
Hand protection — Guidance for selection and use

*Protection de la main — Lignes directrices pour la sélection et
l'utilisation*

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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*, 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).

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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

For the past year a push has taken place to align EN and ISO standards. Currently some are covered by a single standard, others are identical, but not yet as an EN ISO standard, others have not been developed as ISO or CEN standard. The table below describes the state of the various standards.

EN Standard	ISO Standard	Future state
EN 420:2010	ISO 21420:2020	same
EN ISO 374-1:2016+A1:2018	ISO 374-1: 2016 + Amd 1:2018	same
EN ISO 374-2:2019	ISO 374-2:2019	Already equivalent, but single standard as EN ISO
EN ISO 374-4:2019	ISO 374-4:2019	Already equivalent, but single standard as EN ISO
EN ISO 374-5:2016	ISO 374-5:2016	same
EN ISO 374-6	ISO 374-6	joint project in preparation
EN 388:2016+A1:2018	ISO 23388:2018	Already equivalent, but single standard as EN ISO
EN 407:2020+A1:2021	ISO 23407:2021	Already equivalent, but single standard as EN ISO
No CEN equivalent	ISO 18889	EN ISO 18889 once adopted
EN ISO 19918	ISO 19918	same
EN 16523-1:2015 (liquid permeation) EN 16523-2:2015 (gas permeation) <i>Replaced EN 374-3</i>	not equivalent to ISO 6529 but many similarities	Revision of ISO 6529 will more closely align ISO with EN
EN 16530:2016 (electrostatic)	No ISO equivalent	TBD
EN 16778: 2016 (DMFA concentration)	No ISO equivalent	TBD
EN 12477:2001 + A1:2005 (welder)	No ISO equivalent	TBD
EN 511:2006	No ISO equivalent	TBD
EN 659:2003 +A1:2008	ISO 15383:2001 ISO 11999-4:2015	Revision of EN 659 will more closely align EN with ISO
No CEN equivalent	ISO 16073-4:2019	Revision of EN 659 will more closely align EN with ISO
No CEN equivalent	ISO 18639-4:2018	Revision of EN 659 will more closely align EN with ISO
		TBD to be decided

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Hand protection — Guidance for selection and use

1 Scope

This document gives information on the selection and use of personal protective equipment for the hand protection.

The application of this document requires that the risk assessment has been carried out and the hazards have been minimized accordingly through substitution and technical and organizational measures.

On this basis, this document contains information that supports employers in counteracting certain risks to hands that could not be sufficiently reduced by substitution and technical and organizational measures by selecting and using suitable protective gloves.

This document provides explanations on selection, usage and training applicable to protective gloves. The explanations concerning specific hazards are provided in annexes.

This guidance considers the following risks:

- mechanical, (see [Annex A](#));
- chemical, (see [Annex B](#));
- biological, (see [Annex C](#));
- thermal, (see [Annex D](#) and [E](#));
- electrostatic discharge (see [Annex F](#));
- ionizing radiation and radioactive contamination (see [Annex G](#)).

This guidance does not cover other risks, because pertinent international or national publications are available or because the relevant information was not available in ISO/TC 94/SC 13/WG 8. Risks not covered include e.g.:

- cuts and stabs by hand knives;
- use of chain saws (covered by ISO 11393-4:2018, Annex A);
- animal bites;
- needlesticks;
- electrocution;
- optical radiation;
- vibrations;
- electric fault arcs;
- firefighting (covered by ISO/TR 21808);
- sport.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology 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/>

4 Selection

4.1 General principles

In most countries, manufacturing of gloves is subject to specific legislation, e.g. concerning personal protective equipment, medical devices, etc. Adequate design and construction ensures that a protective glove:

- is appropriate for the risks involved, without itself leading to any increased risk, e.g. entanglement on rotating parts, entrapment, formation of ignition sparks;
- corresponds to existing conditions at the workplace, e.g. grip, tactile sensitivity, waterproofness, breathability, visibility;
- takes account of ergonomic requirements and the worker's state of health, e.g. size, fit, potential allergens.

As a principle, a protective glove is intended for personal use. If the circumstances require that personal protective equipment is used by several persons (e.g. metal ring mesh glove, glovebox), this results in additional hygiene requirements.

Important instructions for the safe use of protective gloves can be found in the supplied manufacturer's instructions and information. The advertised performance levels were achieved under laboratory conditions performed on unused gloves and cannot necessarily be transferred to the actual conditions of use. More detailed information can be obtained from the manufacturers.

Practical tests are a prerequisite for the selection of suitable protective gloves. Criteria for the selection of protective gloves are not only the best possible protection but also ergonomic factors such as wearing comfort, tactile sensitivity and grip. Physiological factors such as wearing comfort, sensitivity or sweat development can be tested in wear tests.

The dexterity of the fingers and the ability to pick up, hold and/or operate objects safely are limited by the wearing of protective gloves. The better the flexibility of the glove and the coefficient of friction of the gripping surfaces are adapted to the geometry and surface characteristics of the objects to be handled, the greater the grip safety for the user.

Only on the basis of the risk assessment is it possible to select the protective glove actually suitable for a particular activity.

A protective glove is suitable if

- a) it meets the legal requirements (for example in Europe CE marking),
- b) it is accompanied by the manufacturer declaration of conformity,
- c) it is capable of reducing the risk to the user to an acceptable level throughout the period of use, and
- d) it can be used under the given working conditions.

NOTE Any modification to the glove requires formal approval by the manufacturer.

4.2 Selection in function of specific hazards

With regard to the hazards covered by the scope of this document, annexes dealing with those specific hazards provide the information required to make the selection correctly.

4.3 Combination with other PPE

The combination of PPE only protects the user if a seamless transition between the equipment parts is ensured. This can be achieved by these methods, for example

- adequate cuff length,
- adequate arm protectors,
- connection with a protective suit, e.g. glove adapter, taping, and
- sleeve design of the protective suit, e.g.: thumb loop, throw-on sleeves.

