International Standard

ISO 11999-4

Second edition
2024-08

PPE for firefighters — Test methods and requirements for PPE used by firefighters who are at risk of exposure to high levels of heat and/or flame while fighting fires occurring in structures —

Part 4:
Gloves

Reference number
ISO 11999-4:2024(en)

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Published in Switzerland

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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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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 protection — Protective clothing and equipment*, Subcommittee SC 14, *Firefighters' personal equipment*.

This second edition cancels and replaces the first edition (ISO 11999-4:2015), which has been technically revised.

The main changes are as follows:

— technical and editorial changes have been made throughout the document.

A list of all parts in the ISO 11999 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

PPE for firefighters — Test methods and requirements for PPE used by firefighters who are at risk of exposure to high levels of heat and/or flame while fighting fires occurring in structures —

Part 4: Gloves

1 Scope

This document specifies minimum design and performance requirements for gloves as part of personal protective equipment (PPE) to be used by firefighters, primarily, but not solely, to protect against exposure to flame and high thermal loads.

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 811, *Textiles — Determination of resistance to water penetration — Hydrostatic pressure test*

ISO 3146, *Plastics — Determination of melting behaviour (melting temperature or melting range) of semi-crystalline polymers by capillary tube and polarizing-microscope methods*

ISO 3175-1, *Textiles — Professional care, drycleaning and wetcleaning of fabrics and garments — Part 1: Assessment of performance after cleaning and finishing*

ISO 6330, *Textiles — Domestic washing and drying procedures for textile testing*

ISO 6942, *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 9151, *Protective clothing against heat and flame — Determination of heat transmission on exposure to flame*

ISO 11999-1, *PPE for firefighters — Test methods and requirements for PPE used by firefighters who are at risk of exposure to high levels of heat and/or flame while fighting fires occurring in structures — Part 1: General*

ISO 11999-2, *PPE for firefighters — Test methods and requirements for PPE used by firefighters who are at risk of exposure to high levels of heat and/or flame while fighting fires occurring in structures — Part 2: Compatibility*

ISO 12127-1, *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 12947-4, *Textiles — Determination of the abrasion resistance of fabrics by the Martindale method — Part 4: Assessment of appearance change*

ISO 13938-1, *Textiles — Bursting properties of fabrics — Part 1: Hydraulic method for determination of bursting strength and bursting distension*

ISO 13938-2, *Textiles — Bursting properties of fabrics — Part 2: Pneumatic method for determination of bursting strength and bursting distension*

ISO 13994, *Clothing for protection against liquid chemicals — Determination of the resistance of protective clothing materials to penetration by liquids under pressure*

ISO 13996, *Protective clothing — Mechanical properties — Determination of resistance to puncture*

ISO 13997, *Protective clothing — Mechanical properties — Determination of resistance to cutting by sharp objects*

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

ISO 16604, *Clothing for protection against contact with blood and body fluids — Determination of resistance of protective clothing materials to penetration by blood-borne pathogens — Test method using Phi-X 174 bacteriophage*

ISO 17493:2016, *Clothing and equipment for protection against heat — Test method for convective heat resistance using a hot air circulating oven*

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

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

EN 13087-1:2000, *Protective helmets — Test methods — Conditions and conditioning*

ASTM F2010/F2010M-10, *Standard test method for evaluation of Glove effects on wearer finger dexterity using a modified pegboard test*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11999-1 apply.

