

Table 2 — Performance levels for limited flame spread

Performance level	After flame time s	After glow time s
1	≤15	no requirement
2	≤10	≤120
3	≤3	≤25
4	≤2	≤5

If the outermost layer melts, the material shall not produce molten or flaming debris

After flame time is measured to the nearest second and after flame times of less than 1,0 s should be recorded as zero.

Afterglow time is measured to the nearest second and afterglow times of less than 1,0 s should be recorded as zero.

4.5.3 Contact heat

Using the test method [6.3](#) the material shall correspond to the requirements of [Table 3](#).

Table 3 — Performance levels for contact heat test

Performance level	Contact temperature ($\pm 2\%$) T_c °C	Threshold time t_t s
1	100	≥ 15
2	250	≥ 15
3	350	≥ 15
4	500	≥ 15

For contact heat performance levels of 3 or 4, the limited flame spread test according to 6.2 shall be performed. The product shall reach at least level 3 in the limited flame spread test, otherwise the maximum contact heat performance that shall be reported is level 2.

Innermost layers of the glove shall be inspected, it shall show no sign of melting (dripping) and holing.

4.5.4 Convective heat

Using the test method 6.4 the material shall correspond to the requirements of Table 4.

Table 4 — Performance levels for convective heat

Performance level	Lowest measured t_{24} (time necessary for an increase of 24 °C)
1	≥ 4
2	≥ 7
3	≥ 10
4	≥ 18

For convective heat performance levels of 3 or 4, the limited flame spread test according to 6.2 shall be performed. The product shall reach at least level 3 in the limited flame spread test, otherwise the maximum convective heat performance that shall be reported is level 2.

Innermost layers of the glove shall be inspected, it shall show no sign of melting (dripping) and holing.

4.5.5 Radiant heat

Using the test method 6.5 the material shall correspond to the requirements of Table 5.

Table 5 — Performance levels for radiant heat

Performance level	Heat transfer time t_{24} s
1	≥ 7
2	≥ 20
3	≥ 50
4	≥ 95

For radiant heat performance levels of 3 or 4, the limited flame spread test according to 6.2 shall be performed. The product shall reach at least level 3 in the limited flame spread test, otherwise the maximum radiant heat performance that shall be reported is level 2.

Innermost layers of the glove shall be inspected, it shall show no sign of melting (dripping) and holing.

4.5.6 Small splashes of molten metal

Using the test method 6.6 the number of droplets which produce a temperature rise of 40 °C, shall correspond to the requirements of Table 6.

Table 6 — Levels of performance for the test of small splashes of molten metal

Performance level	Number of droplets
1	≥10
2	≥15
3	≥25
4	≥35

For small splashes of molten metal performance levels of 3 or 4, the limited flame spread test according to 6.2 shall be performed. The product shall reach at least level 3 in the limited flame spread test, otherwise the maximum small splashes of molten metal performance that shall be reported is level 2.

Outermost and innermost layers of the glove shall be inspected, it shall show no sign of melting. No hole shall appear on innermost layer.

4.5.7 Large quantities of molten metal

Using the test method 6.7 the PVC foil skin-simulant shall not exhibit any smoothness or other changes to the grained surface with the relevant quantities of molten iron used. See Table 7.

Table 7 — Levels of performances for the test of large quantities of molten metal

Performance Level	Molten iron (±1 g)
	g
1	30
2	60
3	120
4	200

For large quantities of molten metal performance levels of 3 or 4, the limited flame spread test according to 6.2 shall be performed. The product shall reach at least level 3 in the limited flame spread test, otherwise the maximum large quantities of molten metal performance that shall be reported is level 2.

Material and material assemblies which ignite during the test do not meet the requirement of this test.

Innermost layers of the glove shall be inspected, it shall show no sign of melting and holing.

The use of molten iron is mandatory. Other optional molten materials could be tested as required (example Aluminium, molten glass.). The corresponding test results shall be given on the information supplied by the manufacturer (see Clause 8).

