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Wildland firefighting personal protective equipment — Requirements and test methods

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National foreword

This British Standard is the UK implementation of ISO 16073:2011.

The UK participation in its preparation was entrusted to Technical Committee PH/14, Firefighters' personal protective equipment.

A list of organizations represented on this committee can be obtained on request to its secretary.

National Annex NA (informative) provides additional information on BS ISO 16073:2011.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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INTERNATIONAL STANDARD

ISO 16073

First edition
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Wildland firefighting personal protective equipment — Requirements and test methods

Équipement de protection individuelle pour la lutte contre les feux d'espaces naturels — Exigences et méthodes d'essai

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 16073 was prepared by Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 14, *Fire-fighters' personal equipment*.

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Introduction

This International Standard provides minimum performance requirements for wildland firefighters' personal protective equipment (PPE) designed for use for extended periods during wildland firefighting.

Wildland firefighting involves work carried out mostly in summer temperatures and for many hours, during which the firefighter can develop high levels of metabolic heat. As a consequence, the PPE is required to be light, flexible and commensurate with the risks to which the firefighter can be exposed in order to be effective without introducing excessive heat stress to the wearer.

It is very important to train firefighters in the selection, use, care and maintenance of the PPE covered by this International Standard, including an understanding of its limitations.

Nothing in this International Standard is intended to restrict any jurisdiction, purchaser or manufacturer from exceeding these acceptable performance requirements.

A number of Member bodies have raised issues regarding harmonization of test methods for different items of PPE, e.g. radiant heat tests on footwear and apparel. This has been extensively discussed, but requires considerable testing and validation before it can be addressed in this International Standard. Technical Committee ISO/TC 94/SC 14 has agreed that this will be a priority for the next revision. Similarly, the issue of testing of complete assemblies of PPE has been only slightly addressed and will be further explored in the next revision.

It is intended that a risk assessment be undertaken to determine if the PPE covered by this International Standard is suitable for its intended use and the expected exposure. It is intended that the risk assessment be used to determine what types of PPE are necessary for head, face, hands, body and feet.

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Wildland firefighting personal protective equipment — Requirements and test methods

1 Scope

This International Standard specifies the minimum performance requirements and methods of test for personal protective equipment (PPE) covering the torso, neck, arms, hands, legs, feet, head, eyes and hearing for wildland firefighting.

This International Standard covers the general design of the PPE, the minimum levels of performance for the materials employed and the methods of test used. This PPE is not intended to provide protection during fire entrapment.

This International Standard does not cover PPE for structural firefighting (see ISO 11613), for use against chemical, biological, radiological and nuclear hazards, or for use where a reflective outer surface is required (see ISO 15538).

Activities in support of wildland firefighting, such as the cutting of trees and the use of a chainsaw can require additional protection to that provided in this International Standard. Users are directed to those relevant standards for the requirements associated with such protection.

NOTE Performance requirements for respiratory protective devices (RPD) for wildland firefighting are not available at the time of publication. An International Standard for RPD is under development.

2 Normative references

The following referenced documents are indispensable for the application 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 139, *Textiles — Standard atmospheres for conditioning and testing*

ISO 3071, *Textiles — Determination of pH of aqueous extract*

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 4045, *Leather — Chemical tests — Determination of pH*

ISO 4674-1, *Rubber- or plastics-coated fabrics — Determination of tear resistance — Part 1: Constant rate of tear methods*

ISO 5077, *Textiles — Determination of dimensional change in washing and drying*

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

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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 11092, *Textiles — Physiological effects — Measurement of thermal and water-vapour resistance under steady-state conditions (sweating guarded-hotplate test)*

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

ISO 12947-2, *Textiles — Determination of abrasion resistance of fabrics by the Martindale method — Part 2: Determination of specimen breakdown*

ISO 13506, *Protective clothing against heat and flame — Test method for complete garments — Prediction of burn injury using an instrumented manikin*

ISO 13688, *Protective clothing — General requirements*

ISO 13934-1, *Textiles — Tensile properties of fabrics — Part 1: Determination of maximum force and elongation at maximum force using the strip method*

ISO 13935-2, *Textiles — Seam tensile properties of fabrics and made-up textile articles — Part 2: Determination of maximum force to seam rupture using the grab method*