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/

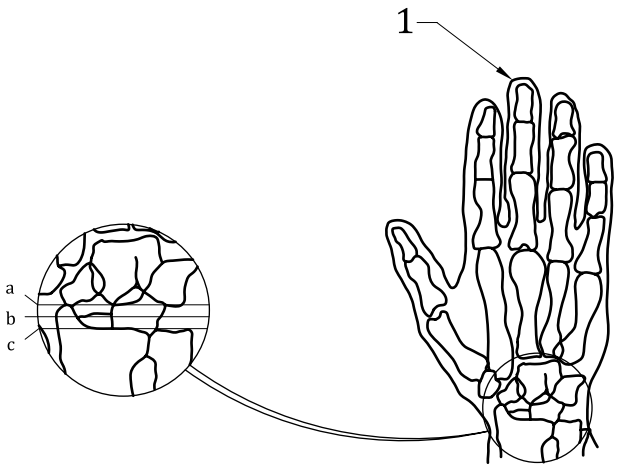
4 Glove design requirements

4.1 General

Gloves shall consist of a component assembly meeting the design and performance requirements of this document, ISO 21420 and ISO 11999-1. The component assembly shall be permitted to be configured as a continuous or joined single layer or as continuous or joined multiple layers. The component assembly shall be permitted to be different for the palm, back, and fingers.

4.2 Glove body length

The glove shall extend circumferentially beyond the wrist crease for not less than 25 mm. The location of the wrist crease shall be determined as shown in Figure 1.



Key

1 dactylion III

a Stylion.

b Wrist crease.

c Proximal edge of navicular.

Figure 1 — Anatomical landmarks at the base of the hand

4.3 Wristlet or cuff

Gloves can be provided with either a cuff or a wristlet or both. Where gloves are provided with a cuff or a wristlet, the sample glove body and the cuff or wristlet shall extend circumferentially for at least 50 mm beyond the wrist crease, taking into consideration the requirement specified in 4.2. Where gloves are not provided with a cuff or a wristlet, the sample glove shall extend circumferentially for at least 50 mm beyond the wrist crease, which is a 25 mm addition to the requirement in 4.2.

4.4 Glove sizing

Glove sizing shall be as required in 4.4.1 and 4.4.2.

4.4.1 Minimum sizing

Gloves shall be provided in a range of seven sizes based on cluster analysis to better cover the diverse range of hand sizes due to gender, race and age. The manufacturer shall indicate the range in hand circumference and hand length for wearers of each glove size as determined in 4.4.2 and in ISO 21420:2020, 6.1.

NOTE The intent of this requirement is to allow manufacturers to report information to the user that assists in their selection of the appropriate size. Standard sizes are not defined by this document. To better cover the diverse range of hand sizes due to gender, race and age. See Reference [1].

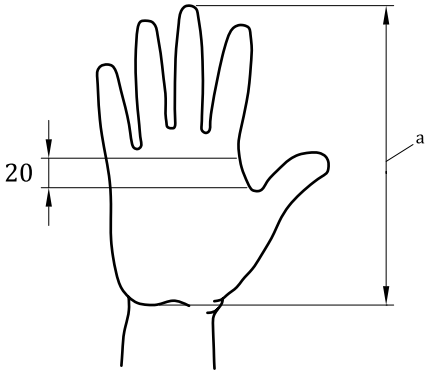
4.4.2 Hand dimensions

Hand dimensions for the selection of proper glove size shall consist of measuring two dimensions, namely hand circumference and hand length, as shown in Figure 2.

Hand circumference shall be measured by placing the measuring tape on a table or other flat surface with the numerals facing downward. The subject shall place the right hand, palm down and fingers together, in the middle of the tape so that the tape can pass straight across the knuckles (metacarpals). The circumference shall be measured to the nearest millimetre, 20 mm from the crotch between the thumb and the index finger, as shown in Figure 2.

Hand length shall be measured by placing the subject's hand, palm down, on a piece of paper with the fingers together and the hand and arm in a straight line. The thumb shall be fully abducted, extended away from the palm as far as possible. The paper shall be marked at the tip of the third, or middle, finger. A pencil mark shall be placed in the notch at the base of the thumb where the thumb joins the wrist. The straight-line distance between the two points shall be measured to the nearest millimetre, as shown in Figure 2.

Dimensions in millimetres



[a] Hand length.

Figure 2 — Method of measuring hand dimensions for the selection of proper gloves

4.4.3 Innocuousness

Gloves shall conform the innocuousness of protective gloves requirements specified in ISO 21420:2020, 4.2.

4.4.4 Other design requirements

Gloves shall be designed to be close fitting at the wrist to restrict the entry of embers or foreign particles through the glove openings.