4.4 Wearing trials

Wearing trials can be used to assess the ergonomic and workplace-specific suitability of the protective gloves, including for example

- Ease and speed of donning on and doffing off the gloves,
- comfort, e.g. sweating, flexibility, disturbing seams,
- compatibility with all other PPE items,
- ability to perform all expected tasks without hindrance and without difficulty, e.g. secure grip, tactile sensitivity, and
- maintaining protection in all working positions, e.g. covering with the sleeve.

A systematic approach to carrying out the wearer trials includes, for example

- selection of the participants according to a cross-section of the respective occupational group (height, weight, age, gender, etc.),
- structured collection of feedback for evaluation, so that both qualitative and quantitative data collection and analysis are possible; this can be achieved by using a structured questionnaire, structured or semi-structured interviews and/or group discussions, and
- sufficient number of participants to ensure an appropriate selection of suitable protective gloves for all affected employees in a work area.

4.5 Sweating

Sweating when wearing liquid-tight gloves for long periods of time, through heavy physical activity and/or high ambient temperatures can lead to skin reddening, softening and irritations. Gloves designed with a knitliner or flocklining, wearing a textile underglove or changing gloves frequently help providing added comfort and preserve the highest integrity of the gloves. Regular skin care can help to reduce the negative effects of skin softening (e.g. after work cream).

4.6 Allergens

According to ISO 21420, the manufacturer provides the user on request with a list of substances contained in a glove that are known to cause allergies. In the case of gloves containing natural rubber, the information for use include a warning which read something like this: "The glove contains natural rubber which may cause allergic reactions".

5 Usage

5.1 Testing before use or re-use

By checking the protective gloves before use or re-use (e.g. visual assessment of the surface condition of the barrier), hazards due to possible damage, quality defects, and flaws such as tear, abraded areas, holes or cracks, especially in finger crotches, broken seams or other defects can be identified. The protective effect can be reduced e.g. by pointed objects, soot or heat-induced material embrittlement. Wet gloves, be it inside or outside, may have reduced performance levels and cause skin discomfort. Skin discomfort can also be caused when gloves are worn on wet or dirty hands.

Checking the protective gloves before use also helps to determine whether their expiry date has already passed.

Only fitting gloves (correct size) offer the intended protective performance and suitability.

5.2 Use

Important instructions for the safe use of protective gloves can be found in the supplied manufacturer's instructions and information.

According to ISO 21420, the manufacturer provides the user with instructions together with the gloves containing all relevant information for safe use. Whether the glove is designed for single use or might be reused is an important instruction to be followed.

Employers are responsible of giving appropriate and understandable instructions to the workers. At the same time, workers are responsible of making correct use of the personal protective equipment supplied to them in accordance with the training and the instructions given by their employer.

6 Training

Training of employees/users in the correct handling of their protective gloves is a prerequisite for their correct use. Providing only written instructions or information without practical demonstrations, training and exercises may not be sufficient.

Important instructions for the safe use of protective gloves can be found in the supplied manufacturer's instructions and information. This can include

- information on why the protective gloves can be worn,
- information on personal responsibility for correct use and care, and
- information about the limitations and possibilities of the protective gloves:
 - what they can protect against;
 - what they do not protect against;
- how to don, use/wear and doff the protective gloves;
- how to store the protective gloves when not in use;
- information on precautions for cleaning;
- how to determine when the protective gloves are no longer appropriate and can be disposed of;
- procedures for the environmentally sound disposal of gloves which are no longer fit for use;
- how to obtain replacement;
- emergency response.

Annex A (informative)

Mechanical hazards

A.1 General

Gloves according to ISO 23388 (ISO 23388:2018 is equivalent to the EN 388:2016 + A1:2018) offer protection against damage caused by abrasion, cut, puncture, or tear resistance being a product feature. The abrasion, puncture and tear resistance are assigned to four performance levels, the cut resistance to five or 6 performance levels (see ISO 23388:2018, Tables 1 and 2). According to ISO 23388, protective gloves against mechanical risks achieve at least performance level 1 or at least performance level A for the TDM (tomodynamometer) cut resistance test according to ISO 13997 for at least one of the properties (abrasion, cut, tear propagation and puncture resistance).

NOTE 1 The two cut test methods coexist because they are well established in different regions and standards. The Coupe-test is more cut by pressure, the TDM-test according to ISO 13997 is a slash type of cut.

NOTE 2 See the following pictogram used to indicate conformity with ISO 23388:



ISO 7000 - 2490

Table A.1 — Levels of performance

Test	Level 1	Level 2	Level 3	Level 4	Level 5
6.1 Abrasion resistance (number of rubs)	100	500	2 000	8 000	—
6.2 Coupe test: Blade cut resistance (index)	1,2	2,5	5,0	10,0	20,0
6.4 Tear resistance (N)	10	25	50	75	—
6.5 Puncture resistance (N)	20	60	100	150	—

Table A.2 — Levels of performance for materials tested with ISO 13997

	Level A	Level B	Level C	Level D	Level E	Level F
6.3 Cut resistance (N) (ISO 13997)	2	5	10	15	22	30

Gloves according to ISO 23388 can also provide specific protection against impact. If parts of the glove meet the requirements for specific impact protection and this has been tested positively, the glove is marked with "P" in addition to the 5 performance levels.

The performance levels determined in accordance with ISO 23388 provide valuable assistance and orientation in the pre-selection of products. They always refer to the test method or conditions. This means that the performance levels are always to be seen relatively and the higher the number or the wider the letter in the alphabet, the higher the theoretical level of protection. Protection in real life may depend on many factors, therefore a wearer trial or suitability test according to 4.4 can confirm the practical suitability.

These performance levels specified by the manufacturer serve as a selection guide for the use of the protective gloves. However, they do not give any direct indication of the specific protection or suitability in defined applications and their risks.

Wetness and penetrating moisture can reduce the protective properties of protective gloves. Not all protective gloves are liquid-tight, but only those that have been explicitly recommended by the manufacturer.