5 Sampling and conditioning

Specimens shall be conditioned in the following conditioning atmosphere:

- temperature (23 ± 2) °C and relative humidity (50 ± 5) %.

The following conditioning could 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 before testing.

6 Test methods

6.1 General

6.1.1 General information

The test shall be started within 5 min after removal of the specimen from the conditioning.

For multi-layered gloves, the tests are carried out simultaneously on all layers, even if these in some circumstances, are no longer connected. This applies to test methods described in [6.2](#) to [6.7](#).

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

- statistical method e.g. as given in ISO 5725-2;
- mathematical method e.g. as given in ISO/IEC Guide 98-3;
- uncertainty and conformity assessment as given in ISO/IEC Guide 98-4;
- JCGM-100:2008^[1].

6.1.2 Optional additional tests

If special applications require testing in a different environment, manufacturer, in the information supplied by the manufacturer (see [Clause 8](#)), shall describe that environment and conditioning and testing shall be performed in that environment.

6.2 Limited flame spread

6.2.1 Specimen

For whole gloves, three specimens shall be tested.

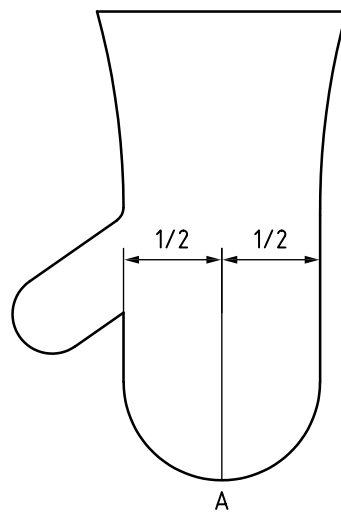
All outer material of high thermal resistant gloves and hand protective equipment against thermal risks shall be tested according to ISO 15025:2016, method A, except for 8.1.1, only three specimens are necessary.

6.2.2 Procedure for gloves

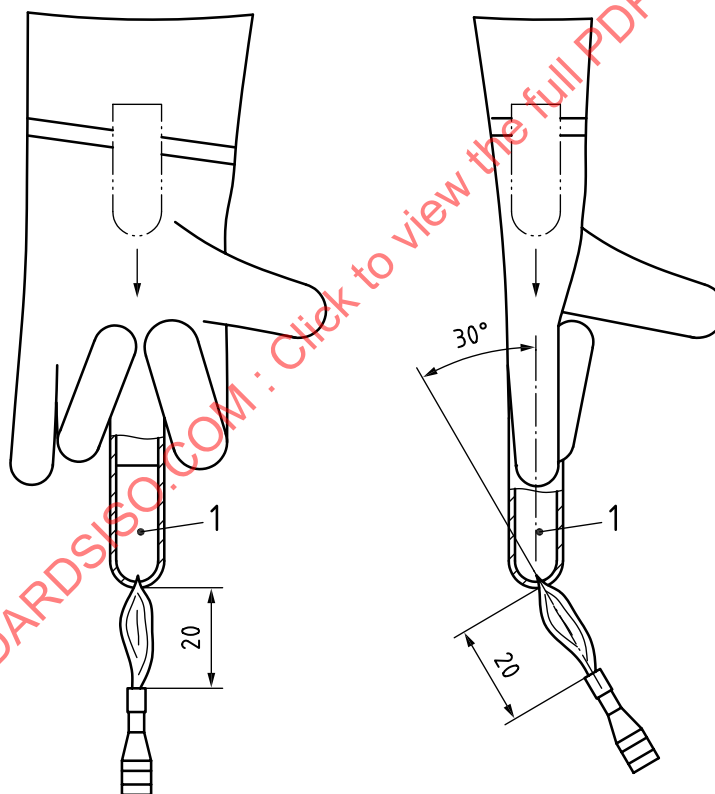
Test method according to ISO 15025:2016, method B, for complete gloves with the following modification:

The glove is mounted vertically so that the point A (see [Figure 1](#)) is at the midpoint of the lower edge.