5 Glove sampling, testing, and pretreatment

5.1 General

Sampling shall be as required in 5.2 and 5.3, testing as required in 5.4, and pretreatment as required in 5.5.

5.2 Sampling levels for testing

Unless otherwise specified, the number and size of specimens for the different tests shall be in accordance with the respective standards.

5.3 Sampling level for determining design compliance

Inspection for determining compliance with the design requirements specified in 4.2 to 4.4 shall be performed on whole gloves with all labels and accessories.

5.4 Testing

Testing for determining material and component conformity with the requirements specified in Clauses 6 to 9 shall be performed on samples representative of materials and components used in the actual construction of the protective glove. If suitably sized representative materials and components for the respective test method cannot be obtained, then samples from the glove shall be used as specified in the

performance requirement. The responsible testing laboratory organization shall be permitted to also use sample materials cut from representative protective gloves.

In all surface tests, the outermost surface shall be exposed.

In all tests involving measurements, the determination of compliance shall be based on the mean value unless otherwise specified.

The uncertainty of measurement for each test method described in this document shall be assessed and reported according to JCGM 100. One of the following approaches should be used:

— a statistical method, e.g. as given in ISO 5725-2;

— a mathematical method, e.g. as given in ISO/IEC Guide 98-1;

— Uncertainty and conformity assessment as given in ISO/IEC Guide 98-4;

— JCGM 100:2008.

5.5 Pre-treatments

Pre-treatments shall be as required in 5.5.1 to 5.5.3.

NOTE Pre-treatments are undertaken to provide uniformly treated materials for testing. Ageing, life expectancy, and washing instructions are not to be confused with the following pre-treatments.

5.5.1 Pre-treatment by laundering or dry cleaning

Pre-treatment by laundering or dry cleaning is undertaken to remove finishes and contaminants.

Test samples shall be subjected to five cleaning cycles (a cleaning cycle is one wash cycle and one drying cycle) in accordance with the procedures of ISO 6330 wash procedure 6 N (machine Type A and reference detergent 3 (ECE)) drying procedure F (machine Type A1) exhaust temperature normal (minimum 60 °C, maximum 80 °C) specified in the care labelling.

Materials that are labelled as "dry cleanable only" shall be dry cleaned five times in accordance with ISO 3175-1. After five cycles of washing/drying or dry cleaning, sample gloves shall be donned by a test subject and shall be flexed by making a tight fist 10 times during a 30 s period.

5.5.2 Dry conditioning

Unless otherwise specified in the specific test methods, all specimens shall be conditioned at (20 ± 2) °C and relative humidity of (65 ± 5) % for a minimum of 24 h prior to testing.

Sample gloves and sample specimens shall be tested within 5 min after removal from conditioning.

5.5.3 Wet conditioning

Sample gloves or sample specimens shall be conditioned by completely immersing the glove or the glove specimen in water at a temperature of (20 ± 2) °C for 2 min. Where gloves are used, the glove specimen shall be first filled with water prior to immersion.

Sample gloves, or the material assembly of the same construction, shall be removed from water and hung in a vertical position, gloves shall be hung with the fingers up, for 5 min, then laid horizontal between textile blotting paper both under and over the specimen, using an applied differential pressure of 3,5 kPa for a period of 20 min.

Sample gloves or sample specimens shall be tested within 5 min of conditioning.

6 Glove performance requirements

Gloves, when tested according to the requirements listed in Table 1, the minimum performance requirements shall be met, for all tests.