A.2 Information sources

Important application instructions for the use of protective gloves against mechanical risks can be found in the manufacturer's instructions and information supplied with the product. According to ISO 23388:2018, Clause 8, these include

- information on special tests carried out under different climatic conditions,
- where appropriate, a warning that the overall classification for gloves with two or more layers does not necessarily reflect the performance of the outermost layer,
- where appropriate, a warning that if dulling occurs during the cut resistance test, the results of the coupe test are only indicative, whereas the TDM cut resistance test in accordance with ISO 13997 provides reference results in terms of performance,
- if protection against impact is claimed, that the areas for which protection is specified are mentioned, as well as a warning that the protection does not apply to fingers, and
- for gloves with mechanical resistance, which have a tear resistance rating of 1 or higher, a warning that gloves will not be worn in cases where there is a risk of getting caught in moving parts of the machine.

More detailed information can be obtained from the manufacturers.

A.3 Mechanical properties

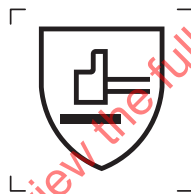
- The abrasion resistance test is intended to simulate the wear and tear of the glove material during use. Samples of the material of the palm are fixed with double-sided adhesive tape on sample holders and are moved with a specified sequence of movements and loaded against an abrasive paper until a hole occurs.
- For the determination of the cut resistance there is on the one hand the cutting method with a rotating circular blade according to ISO 23388, where the cutting index is determined under a constant force by repeated contact and is calculated depending on the sharpness of the circular blade. However, due to the further development of the glove materials used, which can also consist of mineral or steel fibres, this method dulls the knife too quickly.
- If the blade is dulled too early, another cutting method is used. In this method, the resistance to cutting is determined from a linear one-time movement under increasing force until penetration. This test method provides an additional statement on the cut resistance for work with different and also impact-like force effects.
- All materials used for glove production can be cut through. According to ISO 23388, protective gloves that are supposed to have a certain cut resistance are tested and evaluated according to specific procedures. If the given risk requires an even higher level of protection, the use of cut-resistant gloves made of metal ring mesh (EN 14328) can be considered with all its disadvantages (e.g. wearing comfort, sensitivity).
- The two test methods of ISO 23388:2018, 6.2 and 6.3, are not comparable and there is no correlation between the levels of performance. Therefore, the user can only select the correct protective gloves for the corresponding risk if the manufacturer has clearly defined the use of the gloves in the

instructions for use. This means that, depending on the area of application and risk assessment in the company, protective gloves that have been certified with one or both cut protection levels are suitable.

- To determine the puncture resistance, a nail is pressed onto the glove material at a relatively low speed. The force required to either pierce the material or stretch it to 50 mm is given. The protection against injuries caused by sharp corners during e.g. assembly work can be determined by this test method. Hazards caused by the use of needles or rapid penetration of nails are not covered by the test.
- The tear resistance is a quality feature of the glove material. If the material layers of the glove are not bonded together, the individual layers of the inner glove are tested individually.
- According to ISO 23388, parts of the glove which are designed and manufactured to provide specific impact absorption to protect e.g. knuckles, palm and back of the hand against impact, meet the performance of protection class 1 according to EN 13594:2015, Table 7. Due to the test procedure (dimensions of the test sample) the finger protection against impact cannot be tested.

A.4 Marking

The following figure uses three examples to explain the marking of the performance levels carried out by the manufacturer according to ISO 23388.



ISO 23388

Example 1: 3 4 4 3 E P

Example 2: 3 X 0 3 E

Example 3: 3 2 0 3 X

Example	N° 1	N° 2	N° 3
Abrasion (6.1)	level 3	level 3	level 3
Cut (6.2)	level 4	test not performed or not applicable	level 2
Tear (6.4)	level 4	level 1 not achieved	level 1 not achieved
Puncture (6.5)	level 3	level 3	level 3
Cut (6.3)	level E	Level E	test not performed
Impact protection	achieved	test not performed	test not performed

The marking "X" instead of a number indicates that the glove has not been tested or that the test method seems unsuitable for the glove assembly or the glove material. According to ISO 21420, the manufacturer's instructions and information explain the reasons for the indication "X".

A.5 Procedure for selecting protective gloves against mechanical hazards

The conscientious selection of protective gloves against mechanical risks takes particular account of the type of activity and its general conditions, such as:

- material of the workpiece (e.g.: paper, metal);
- geometry of the cutting edge (e.g.: knife blade, cutting/punching burr);
- length of the cut edge (short knife blade, sharp edge of a metal sheet);
- expected cutting force (e.g. touching a cutting edge, force guided knife);
- movement of the cutting edge relative to the hand, e.g. pulling over the surface or pressing on the surface;
- humidity;
- contact with oils or greases;
- necessary dexterity;
- exposed body parts.

Annex B (informative)

Chemical hazards

B.1 General

When selecting chemical protective gloves, chemical hazards are the primary consideration, but other hazards are also important: these include electrostatic charge, mechanical wear and tear or open flames.

Chemical protective gloves can only provide protection if they have no openings in the barrier layer, i.e. no penetration takes place, and if they are resistant enough that the barrier function cannot be impaired during the activity. If damaged, gloves protecting against chemicals lose their protective effect.

Contaminated gloves carry the risk of contaminating the wearer, e.g. when taking them off, and other surfaces they touch. These include in particular unused gloves, products and furniture.

Manufacturers provide instructions with the gloves to the user in order to determine:

- The best process to clean out and decontaminate the gloves before taking them off.
- The most suitable process to take the gloves off.
- The best process to restore, let dry and preserve the gloves before reuse.

ISO 374-1:2016, Clause 7, explicitly states: "For reusable gloves, the manufacturer provides the relevant instructions for decontamination. If there is no information about decontamination, then it is intended for single use only and the following warning is added: "For single use only"".