Dimensions in millimetres

**Figure 1 — Mounting of test glove**

Dimensions in millimetres

**Key**

1 metallic rod

Figure 2 — Mounting of test glove (finger simulation)

The burner is placed below the glove so that it is in a plane with the vertical middle line of the glove or the middle finger and is perpendicular to the surface of the glove. The burner is mounted at an angle of $30^\circ \pm 3^\circ$ to the vertical. The distance between the tip of the burner and the lower edge of the glove or the middle finger shall be $20 \text{ mm} \pm 2 \text{ mm}$.

For leather gloves and mittens, a metallic rod simulating the finger shall be inserted to ensure that the material is in contact to the flame and limit the retraction of material during all the test time (see [Figure 2](#)).

The rod shall be rigid. Material and dimensions have no influence on the test.

The after flame time and afterglow time shall be recorded after an ignition time of $(10 \pm 0,5)$ s (see [Table 2](#)).

6.2.3 Test report

The test report shall contain the following information:

- a reference to the clause of this document, i.e. ISO 23407:2021;
- the reference of the sample;
- the three single values for after flame time and afterglow time to the nearest second;
- any deviation from the test method;
- the performance level corresponds to the situation where the three single values fulfilled one level of [Table 2](#) (the lower test result defines the level of performance);
- report any observations of changes in the physical appearance of the material specimens following exposure: the occurrence of melting, the occurrence of debris, the number of holes that develop, the size of the largest hole to the nearest millimetre, the seam integrity.

6.3 Contact heat

6.3.1 Specimen

For gloves, palm area shall be tested. All other areas, different from the palm, intended to be exposed to contact heat shall be tested (e.g. palm side of fingers area).

For hand protective equipment, all areas intended to be exposed to contact heat shall be tested.

For each tested part, three specimens taken from three different products shall be tested.

If a reinforcement is added to the tested area, then the samples taken shall be without reinforcement.

6.3.2 Procedure

The test method described in ISO 12127-1:2015 shall be applied.

6.3.3 Test report

The test report shall contain the following information:

- a reference to the clause of this document, i.e. ISO 23407:2021;
- the reference of the sample;
- the contact temperature T_c ;
- the three single values for the threshold time, t_p , to the nearest whole second;
- any deviation from the test method;
- the performance level in accordance with [Table 3](#) based on the lowest of the single values;

- report any observations of changes in the physical appearance of the material specimens following exposure: the number of holes that develop, the size of the largest hole to the nearest millimetre, hardening, swelling, shrinking, melting...

The manufacturer may additionally report test results from the parts of the glove with reinforcement in the information as described in [Clause 8](#). The material of the reinforcement shall not melt at the test temperature.

6.4 Convective heat

6.4.1 Specimen

The specimens shall be taken from the palm and the back of the glove if different from the palm.

If the protection is given by a multi-layered assembly, the full assembly shall be tested in the usual order of the layers.

For each material or material assembly, three specimens shall be tested taken from three different products.

The size of the tested specimen shall be (140 ± 5) mm $\times$ (140 ± 5) mm taken from the glove. If it is not possible to take such a specimen from a glove then a material sample shall be used, provided it was produced in the same way as the glove and includes any seam present.

If a reinforcement is added to the tested area, then the samples taken shall be without reinforcement.

6.4.2 Procedure

The test method described in ISO 9151:2016 shall be applied, with modifications of specimen ([6.4.1](#)).

6.4.3 Test report

The test report shall contain the following information:

- a reference to the clause of this document, i.e. ISO 23407:2021;
- the reference of the sample;
- the 3 single values of t_{24} (time necessary for an increase of 24 °C) in seconds;
- any deviation from the test method;
- the performance level in accordance with [Table 4](#) based on the lowest of the single value;
- report any observations of changes in the physical appearance of the material specimens following exposure: the number of holes that develop, the size of the largest hole to the nearest millimetre, hardening, swelling, shrinking.