Table 1 — Glove performance requirements

Performance category	Performance requirement
a) Thermal	7.2 Flame resistant Required
	7.3 Heat transfer (flame exposure), s $HTI_{24} \geq 15$ and $HTI_{24} - HTI_{12} \geq 4$
	7.4 Heat transfer (radiant exposure), s $RHTI_{24} \geq 22$ and $RHTI_{24} - RHTI_{12} \geq 6$ TF ≤ 60 %
	7.5 Heat transfer (conductive exposure), s $t_t \geq 14$
	7.6 Heat resistance, °C ≤260 °C, ≤5 % shrinkage
	7.7 Thread heat resistance, °C ≤260
b) Mechanical	8.1 Abrasion resistance, rubs ≥6 000 palm ≥3 000 Back of hand
	8.2 Cut resistance, N ≥5 – Glove body ≥7 – Cuff or wristlet
	8.3 Tear resistance, N ≥50
	8.4 Bursting strength, kPa ≥200
	8.5 Puncture resistance, N ≥120
c) Barrier	9.1 Water penetration resistance No appearance of water drops
	9.2 Liquid penetration resistance, min No penetration, >60
	9.3 Liquid penetration resistance (runoff method) 80 % run off and no penetration
	9.4 Whole glove integrity No leakage
	9.5 Viral penetration resistance No penetration
d) Ergonomic	10.1 Dexterity ≥Level 4
	10.2 Grip ≥80 % of bare-hand control

Table 1 *(continued)*

Performance category	Performance requirement
	10.3 Linear inversion No inversion
	10.4 Dry hand donning and doffing time, s ≤10
	10.4 Wet hand donning and doffing time, s ≤20

7 Glove thermal performance requirements

7.1 General

The thermal requirements for firefighter gloves shall be as required in 7.2 to 7.7.

7.2 Flame resistance

The glove component assembly, when tested in accordance with ISO 15025 Procedure A for surface ignition, after dry conditioning according to 5.5.2 and after laundering/dry-cleaning pre-treatment according to 5.5.1 and 5.5.2 dry conditioning, shall meet the following requirements:

a) No specimen shall exhibit hole formation in any layer.

b) No specimen shall produce flaming or molten debris.

c) The mean value of afterflame time shall be ≤2 s.

d) The mean value of afterglow time shall be ≤2 s.

If suitably sized representative materials cannot be obtained, then the whole glove shall be used for testing. The flame shall be contacted on the glove at the palm side, back side, and fingertips. If the glove component assembly incorporates wristlet material, this material shall be tested separately, applying the flame to the outer surface of the wristlet material.

If the glove component assembly incorporates seams, specimens of the assembly containing seams shall be tested separately by applying the flame to the seam portion of the component assembly with the seam oriented vertically. Seams shall not separate.

For testing finger tips, use the test method in ISO 15025, procedure A, surface ignition, with the following modifications:

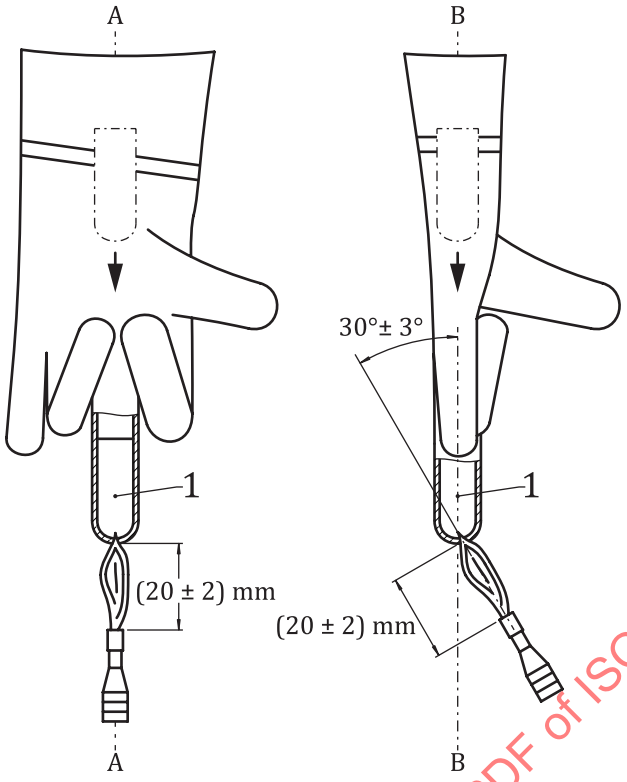
— The gloves shall be mounted in a vertical position so that the longest finger of the glove hangs down lowest. A metallic rod simulating a finger shall be inserted to ensure that the material is in contact to the flame and limits the retraction of the material for the duration of the test. The rod shall be rigid. Material and dimensions shall have no influence on the test. See Figure 3.