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

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 15025:2000, *Protective clothing — Protection against heat and flame — Method of test for limited flame spread*

ISO 17075, *Leather — Chemical tests — Determination of chromium(VI) content*

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

EN 167:2001, *Personal eye-protection — Optical test methods*

EN 168:2001, *Personal eye-protection — Non-optical test methods*

EN 170, *Personal eye-protection — Ultraviolet filters — Transmittance requirements and recommended use*

EN 172, *Personal eye protection — Sunglare filters for industrial use*

EN 388:2003, *Protective gloves against mechanical risks*

EN 420:2003 + A1:2009, *Protective gloves — General requirements and test methods*

EN 471:2003 + A1:2007, *High-visibility warning clothing for professional use — Test methods and requirements*

EN 13087-1:2000 + A1:2001, *Protective helmets — Test methods — Part 1: Conditions and conditioning*

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EN 13819-1:2002, *Hearing protectors — Testing — Part 1: Physical test methods*

EN 13819-2:2002, *Hearing protectors — Testing — Part 2: Acoustic test methods*

EN 15090, *Footwear for firefighters*

ASTM F 1868-02, *Standard Test Method for Thermal and Evaporative Resistance of Clothing Materials Using a Sweating Hot Plate*

CIE 54.2, *Retroreflexion — Definition and measurement*

NFPA 1977, *Standard on Protective Clothing and Equipment for Wildland Fire Fighting*

3 Terms and definitions

For the purpose of this document, the following terms and definitions apply.

3.1
behind-the-head headband earplug
earplug designed to be worn with the headband passing behind the head

3.2
behind-the-head earmuff
earmuff designed to be worn with the headband passing behind the head

3.3
brim
⟨helmet⟩ ridge protruding outwards from the basic shape of the shell, forming the lower edge of the shell and including its associated fairings and radiusing

3.4
char
brittle residue that results when material is exposed to thermal energy

3.5
cleaning cycle
washing and drying cycle or a dry cleaning cycle

3.6
closure system
method of fastening the openings in the garment including combinations of more than one method of achieving a secure closure

NOTE This term does not cover seams.

3.7
clothing assembly
garments designed to always be worn together

NOTE If several garments are used to achieve the performance levels, they are clearly labelled to this effect.

3.8
component assembly
combination of all materials of a multilayer item presented exactly as the finished item's construction

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3.9
coverall
overall
one-piece garment that completely covers the wearer's torso, arms and legs

3.10
cuff
⟨garment⟩ finished edge of the sleeve opening

3.11
cuff
⟨glove⟩ circular, flared or otherwise expanded part of the glove that extends beyond the opening of the glove body to cover the wrist area

3.12
cup
hollow component that is mounted on the headband of a hearing protector and to which a cushion and a liner are usually fitted

3.13
cushion
deformable component, usually containing a foam plastic or fluid filling, fitted to the rim of the cup to improve the comfort and fit of the earmuffs on the head

3.14
drip, verb
to run or fall in drops or blobs

3.15
dripping, noun
softening with material movement and consequent detachment

3.16
ear flap
part or accessory of the helmet which protects at least the ears of the wearer

3.17
earmuff
hearing protector consisting of a cup that is pressed against each pinna or of a circumaural cup that is pressed against the head around each pinna

NOTE The cups can be pressed against the head with a headband or by means of a device attached to a helmet or other equipment.

3.18
earplug
hearing protector worn within each of the external ear canals (aural) or in the concha, against the entrance to each of the external ear canals (semi-aural)

3.19
facial opening
opening in the front of the fire hood interfacing with the eye protectors/respiratory protective device facemask

3.20
firefighter's protective clothing
specific garments providing protection for the firefighter's torso, neck, arms and legs, but excluding the head, hands and feet

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3.21
firefighter's protective glove
specific gloves for protection of the firefighter's hands and wrists

3.22
fire hood
item worn directly in contact with the head to protect exposed parts of the head and neck not covered by other PPE

3.23
fluorescence
process by which radiant flux of certain wavelengths is absorbed and reradiated non-thermally in other, usually longer, wavelengths

3.24
garment
single item of clothing which may consist of single or multiple layers

3.25
glove body
part of the glove that extends from the tip of the fingers to 25 mm beyond the wrist crease

3.26
hardware
non-fabric items used in protective clothing, including those made of metal or plastics

EXAMPLE Fasteners, rank markings, buttons and zippers.