Gloves designed with an absorbent inner knit lining help provide added comfort. Undergloves may be used to help in absorbing sweat, but it may reduce the dexterity and tactile sensitivity. Overgloves may be used to increase the mechanical protection, but it may reduce the dexterity and tactile sensitivity.

NOTE See the following pictogram used to indicate conformity with ISO 374-1 and ISO 18889:



Protection against chemicals
ISO 7000 - 2414



Protection against agricultural pesticides
ISO 7000 - 3126

B.2 Information sources

Information sources for occurring hazards and the selection of suitable gloves are for example:

a) Safety data sheet

The information on personal protective equipment given in section 8.2 of the Safety Data Sheet "Exposure controls" gives an indication of suitable barrier materials of chemical protective gloves and their thickness.

Section 2 “Hazard(s) identification” relative to contact with skin.

Section 9 “Physical and Chemical Properties” of the Safety Data Sheet gives the properties of each chemical. Important parameters include

- state of aggregation,
- solidification and boiling temperature,
- composition (volumetric/gravimetric) of mixtures, and
- corrosion properties.

b) Manufacturer’s instructions and information

Important instructions for the suitability and safe use of chemical protective gloves can be found in the supplied manufacturer’s instructions and information. More detailed information can be obtained from the manufacturers.

c) Permeation databases

Some manufacturers provide online databases for permeation on specific substances in addition to information in the “Information for Use” sheet or booklet. For mixtures, the exact composition is decisive and the components of the mixture may interact with each other. There the permeation information of the shortest breakthrough time may actually be an over estimation of the protection time.

B.3 Performance levels and chemical and physical properties

B.3.1 General

In the following subclauses, some chemical-physical properties of gloves are explained which are important for their selection.

B.3.2 Penetration

According to ISO 374-1:2016, 3.5, penetration is the movement of a chemical through materials, seams, pinholes, or other imperfections in a protective glove material on a non-molecular level.

The penetration tests according to ISO 374-2 (equivalent to EN 374-2) are primarily quality testing methods and not performance tests.

B.3.3 Permeation (breakthrough)

B.3.3.1 Test of the breakthrough time according to EN 16523-1

According to ISO 374-1:2016, 3.6, permeation is a process by which a chemical moves through a protective glove material on a molecular level. Permeation involves the following:

- absorption of molecules of the chemical into the contacted (outside) surface of a material;
- diffusion of the absorbed molecules in the material;
- desorption of the molecules from the opposite (inside) surface of the material.

It is important to note the difference between a breakthrough time determined under standard conditions according to EN 16523-1 and the maximum wearing time of a chemical protective glove. The latter is the time a protective glove can be worn under working conditions without being permeated by the chemical agent.

The breakthrough time (normalized breakthrough time) is determined under normatively defined test conditions that do not represent the real conditions of use. These breakthrough times provide an

orientation about the permeation behaviour of a specific chemical when it comes into contact with a barrier material. They are determined based on a test conducted in the palm area or, if there are seams, in the hand area, on the seams. In addition, gloves longer than 400 mm are tested for permeation in the cuff; in this case the claimed levels refer to the lowest obtained results between palm and cuff.

The breakthrough time is the time required by a chemical to reach a permeation rate of $1,0 \mu\text{g}/(\text{cm}^2\cdot\text{min})$. The normalised breakthrough time determined in accordance with EN 16523-1 gives the following performance levels assigned according to ISO 374-1:2016, Table 1.

Table B.1 — Permeation performance levels

Measured breakthrough time min	Permeation performance level
>10	1
>30	2
>60	3
>120	4
>240	5
>480	6

B.3.3.2 Testing the cumulative permeation according to ISO 19918

This test is used to determine the permeation of chemicals with low vapour pressure and/or insolubility in water. The chemical to be tested is applied to the glove material and the mass of the test chemical ($\mu\text{g}/\text{cm}^2$) which has permeated the glove material within a defined time is measured. The test is used in particular to determine the cumulative permeation of pesticides.

B.3.4 Degradation

According to ISO 374-1:2016, 3.4, degradation is the deleterious change in one or more properties of a protective glove material due to contact with a chemical. Indications of degradation may include flaking, swelling, disintegration, embrittlement, colour change, dimensional change, appearance, hardening, softening, etc.

The contact of a specific chemical with a barrier material can change or destroy its structure. This affects the physical and chemical properties of the barrier material and consequently influences the breakthrough time. Due to the reduction of mechanical stability, holes or cracks can form during the activity, which lead to penetration.

According to ISO 374-4 (is equivalent to EN 374-4), degradation is determined but not evaluated.

B.3.5 Mechanical properties

Frequently occurring mechanical hazards are, for example, parts with dangerous surfaces (sharp edges, pointed components, etc.). In addition, there are also mechanical stresses that do not represent an obvious hazard, e.g. abrasive surfaces or materials (see also [Annex A](#)).

B.3.6 Marking

According to ISO 374-1 for chemical protective gloves, these are marked with the Erlenmeyer pictogram and the corresponding performance characteristics (Type A to Type C).

Type A	Type B	Type C
ISO 374-1/Type A  UVWXYZ	ISO 374-1/Type B  XYZ	ISO 374-1/Type C  (No letters below the pictogram)
Penetration tests	Penetration tests	Penetration tests
Permeation tests at least 6 chemicals ^a Performance level 2 ^b	Permeation tests at least 3 chemicals ^a Performance level 2 ^b	Permeation tests at least 1 chemical ^a Performance level 1 ^c
^a From the list of 18 chemicals. ^b breakthrough time >30 min. ^c breakthrough time >10 min.		

In order to make it clear that this is a lower performance level, no letters may appear below the pictogram on Type C chemical protective gloves according to ISO 374-1.