— The burner is positioned below the glove so that it is in the plane normal to the palm of the hand and including the longest finger of the glove, plane A. Plane A is perpendicular to the plane of the palm of the glove, plane B.

— The burner is mounted at an angle of (30 ± 3)° to plane B, with the tip of the flame contacting the lowest point of the glove or finger.

— The vertical distance between the top of the burner and the lowest point of the glove or finger shall be (20 ± 2) mm.

Performance shall be determined using the worst performance from all areas of the glove that are tested.



Key

1 longest finger of the glove

A plane A

B plane B

Figure 3 — Position of the glove relative to the burner for testing fingers

7.3 Heat transfer (flame exposure)

The glove component assembly, or material assembly of the same construction but of sufficient size for testing, when tested in accordance with ISO 9151, shall meet the performance requirements in Table 2. Testing shall be performed on the glove component assembly after the following pre-treatments:

a) after 5.5.2 dry conditioning;

b) after the pre-treatment specified in 5.5.1, followed by 5.5.2 dry conditioning.

Table 2 — Classification of heat transfer (flame exposure)

Performance		Requirement (s)
Heat transfer index	HTI_{24}	≥15
	$HTI_{24} - HTI_{12}$	≥4

Where a multi-layered glove is tested, the samples shall be from all the materials/components of the glove. Where made of different materials, the palm, back side, thumb, fingers, finger gussets and fingertips of the glove shall be tested. The performance of the glove shall be determined using the lowest mean result for each part.

7.4 Heat transfer (radiant exposure)

The glove component assembly, or material assembly of the same construction but of sufficient size for testing, when tested in accordance with ISO 6942, Method B at a heat flux density of 40 kW/m^2, shall meet

the performance requirements in Table 3 and shall have a mean transmission factor, ≤60 %. Testing shall be performed on the glove component assembly after the following pre-treatments:

a) after 5.5.2 dry conditioning;

b) after the pre-treatment specified in 5.5.1, followed by 5.5.2 dry conditioning.

Table 3 — Classification of heat transfer (radiant exposure)

Performance		Requirement
Radiant heat transfer index	$RHTI_{24}$	≥22 s
	$RHTI_{24} - RHTI_{12}$	≥6 s
	TF	≤60 %

Where a multi-layered glove is tested, the samples shall be from all the materials/components of the glove. Where made of different materials, the palm, back side, thumb, fingers, finger gussets and fingertips of the glove shall be tested. The performance of the glove shall be determined using the lowest mean result for each part.

7.5 Heat transfer (conductive exposure)

The glove component assembly, or material assembly of the same construction of sufficient size for testing, when tested in accordance with ISO 12127-1 at a contact temperature of $(260\ ^{+5}_{-0})$ °C shall have a threshold time, t_t, of ≥14 s after the following conditions:

a) after 5.5.2 dry conditioning;

b) after 5.5.1 pre-treatment followed by 5.5.2 dry conditioning;

c) after 5.5.1 pre-treatment followed by 5.5.3 wet conditioning.

Where a multi-layered glove is tested, the samples shall be from all the materials/components of the glove. Where made of different materials, the palm, back side, thumb, fingers, finger gussets and fingertips of the glove shall be tested. The performance of the glove shall be determined using the lowest mean result for each part.

7.6 Heat resistance

Glove specimens shall be tested in accordance with ISO 17493 at $(260\ ^{+8}_{-0})$ °C before and after the pre-treatment specified in 5.5.1 followed by 5.5.2 dry conditioning. Complete gloves shall be tested in accordance with ISO 17493:2016, 8.2 with glass beads.

Complete gloves shall not melt, separate, or ignite, and shall not shrink in length or width more than 5 %.

Specimens of the innermost lining of the glove body component assembly, in contact with the wearer's skin, shall be tested separately and shall not melt, separate, ignite or shrink more than 5 %.