3.27
harness
complete assembly by means of which the helmet is maintained in position on the head, and which may provide a means of absorbing energy

3.28
headband
⟨helmet⟩ part of the harness surrounding the head

3.29
headband
⟨earmuffs⟩ band, usually of metal or plastics, designed to enable the earmuffs to fit securely around the ears by exerting force against the cups and pressure through the cushions

3.30
headband
⟨earplugs⟩ band, usually of metal or plastics, designed to enable the earplug (disposable or re-usable) to be held within (aural) or against (semi-aural) the entrance to the external ear canals by exerting force against the earplug elements

3.31
headband
⟨eye protection⟩ part of the eye protector that is fitted around a head to hold the eye protector in position

3.32
headform
shape replacing the head for testing

NOTE 1 The headform used for testing helmets is designed according to EN 960.

NOTE 2 The headform used for testing eye protection is designed according to EN 168.

NOTE 3 The headform used for testing hearing protection is designed according to EN 13819 (all parts).

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3.33
headstrap
⟨earmuffs⟩ flexible strap fitted to each cup or to the headband close to the cup

NOTE The headstrap is designed to support behind-the-head and under-the-chin earmuffs by passing over, and resting on top of, the head.

3.34
helmet accessory
additional device approved by the manufacturer, which may be attached to the helmet and which is intended to be removable by the user, but which provides no protection to the wearer

EXAMPLE Lamp bracket and cable clip.

3.35
helmet for wildland firefighting
headgear intended to ensure protection of the wearer's head (and optionally the wearer's neck) against hazards that might occur during operations of wildland firefighting

NOTE Hereinafter, the helmet for wildland firefighting is referred to as “helmet”.

3.36
helmet shell
component in hard material with smooth finish, which gives the helmet its general shape and on which may be fixed various accessories

3.37
high visibility material
trim
retroreflective, fluorescent or combination retroreflective and fluorescent material attached to the outer material for visibility enhancement

NOTE Retroreflective materials enhance night-time visibility and fluorescent materials improve daytime visibility.

3.38
horizontal clearance
horizontal distance between the headband and the inside of the shell or any protruding part of the inside of the shell

3.39
innermost lining
lining on the innermost face of a component assembly of a garment closest to the wearer's skin

NOTE Where the innermost lining forms part of a material combination, the material combination is regarded as the innermost lining.

3.40
insertion loss
mean algebraic difference in decibels between the one-third octave band sound pressure level, measured by the microphone of the acoustic test fixture in a specified sound field under specified conditions, with the hearing protector absent, and the sound pressure level with the hearing protector on, with other conditions identical

3.41
interface area
area where items of PPE meet or overlap

EXAMPLE The protective coat/helmet/eyewear/respiratory protective device face piece area, the protective coat/glove area and the protective trouser/footwear area.

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3.42
interface component
item(s) designed to provide limited protection to interface areas

EXAMPLE Fire hood and protective wristlets.

3.43
interlining
layer between the outermost layer and the innermost lining in a multilayer garment

3.44
liner
acoustically absorptive material contained within the cup, intended to increase the attenuation of the earmuffs at certain frequencies

3.45
lining
innermost layer of a component assembly

3.46
main seam
seam that is necessary to maintain the integrity of the item

3.47
material combination
material produced from a series of separate layers, intimately combined prior to the item's manufacturing stage

EXAMPLE A quilted material.

3.48
means of fixing
means by which the ocular of the visor is supported and interfaced with the designated helmet(s)

NOTE This means can be an integral part of the helmet, fixed permanently or temporarily to it, or worn separately, but at the same time as the helmet.

3.49
melt, verb
to liquefy a material, usually by exposure to heat resulting in a non-reversible change

NOTE For the purposes of this International Standard, melting is observed as the response to heat as evidenced by flowing or dripping.

3.50
mesh
woven or perforated, metal mesh; moulded, woven or perforated plastic mesh

3.51
mesh face screen
mesh-type eye protector with mesh face protection that can be worn with a support, directly on the head or in conjunction with a helmet

See Clause 8.

3.52
mesh face screen with additional or alternative ocular(s)
mesh face screen incorporating one or two additional or alternative protective oculars

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3.53
mesh goggle
eye protector with mesh ocular(s), which tightly encloses the orbital area and sits on the face

NOTE Mesh goggles are usually held in position by a headband.