Tests are carried out by the manufacturer with the following chemicals:

CODE LETTER	CHEMICAL	CAS NUMBER	CLASS
A	Methanol	67-56-1	Primary alcohol
B	Acetone	67-64-1	Ketone
C	Acetonitrile	75-05-8	Nitrile compound
D	Dichloromethane	75-09-2	Chlorinated hydrocarbon
E	Carbon disulphide	75-15-0	Sulphur containing organic compound
F	Toluene	108-88-3	Aromatic hydrocarbon
G	Diethylamine	109-89-7	Amine
H	Tetrahydrofuran	109-99-9	Heterocyclic and ether compound
I	Ethyl acetate	141-78-6	Ester
J	n-Heptane	142-82-5	Saturated hydrocarbon
K	Sodium hydroxide 40 %	1310-73-2	Inorganic base
L	Sulphuric acid 96 %	7664-93-9	Inorganic mineral acid, oxidizing
M	Nitric acid 65 %	7697-37-2	Inorganic mineral acid, oxidizing
N	Acetic acid 99 %	64-19-7	Organic acid
O	Ammonium hydroxide 25 %	1332-21-6	Organic base
P	Hydrogen peroxide 30 %	7722-84-1	Peroxide
S	Hydrofluoric acid 40 %	7664-39-3	Inorganic mineral acid
T	Formaldehyde 37 %	50-00-0	Aldehyde

The table above covers representative chemicals of the main chemical families.

ISO 18889 describes requirements for protective gloves for plant protection products (PPP) during handling and follow-up work. In addition to the general requirements according to ISO 21420, requirements are also set for permeation behaviour, mechanical properties and design.

G1	G2	GR
		
Penetration tests	Penetration tests	
Permeation test ISO 374-1; ≥Type C	Permeation tests ISO 374-1; ≥Type B	Permeation test ISO 374-1; ≥performance level 2 with NaOH 40 % (K)
Cumulative permeation ISO 19918 1 h with diluted PPP	Cumulative permeation ISO 19918 1 h with diluted PPP 15 min with concentrated PPP	Cumulative permeation ISO 19918 1 h with diluted PPP
<10 µg/(cm ² ·min)	<1 µg/(cm ² ·min)	<1 µg/(cm ² ·min)
glove length ≥240 mm	glove length ≥290 mm	
		Coating at least in the palm of the hand and above the finger-tips
	Minimum performance levels (ISO 23388): Abrasion resistance : 2 Puncture resistance : 1 Cut resistance (Coupe-Test): 1 or Cut resistance (ISO 13997): A	Minimum performance levels (ISO 23388): Abrasion resistance : 2 Puncture resistance : 1 Tear resistance : 1 Cut resistance (Coupe-Test): 1 or Cut resistance (ISO 13997): A

B.4 Procedure for the selection of chemical protective gloves

B.4.1 Determination of the required breakthrough time or wearing time

The barrier function results from the permeation and degradation behaviour of a material towards a specific chemical and depends on many different factors, which are described as examples in the following sections.

B.4.2 Barrier material

- material or combination;
- material thickness;

- antistatic properties (see [Annex F](#));
- etc.

B.4.3 Chemical

- concentration;
- molecule size;
- state of aggregation;
- polarity;
- surface tension;
- oxidation behaviour;
- causticity;
- etc.

Often not all data is publicly available and the interactions are not known. In these cases, manufacturers of chemical protective gloves provide normatively determined permeation and degradation data.

B.4.4 Contact surface (contact type)

When selecting a suitable glove, the contact area is decisive for the exposure (dose) with regard to a breakthrough. However, the contact area and type of contact do not affect the breakthrough time (see [B.4.6](#)).

B.4.5 Maximum wearing time

The breakthrough time given is not a maximum contact or wearing time after wetting. The maximum wearing time (actual breakthrough time) corresponds to the breakthrough time minus all activity-related influences, such as

- temperature,
- elongation, and
- chemical-physical properties.

B.4.6 Breakthrough time (normatively determined) ≠ breakthrough time (actual)

The breakthrough time refers to the area-related permeation rate ($1,0 \mu\text{g}/(\text{cm}^2 \cdot \text{min})$). Due to the complexity and variety of influencing factors, the maximum wearing time cannot be precisely determined on the basis of the normatively determined breakthrough time. Nevertheless, it is only possible to minimize the risks for the glove wearer by means of a well-founded estimation of the maximum wearing time.

Due to the following influences, it has proven useful in practice to estimate the maximum wearing time in relation to the normatively determined breakthrough time for many materials as differing significantly:

- caused by the body temperature of the wearer, the application temperature of the barrier material is usually above the normative test temperature of 23 °C;
- exposure over large areas (e.g. splashes) increases the potential exposure;
- handling of acutely toxic substances or CMR (carcinogenic, mutagenic or toxic for reproduction) substances;

- Degradation of the glove's material caused by the chemical;

More detailed information can be obtained from the manufacturers.

B.5 Chemical protective gloves for the handling of plant protection products and re-entry work

G1 gloves only provide protection against diluted plant protection products. The use is limited to activities without mechanical stress. This allows activities to be carried out with the necessary sensitivity (e.g. changing nozzles).

G2 gloves offer protection against diluted and concentrated plant protection products and have a low mechanical resistance.

GR gloves are suitable for carrying out follow-up work where contact with dry or partially dry plant protection products residues is to be expected.

B.6 Chemical protective gloves with additional protective properties

B.6.1 General

The combination of protective properties usually achieved by additional protective layers impairs the dexterity and sensitivity of the glove wearer.

B.6.2 Additional mechanical protection

If necessary, chemical gloves equipped with an additional mechanical protective layer (e.g.: cut protection fabric) may be required (see [Annex A](#)). The arrangement of the layers has a considerable influence on the protective effect:

- If necessary, chemical protective gloves are lined with an additional layer (e.g.: cut resistant fabric) for an added mechanical protection (see [Annex A](#)). The arrangement of the layers though has a significant impact on the protective performance of the glove.
- As an example, with the mechanical resistance liner set on the outside surface of the glove, the chemical protective barrier may remain unimpaired from mechanical stresses, but the mechanical resistance may be reduced through the contact with the chemical. With the mechanical resistance liner on the inside of the glove, the chemical barrier may be easily cut or damaged, resulting in penetration of the chemical.