Where a multi-layered glove is tested, the samples shall be from all the materials/components of the glove. Where made of different materials, the palm, back side, thumb, fingers, finger gussets and fingertips of the glove shall be tested. The performance of the glove shall be determined using the lowest mean result for each part.

NOTE 5 % shrinkage has been selected due to sizing (shrinkage in excess of 5 % will adversely affect circulation to the fingers).

7.7 Thread heat resistance

All thread used in the construction of the protective glove, when tested in accordance with ISO 3146 Method B at a temperature of $(260\ ^{+5}_{-0})$ °C, shall not ignite, melt or char.

8 Glove mechanical performance requirements

8.1 Abrasion resistance

Specimens of sufficient size for testing of the outer material of the glove body component assembly, when tested in accordance with ISO 12947-4 with abradant specified in ISO 23388:2018, 6.4, pressure of 9 kPa after dry conditioning, see 5.5.2, shall meet the performance requirements in Table 4.

Table 4 — Classification of abrasion resistance

Performance	Requirement	
	Palm	Remainder of body of the glove
Wear through rubs (I.e. no hole)	≥6 000 rubs	≥3 000 rubs

Where a multi-layered glove is tested, the samples shall be from all the materials/components of the glove. Where made of different materials, the palm, back side, thumb, fingers, finger gussets and fingertips of the glove shall be tested. The performance of the glove shall be determined using the lowest mean result for each part.

Dimensions of specimen and auxiliary materials shall be as follows:

a) Dimensions of abradant:

The diameter of the abradant shall be $(38\ ^{+5}_{-0})$ mm.

b) Dimensions of the test specimen felt substrate:

The diameter of the test specimen felt substrate shall be $(140\ ^{+5}_{-0})$ mm.

c) Dimensions of the abradant foam backing:

The diameter of the foam backing shall be $(38\ ^{+5}_{-0})$ mm.

An abrasion cycle is a completion of all the translational abrasion movements tracing a Lissajous figure comprising 16 rubs, i.e. 16 revolutions of the two outer drives and 15 revolutions of the inner drive of the Martindale abrasion tester.

8.2 Cut resistance

Specimens of the glove body component assembly, or material assembly of the same construction but of sufficient size for testing, from the palm, back sides, and fingertips, when tested in accordance with ISO 13997, shall meet a performance requirement of ≥5 N. Testing shall be performed on the glove body assembly after the following conditions:

a) after 5.5.2 dry conditioning;

b) after 5.5.1 pre-treatment followed by 5.5.3 wet conditioning.

Where a multi-layered glove is tested, the samples shall be from all the materials/components of the glove. Where made of different materials, the palm, back side, thumb, fingers, finger gussets and fingertips of the glove shall be tested. The performance of the glove shall be determined using the lowest mean result for each part.

Where cuffs or wristlets are provided, specimens of the glove cuff or glove wristlet component assembly shall be separately tested and achieve a cut force of ≥7 N.

8.3 Tear resistance

Specimens of sufficient size for testing of the outer woven material of the glove body component assembly, when tested in accordance with ISO 23388:2018, 6.4, after 5.5.2 dry conditioning, shall meet a performance requirement of ≥50 N.

Where a multi-layered glove is tested, the samples shall be from all the materials/components of the glove. Where made of different materials, the palm, back side, thumb, fingers, finger gussets and fingertips of the glove shall be tested. The performance of the glove shall be determined using the lowest mean result for each part.

8.4 Burst strength

As per ISO 13938-1 or ISO 13938-2 for knitted materials where a hydraulic/pneumatic pressure is applied at a rate not greater than 100 cm^3/min until failure, the burst pressure after 5.5.2 dry conditioning, shall meet a performance requirement of ≥200 kPa.

Test Area shall be 7,3 cm^2

Where a multi-layered glove is tested, the samples shall be from all the materials/components of the glove. Where made of different materials, the palm, back side, thumb, fingers, finger gussets and fingertips of the glove shall be tested. The performance of the glove shall be determined using the lowest mean result for each part.