6.5 Radiant heat

6.5.1 Specimen

Three specimens of (80 ± 5) mm $\times$ (170 ± 5) mm shall be taken from the back of three different gloves.

If the protection is given by a multi-layered assembly, the full assembly shall be tested in the usual order of the layers.

If a reinforcement is added to the tested area, then the samples taken shall be without reinforcement.

6.5.2 Procedure

The test method described in ISO 6942:2002, method B shall be applied, with a heat flux density $Q_0 = (20 \pm 0,4) \text{ kW/m}^2$.

6.5.3 Test report

The test report shall contain the following information:

- a reference to the clause of this document, i.e. ISO 23407:2021;
- the reference of the sample;
- the 3 single values of t_{24} to the nearest 0.1s;
- any deviation from the test method;
- the performance level in accordance with [Table 5](#) based on the lowest of the single value;
- report any observations of changes in the physical appearance of the material specimens following exposure: the number of holes that develop, the size of the largest hole to the nearest millimetre, hardening, swelling, shrinking.

6.6 Small splashes of molten metal

6.6.1 Specimen

Specimens shall be taken from each palm, and the back and cuff of pair of gloves if different materials or constructions are present. The specimen size is $(120 \pm 5) \text{ mm} \times (20 \pm 5) \text{ mm}$.

For each part of the glove 2 specimens taken from 2 different gloves shall be tested.

If the protection is given by a multi-layered assembly, the full assembly shall be tested in the usual order of the layers.

If a reinforcement is added to the tested area, then the samples taken shall be without reinforcement.

6.6.2 Procedure

Test method described in ISO 9150:1988 shall be applied.

NOTE In EN 407, EN 348 is referenced which is deemed equivalent to ISO 9150.

6.6.3 Test report

The test report shall contain the following information:

- a reference to the clause of this document, i.e. ISO 23407:2021;
- the reference of the sample;
- the number of drops on palm, back and cuff areas for each specimen;
- report any observations of changes in the physical appearance of the material specimens following exposure: the number of holes that develop, the size of the largest hole to the nearest millimetre, hardening, swelling, shrinking;
- any deviation from the test method;
- the performance level in accordance with [Table 6](#) based on the lowest result of all single value.

6.7 Large quantities of molten metal

6.7.1 Specimen

The test shall be carried out on three specimens of (260 ± 5) mm $\times$ (100 ± 5) mm for the required quantity of metal from the back and cuff areas of the glove if different materials or constructions, including seams are present. If it is not possible to take specimens of this size from the gloves a sample of material shall be tested, provided that the manufacture of the sample material is identical with that of the glove and include any seam present.

Folds in the material or seam(s) on the outside of the glove can act as trapping points for hot/molten materials areas. The bottom of these folds shall be designed to prevent the metal being retained, for example by incorporating points of diagonal seam or other means.

6.7.2 Procedure

The test method described in ISO 9185:2007 shall be applied (taken into account conditions given in [Table 1](#) of this document).

6.7.3 Test report

The test report shall contain the following information:

- a reference to the clause of this document, i.e. ISO 23407:2021;
- the reference of the sample;
- the metal used and temperature;
- inclination of the specimen;
- for each specimen the mass of metal used;
- the evaluation of the PVC film;
- any deviation from the test method;
- the performance level in accordance with [Table 7](#) based on the lowest mass of metal for each of the all single values;
- report any observations of changes in the physical appearance of the material specimens following exposure. Examples of reported observations are melting, holes, hardening, swelling, shrinking. The seam shall not come apart after the test.

6.8 Tear resistance

6.8.1 Principle

The resistance to tear is defined as the force necessary to propagate a tear in a rectangular specimen slit half way along its length.

6.8.2 Equipment

Only tensile testers of at least Class 2 according to ISO 7500-1:2018, equipped with low inertia force measurement systems shall be used.