B.6.3 Additional thermal protection

Chemical protective gloves, which are also intended to protect against heat or cold, are equipped with internal insulation layers; often cotton liners of different thicknesses (see [Annex D](#) and [Annex E](#)).

Annex C (informative)

Hazards due to micro-organisms

C.1 General considerations for the selection of gloves protecting against microorganisms

The micro-organisms bacteria, viruses or fungi can be infectious, toxic or sensitizing. They can be bound on or in solid materials or occur in liquids. Depending on the environmental conditions, they also multiply in these media. Micro-organisms are assigned to so-called risk groups depending on their infectious hazard (see Directive 2000/54/EC of the European Parliament and of the Council of 18 September 2000 on the protection of workers from risks related to exposure to biological agents at work). Gloves can only protect against micro-organisms where the transmission route is possible via the skin; for other transmission routes (e.g. via the respiratory tract) other PPE is required.

Whether protective gloves protect against micro-organisms can be determined from the instructions for use and the marking. Protective gloves protect either against bacteria and fungi or against bacteria, fungi and viruses. In the evaluation and testing according to ISO 374-5, a distinction is made between fungi and bacteria on the one hand and the significantly smaller viruses on the other hand due to the different penetration behaviour.

Only an intact and undamaged barrier protects against micro-organisms. Consequently, ISO 374-5 provides for testing for tightness (penetration) according to ISO 374-2 to prove barrier properties with regard to micro-organisms. Virus resistance is additionally tested with bacteriophages according to ISO 16604.

If damaged, gloves protecting against micro-organisms lose their protective effect.

Information on whether gloves can be re-used several times for protection against micro-organisms and instructions for decontamination can be taken from the manufacturer's instructions. If no information on decontamination is available, the gloves are intended for single use only. Additional and more detailed information can be obtained from the manufacturer.

Contaminated gloves carry the risk of contaminating the wearer, e.g. when taking them off, and other surfaces they touch. This includes in particular unused gloves, products and furniture.

Gloves designed with an absorbent inner knit lining help provide added comfort. Undergloves may be used to help in absorbing sweat, but it may reduce the dexterity and tactile sensitivity. Overgloves may be used to increase the mechanical protection, but it may reduce the dexterity and tactile sensitivity.

NOTE See the following pictogram used to indicate conformity with ISO 374-5:



ISO 7000 - 2491

C.2 Sources of information

Sources of information for occurring hazards and the selection of suitable personal protective equipment can be found in the Directive 2000/54/EC of the European Parliament and of the Council of 18 September 2000 on the protection of workers from risks related to exposure to biological agents at work and national subordinate regulations.

Detailed information on micro-organisms can be found in the GESTIS Biosubstances database: <https://www.dguv.de/ifa/gestis/gestis-biostoffdatenbank/index-2.jsp>.

C.3 Chemical and physical properties important for the selection of gloves protecting against microorganisms

C.3.1 General

In the case of micro-organisms, permeation and degradation are not important, so they are not determined according to ISO 374-5.

C.3.2 Penetration

Gloves can only protect against micro-organisms if they have no openings in the barrier layer, i.e. no penetration takes place, and if they are sufficiently resistant so that the barrier function is not impaired during the activity.

In the evaluation according to ISO 374-5 it is assumed that protective gloves which have passed the test against air and water leaks provide sufficient protection against the penetration of bacteria and fungi. In addition, the requirements against penetration by viruses require a test according to ISO 16604, whereby no measurable transfer (<1 PFU/ml) of the bacteriophage Phi-X174 in the sample titre may occur. Results are determined based on a test conducted in the palm area or, if there are seams, in the hand area, on the seams. In addition, gloves longer than 400 mm are tested for permeation in the cuff; in this case the claimed levels refer to the lowest obtained results between palm and cuff.

The manufacturer's instructions and information therefore contain the following warning according to ISO 374-5: "The penetration resistance has been assessed under laboratory conditions and relates only to the tested specimen." If not checked for protection against viruses, the following warning is also added: "Not tested against viruses."

The protective effect can be reduced by moisture or the use of disinfectants. Further, more detailed information can be obtained from the manufacturers.

C.3.3 Mechanical properties

Frequently occurring mechanical hazards are, for example, parts with dangerous surfaces (sharp edges, pointed components, etc.). In addition, there are also mechanical stresses that do not represent an obvious hazard, e.g. abrasive surfaces or materials (see also [Annex A](#)).

C.4 Marking

According to the ISO 374-5, the following pictograms are provided as marking on the protective glove:

Marking of gloves that protect against bacteria and fungi

ISO 374-5:2016



Marking of gloves that protect against viruses, bacteria and fungi

ISO 374-5:2016



VIRUS

C.5 Protective gloves against micro-organisms with additional protective properties

C.5.1 General

The combination of protective properties usually achieved by additional protective layers impairs the dexterity and sensitivity of the glove wearer.

C.5.2 Additional mechanical protection

If necessary, protective gloves against micro-organism equipped with an additional mechanical protective layer (e.g.: cut protection fabric) may be required (see [Annex A](#)). The arrangement of the layers has a considerable influence on the protective effect.

If the layer with high mechanical resistance is on the outside, it protects the protective gloves against micro-organism from unintentional and unnoticed mechanical damage and the glove wearers from related hazards. If the external mechanical protective layer is contaminated (see also [5.2](#)), there is a risk that the mechanical protective properties will be reduced.

If the layer with the protective gloves against micro-organism is on the outside, it protects the underlying mechanical protective layer from contamination. In the event of unintentional and unnoticed mechanical damage, there is a risk that the chemical will contaminate the glove wearer via the inner layer, which only protects mechanically.

C.5.3 Additional thermal protection

Protective barriers against micro-organisms, which are also intended to protect against heat or cold, are equipped with internal insulation layers; these are often cotton liners of different thicknesses (see [Annex D](#) and [Annex E](#)).