8.5 Puncture resistance

Specimens of sufficient size for testing of the glove body component assembly, when tested in accordance with ISO 13996 after 5.5.2 dry conditioning and 5.5.3 wet conditioning, shall meet a performance requirements of ≥120 N.

Where a multi-layered glove is tested, the samples shall be from all the materials/components of the glove. Where made of different materials, the palm, back side, thumb, fingers, finger gussets and fingertips of the glove shall be tested. The performance of the glove shall be determined using the lowest mean result for each part.

9 Glove moisture barrier performance

9.1 Water penetration resistance

Specimens of the glove moisture barrier component and its seams, shall be tested in accordance with ISO 811 at 20 kPa for a period of 5 min after the pretreatment specified in 5.5.1 and 5.5.2 dry conditioning, and shall allow no appearance of water drops.

9.2 Liquid penetration resistance

Specimens of the glove moisture barrier component and its seams, when tested in accordance with ISO 13994 using procedure C1 after the pre-treatment specified in 5.5.1 and 5.5.2 dry conditioning, shall meet a performance requirement of >60 min with no penetration for the following liquids:

a) 40 % sodium hydroxide (NaOH) at (20 ± 2) °C;

b) 36 % hydrochloric acid (HCl) at (20 ± 2) °C;

c) 37 % sulfuric acid (H_2SO_4) at (20 ± 2) °C;

d) 100 % o-xylene at (20 ± 2) °C.

9.3 Liquid penetration resistance (runoff method)

Specimens of the glove moisture barrier component and its seams, after the pre-treatment specified in 5.5.1 and 5.5.2 dry conditioning shall meet a performance requirement of >80 % and have no penetration to the innermost surface, when tested in accordance with ISO 6530 using:

a) 40 % sodium hydroxide (NaOH) at (20 ± 2) °C;

b) 36 % hydrochloric acid (HCl) at (20 ± 2) °C;

c) 37 % sulfuric acid (H_2SO_4) at (20 ± 2) °C;

d) 100 % o-xylene at (20 ± 2) °C.

All tests shall be carried out with a pouring time of (10 ± 1) s and at a temperature of (20 ± 2) °C.

9.4 Whole glove integrity

Specimen gloves, when tested in accordance with 11.1, after the pre-treatment specified in 5.5.1 and 5.5.2 dry conditioning, shall meet a performance requirement of no leakage.

9.5 Viral penetration resistance

Specimens of the glove moisture barrier component seams, when tested in accordance with ISO 16604 Procedure A, after the pre-treatment specified in 5.5.1 and 5.5.2 dry conditioning, shall meet a performance requirement of ≥60 min with no leakage.

10 Glove ergonomic performance requirements

10.1 Dexterity

Specimen gloves, when tested for dexterity in accordance with ISO 21420:2020, 6.2, after the pre-treatment specified in 5.5.1 and 5.5.2 dry conditioning, shall meet a performance requirements of ≥level 4.

10.2 Dexterity

After the pre-treatment specified in 5.5.1 and 5.5.2 dry conditioning, gloves shall be tested for dexterity in accordance with ASTM F2010/F2010M-10.

NOTE Although this requirement is only a report, purchasers can find this reporting useful for comparison purposes.

10.3 Grip

Specimen gloves, when tested according to 11.2, shall meet a mass-pulling capacity performance requirement of ≥80 %.

10.4 Liner inversion

Specimen gloves, when tested according to 11.3, shall have no part of the liner invert when the hand is withdrawn from the glove.

10.5 Ease of donning and doffing

Gloves tested according to 11.4 shall have an average donning and doffing time that meets the performance requirement specified in Table 5. Gloves shall also allow the test to be completed, having no detachment of the inner liner or moisture barrier, and allowing full insertion of all digits.

Table 5 — Classification of donning and doffing

Performance	Requirement	
	Dry glove	Wet glove
Dry hand (s)	≤10 s	≤10 s
Wet hand (s)	≤20 s	≤20 s

11 Glove test methods

11.1 Whole glove integrity test

11.1.1 Principle

Test subjects wearing gloves over a water-markable inner glove, partially immerse their hands in a container of water and flex their hands. The inner glove is then examined for water marks.