6.8.3 Test specimen

The test specimen dimensions are defined in [Figure 3](#). Dimensions of the specimen to be tested: (100 ± 10) mm $\times$ (50 ± 5) mm. A (50 ± 5) mm incision is made in the longitudinal direction of the

sample, $(25,0 \pm 2,5)$ mm from the edge. The incision shall be made with a sharp blade straight and perpendicular to the specimen surface. In case the glove contains reinforcements (e.g. pads) in the palm, the test specimen shall be taken from the layers without these reinforcements. Where the test specimen is made of several unbonded layers, the test is performed only on the outer layer.

Dimensions in millimetres

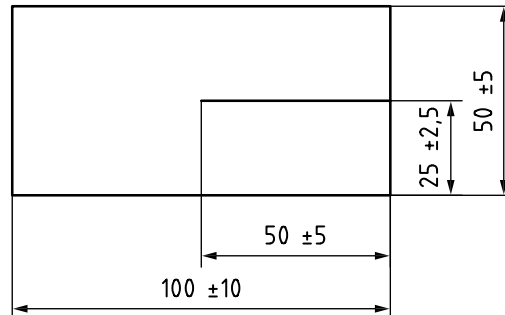


Figure 3 — Test piece

6.8.4 Setting up the test specimen

At least 20 mm of each pre-cut defined strip (see Figure 4) is clamped in a tensile tester with the jaws at least 10 mm apart such as to guarantee a pulling direction parallel to the longitudinal direction of the specimen.



Key

1 strips

Figure 4 — Test strips

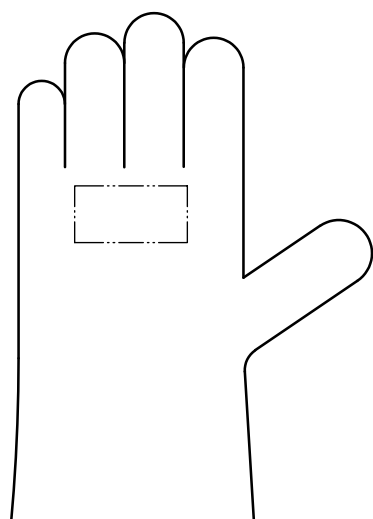
6.8.5 Test method

6.8.5.1 The tearing force is recorded on a X-Y recorder at a tensile test speed of (100 ± 10) mm/min. The specimen shall be torn totally apart. Note that in some cases the tearing may not be in the longitudinal direction of the specimen.

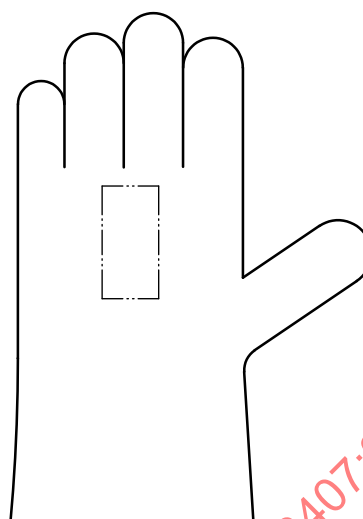
6.8.5.2 If the specimen is not fully torn apart under a force in excess of 75 N, then the test may be stopped and the maximum force reached is recorded.

6.8.5.3 The test shall be performed on one specimen cut from each of four different gloves of the same glove series.

6.8.5.4 Two specimens shall be tested in the direction of the glove from cuff to finger tips, and two specimens shall be tested across the palm width (see Figure 5).



a) Across the palm width of the glove



b) In the direction of the glove

Figure 5 — Tear test - Test area

6.8.5.5 The tear resistance for each specimen is taken as the highest peak recorded, and the result is determined by taking the lowest of the 4 individual values.

6.8.6 Test report

The test report shall contain the following information:

- a reference to the clause of this document, i.e. ISO 23407:2021;
- the reference of the sample.
- the results as per the test given in [6.8.5](#).
- any deviation from the test method.

7 Marking

The marking shall be in accordance with ISO 21420:2020, Clause 7.

The following two pictograms should be used, see [Figures 6](#) and [7](#).



Figure 6 — Graphical symbols ISO 7000-2417