Annex D (informative)

Thermal hazards: Heat

D.1 General

According to ISO 23407 the protective effect of gloves against heat is tested, but not the protection against hot steam and against flying sparks. The protective effect against hot steam can be achieved by a membrane processed in the glove, for which no standardized test methods are available so far.

NOTE 1 EN 407:2020 with amendment is equivalent to ISO 23407.

NOTE 2 See the following pictogram used to indicate conformity with ISO 23407:



ISO 7000 - 2417



ISO 7000 - 3652

It is not only the direct hazard to the hands from the activity that is relevant, but also the ambient temperature and the necessary dexterity. If, for example, the ambient temperature is high and an aid is used for the activity, which means that the hand does not come so close to the heat source, a thinner glove with lower performance levels but better breathability can be the more suitable. For similar reasons, a lower performance level can also be appropriate for dexterity, which is tested according to ISO 21420 but does not have to be claimed.

It is possible that different materials and/or material structures are processed on the glove for the different areas of the fingers, palm, back of the hand, cuff. In this case the purchaser can ask the manufacturer which degree of protection the processed material offers for the individual hand areas relevant for his needs.

Wetness and penetrating moisture can reduce the protective effect of protective gloves. Not all heat-protective gloves are liquid-tight, but only those that have been explicitly declared by the manufacturer.

If damaged heat-protective gloves are not repaired with flame-retardant sewing thread, their protective effect is no longer guaranteed.

Gloves designed with an absorbent inner knit lining help provide added comfort. Undergloves may be used to help in absorbing sweat, but it may reduce further the dexterity and tactile sensitivity.

D.2 Sources of information

Important application instructions for the use of heat-protective gloves can be found in the supplied manufacturer's instructions and information. Additional and more detailed information can be obtained from the manufacturers.

D.3 Thermal tests according to ISO 23407

In all tests the highest performance level offers the highest protection.

D.3.1 Limited flame spread

During the test the glove is hung vertically at a defined distance above an open flame. As a consequence, the area of the glove fingertips is most exposed to the flame, the palm of the hand less and the cuff is hardly exposed. This means that the specified performance level refers to the degree of protection of the glove fingers and not to the protection of the palm or cuff. In addition, for heat-resistant gloves with performance level 3 or 4, all outer materials, accessories with an area of more than 10 cm² and the seams according to ISO 15025 pass the limited flame spread test with the requirements of performance level 3.

Table D.1 — Performance levels for limited flame spread

Performance level	after flame time s	after glow time s
1	≤20	no requirement
2	≤10	≤120
3	≤3	≤25
4	≤2	≤5
NOTE From ISO 23407:2021.		

D.3.2 Contact heat

According to ISO 23407 the contact heat transfer is determined by protective materials according to ISO 12127-1. The temperature increase is measured on the inside of the glove. This temperature does not rise more than 10 °C above an initial value within the test period of 15 s. A stamp with the temperature specified for the power stage is applied to the thinnest part of the material protecting the palm, i.e. without any reinforcements. In case of exposure times of more than 15 s, the heat-protective glove may no longer be able to protect against the temperature for which it is marked and, therefore, require higher power levels.

Table D.2 — Performance levels for contact heat

Performance level	Contact temperature (±2 %) T_c °C	Threshold time t_t s
1	100	≥15
2	250	≥15
3	350	≥15
4	500	≥15
NOTE From ISO 23407:2021.		

The material combination in the palm area and all other areas exposed to contact heat are tested.

D.3.3 Convective heat

This test, carried out in accordance with ISO 9151, tests both the material combination for the protection of the palm and the back of the hand, so that the designated protection of the heat transmission under the influence of flame is achieved for the complete glove. A material sample is clamped vertically in front of a copper calorimeter and positioned horizontally at a distance of (50 ± 2) mm above a gas flame.

Table D.3 — 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
NOTE From ISO 23407:2021.	

D.3.4 Radiant heat

The transmission of radiant heat is determined according to ISO 6942, method B, on the material composition under the influence of a radiation source. A material sample is clamped vertically in front of a copper calorimeter and exposed to a defined heat radiation of 20 kW/m². The mean value of the times for the temperature rise in the calorimeter of 24 °C of three measurement samples is given as the "heat transfer index" for radiant heat in seconds.

Table D.4 — Performance levels for radiant heat

Performance level	Heat transfer t_{24} s
1	≥ 7
2	≥ 20
3	≥ 50
4	≥ 95
NOTE From ISO 23407:2021.	

In this test, only the material combination for the protection of the back of the hand is tested. The protective effect on the palm of the hand is not tested.

D.3.5 Small splashes of molten metal

The number of droplets of molten metal determined according to ISO 9150 (equivalent to EN 348) is decisive for achieving the performance levels according to ISO 23407. The temperature rise of the sensor located behind the sample to 40 °C is tested. Decisive for the performance level is the lowest single value determined for the inside of the glove, the back of the glove or the cuff.

Table D.5 — Performance levels for small splashes of molten metal

Performance level	Number of droplets
1	≥ 10
2	≥ 15
3	≥ 25
4	≥ 35
NOTE From ISO 23407:2021.	

During this test, droplets fall onto the sample at a 45° angle. If the user holds his hand horizontally when a drop of hot metal hits the sample, the droplet cannot immediately roll off and could stick, so that, despite the power level advertised, the temperature in the material build-up increases more rapidly, resulting in damage to the glove or burns to the hand.

D.3.6 Large quantities of molten metal

According to ISO 23407, the test is carried out in accordance with ISO 9185 with molten iron on the material/material combination to protect the back of the hand and the cuff. The damage is assessed by placing a PVC film immediately behind and in contact with the sample and noting the changes in the PVC film after casting. Any adherence of metal to the surface of the sample is also noted. Depending on the result, the test is repeated using a larger or smaller amount of metal until the minimum amount causing damage to the PVC film is determined.

Table D.6 — Performance levels for large quantities of molten metal

Performance level	Molten iron (± 1 g)
1	30
2	60
3	120
4	200
NOTE From ISO 23407:2021.	