11.1.2 Equipment

A water-markable glove shall cover all areas of the tester's hand. The water-markable glove shall be constructed of a fabric which is easily water marked to determine leakage. An example of a water-markable glove material is 100 % cotton with a mass of 50 g/m^2 ± 10 g/m^2 and a thickness of 0,5 mm ± 0,1 mm.

Water used for integrity testing shall be treated with a non-foaming surfactant to lower its surface tension to less than (0,034 ± 0,005) N/m.

11.1.3 Specimens

A minimum of three glove pairs, each of smallest, medium, and largest sizes within the manufacturer's range, shall be used for testing by at least two different test subjects.

11.1.4 Procedure

11.1.4.1 Test subjects shall be selected such that their hand dimensions are as close as possible to the middle of the range for hand length and hand circumference for small and large gloves.

11.1.4.2 The test subject shall don the glove specimen over a water-markable glove.

11.1.4.3 The test subject shall immerse the glove specimen in (20 ± 3) °C water to within 25 mm of the top of the body of the glove specimen for 5 min. The test subject shall flex the glove specimen in a fist-clenching motion every 10 s.

11.1.4.4 The test subject shall remove the glove specimen.

11.1.4.5 The inner glove shall be inspected for water marks.

11.1.5 Report

The appearance of water marks on the inner glove after testing shall be reported for all specimens. The appearance of water marks on the inner glove after testing any glove shall be considered leakage and shall constitute failing performance.

11.2 Grip test

11.2.1 Principle

The bare-handed lifting capacity of a test subject using a dry halyard and a force measuring device is compared with the same test subject wearing wet gloves on a dry and wet halyard.

11.2.2 Equipment

Grip testing shall be conducted with a 9,5-mm-diameter, three-strand, prestretched polyester rope attached to a calibrated force measuring device.

11.2.3 Specimens

A minimum of three glove pairs, each of smallest, medium, and largest sizes within the manufacturer's range shall be used for testing by at least two different test subjects. Each glove pair as a complete set of gloves shall be tested in new, as distributed, condition. Each trial shall be performed with a separate glove pair. The laboratory shall ensure that glove pair specimens do not receive special softening treatments prior to tests. Glove specimens shall be tested after 5.5.2 dry conditioning and 5.5.3 wet conditioning.

11.2.4 Procedure

11.2.4.1 Test subjects shall be selected such that their hand dimensions are as close as possible to the middle of the range for hand length and hand circumference for small and large gloves.

11.2.4.2 Each test subject shall make three successive attempts to lift as much weight using the dry halyard as possible, using both hands and keeping both feet firmly planted on the ground while pulling downward on the halyard. The halyard shall be held straight through the clenched fist in the anatomically neutral position without twisting the halyard around the hand or arm. The technique for pulling shall be the same for all trials. The average mass hoisted over the three trials shall be the bare-handed mass-lift capability.

11.2.4.3 Dry-conditioned specimen gloves shall be tested on a dry rope (see 11.2.4.7.1) and then on a wet rope (see 11.2.4.7.2).

11.2.4.4 Wet-conditioned specimen gloves shall be tested on a dry rope(see 11.2.4.7.1) and then on a wet rope (see 11.2.4.7.2).

11.2.4.5 Each test subject shall be evaluated with a minimum of three pairs of gloves. Test subjects shall attempt one trial with each pair of gloves for a minimum of six grip tests for each set of conditions, with at least three grip tests with small-sized gloves and three grip tests with large-sized gloves.

11.2.4.6 The mass-pulling capacity of test subjects with gloves shall be compared with the bare-handed mass-lift capability. The percentage of mass-pulling capacity with gloves to bare-handed mass-lift capability shall be calculated using Formula (1):

$$C = \frac{m}{B} \times 100 \quad (1)$$

where

C is the bare-handed lifting capacity (%)

m is the mass of the pulling capacity with gloves (kg)

B is the bare-handed mass-lift capability (kg)