The faster the quantities of liquid metal specified by the performance levels flow from the sample arranged at an angle of 70° to the spout, the less material changes occur due to the effect of heat. Although iron melts at 1 400 °C, a higher performance level can be achieved than with aluminium, which melts at 780 °C but tends to adhere to the material surface.

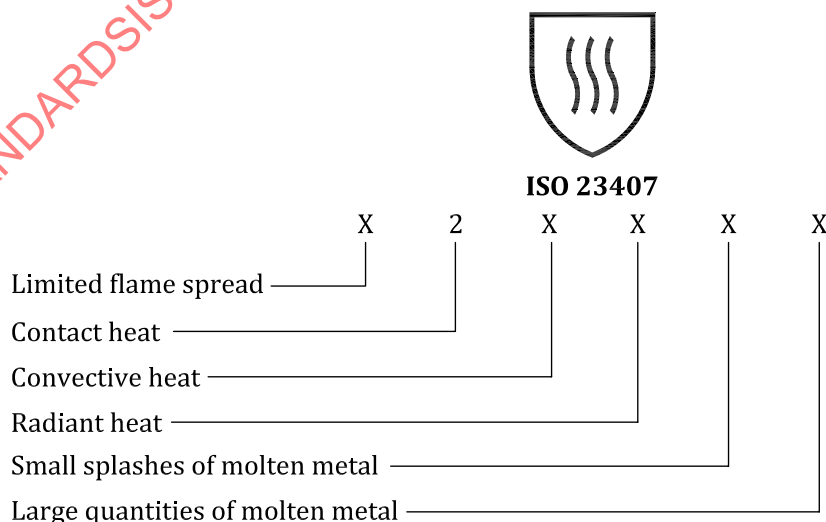
D.3.7 Mechanical properties

In addition to these thermal performance levels shown on the label under the pictogram, the tear resistance of the inner glove surface is also tested according to ISO 23407. The tear strength has a value of at least 10 N.

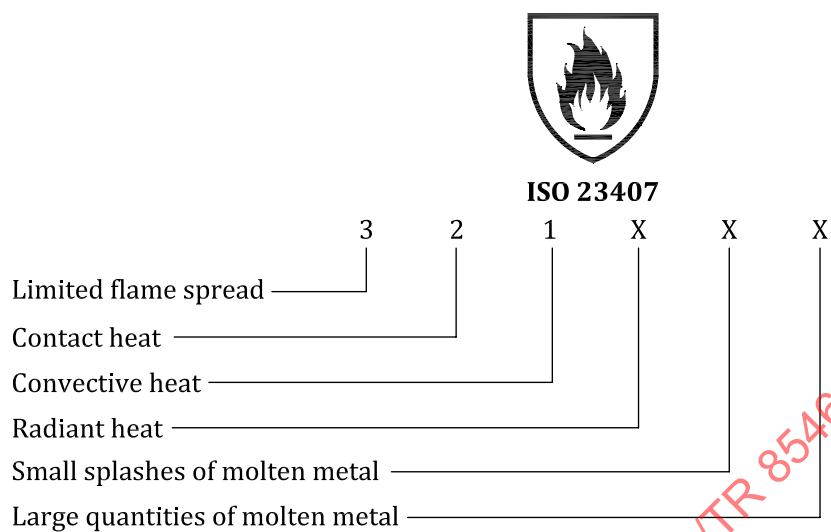
D.4 Marking

Graphical symbols with explanatory performance levels using two examples from ISO 23407 Protective gloves against thermal risks (heat and/or fire).

D.4.1 Without claimed limited flame spread



The marking "X" instead of a number indicates that the glove has not been tested or that the test method seems unsuitable for the glove assembly or the glove material. According to ISO 21420, the manufacturer's instructions and information explain the reasons for the indication "X".

D.4.2 With claimed limited flame spread

The marking "X" instead of a number indicates that the glove has not been tested or that the test method seems unsuitable for the glove assembly or the glove material. According to ISO 21420, the manufacturer's instructions and information explain the reasons for the indication "X".

Annex E (informative)

Thermal risks: Cold

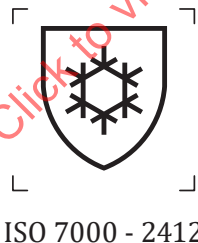
E.1 General

The protective effect of gloves against cold down to $-50\text{ }^{\circ}\text{C}$ is tested according to EN 511. Every person has a different sensation of cold. The results of standardised procedures are used to determine the performance levels. Depending on how sensitive to cold a person is and how much he moves during the activity, these assessments can be relevant for them or not. In addition, wind speed, wetness and moisture can reduce the insulating properties of the glove.

If a person is working in a warmer environment using an aid in contact with an ice-cold object, which prevents the hand from coming into direct contact with the additional source of cold, a thinner glove with lower performance levels but better breathability can be the more appropriate. The thickness and stiffness of the glove can also limit the mobility of the fingers, which in turn increases the risk of frostbite. A lower performance level of the cold protection glove can therefore be appropriate.

If different materials and/or material structures are processed on the glove for the different areas of the fingers, palm, back of the hand, cuff, the procurer can find out from the manufacturer the degree of protection the processed material offers the individual hand areas relevant for his needs.

NOTE See the following pictogram used to indicate conformity with EN 511:



E.2 Sources of information

Important instructions for the use of protective gloves against cold can be found in the manufacturer's instructions and information supplied with the gloves. Additional and more detailed information can be obtained from the manufacturers.

E.3 Mechanical requirements

In addition to the thermal performance levels shown on the label under the graphical symbol, the tear and abrasion resistance of the material of the glove inner surface is also tested in accordance with ISO 23388 (see [A.3](#)). In both cases, the material or the material combination for the protection of the palm achieve at least the lowest performance level for tear and abrasion resistance for gloves with performance level 1 in convective and contact cold, and thus in any case offer little protection against tearing and abrasion. If performance level 2 is offered for convective cold and contact cold, at least performance level 2 for tear resistance and abrasion resistance is achieved.