3.54
mesh spectacle
eye protector with mesh oculars mounted in a spectacle-type frame with or without side shield

NOTE Mesh spectacles are usually held in place by temples.

3.55
mesh-type eye protector
mesh spectacles, mesh goggles, mesh face screens or mesh face screens with one or two oculars

3.56
mesh-type eye protector resistant to high-speed particles
mesh-type eye protector that is able to withstand the impact of high-speed particles

NOTE Such a mesh-type eye protector can be used in applications where there exists a risk of impact by high-speed particles together with the need for good ventilation.

3.57
mesh visor
part of a mesh face screen covering the eye area and all or parts of the face, which can be removed from the frame or housing and be replaced

3.58
ocular area
part of a mesh-type eye protector other than the frame, which permits vision

3.59
ocular
generic term for the light-transmitting part of an eye-protector (made of mesh, mineral or organic material) permitting vision

EXAMPLE Lens, visor and screen.

3.60
ocular additional
ocular used in front of or behind the mesh ocular area to provide supplementary protection

3.61
ocular alternative
ocular replacing the mesh ocular area to provide specific protection

3.62
outer material
outermost material of which the protective clothing is made

3.63
over-the-head earmuff
earmuff designed to be worn with the headband passing over the top of the head

3.64
over-the-head headband earplug
earplug designed to be worn with the headband passing over the top of the head

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3.65
peak
permanent extension of the shell of a helmet above the eyes

3.66
protective coverall
protective garment designed and configured to provide protection to the neck, torso, arms and legs, excluding the head, hands and feet

3.67
protective garment
single item of clothing consisting of single or multiple layers

EXAMPLE Protective coat, protective trousers or protective coverall.

3.68
protective hood
interface component that provides limited protection to the head

See 3.34 and Clause 10.

3.69
protective trousers
trousers that provide protection to the lower torso and legs, excluding the feet

3.70
protective wristlet
interface component that provides limited protection to the protective garment/glove interface area

3.71
retention system
assembly responsible for securing the helmet in position on the head, including items which enable adjustment or improved comfort

3.72
retroreflection
reflection of light in which the reflected rays are preferentially returned in the direction close to the opposite of the direction of the incident rays, with this property being maintained over wide variations of the direction of the incident rays

3.73
seam
any method of permanent joining of two or more pieces of textile material

3.74
shell
helmet shell component in hard material with smooth finish, which gives the helmet its general shape and on which may be fixed various accessories

See 3.36.

3.75
sound attenuation
for a given test signal, the mean difference in decibels between the threshold of hearing, with and without the hearing protector in place, for a panel of test subjects

3.76
suit
upper and lower garment worn together that completely cover the wearer's torso, arms and legs

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3.77
turn-up
turned-up finished edge at the end of the trouser leg

3.78
under-the-chin headband earplug
earplug designed to be worn with the headband passing under the chin

3.79
under-the-chin earmuff
earmuff designed to be worn with the headband passing under the chin

3.80
universal headband earplug
earplug designed to be worn as an over-the-head, a behind-the-head and an under-the-chin earplug

3.81
universal earmuff
earmuff designed to be worn as an over-the-head, a behind-the-head and an under-the-chin earmuff

3.82
ventilation holes
holes provided in the shell to permit circulation of air inside the helmet

3.83
vertical clearance
vertical distance between the top of the headform and the inside of the shell

3.84
visual centre
point on the ocular corresponding to the intersection of the horizontal and vertical planes through the pupil of the appropriate headform

3.85
wearing height
vertical distance from the lower edge of the headband to the highest point of the head or headform

3.86
wildland firefighting
suppressive action involving a fire in vegetative fuels, such as forest, crops, plantations, grass or farmland

3.87
wristlet
circular, close-fitting part of the glove or coat, usually made of knitted material, which extends beyond the opening of the glove body or coat sleeves

NOTE This can be contained within a cuff.

3.88
yoke
area of the fire hood interfacing with the coat

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4 Clothing

4.1 General information

4.1.1 Basic requirements

Firefighters' protective clothing shall consist of

— a coverall,

— a two-piece suit provided with an interface area, or

— a clothing assembly.

If several garments of a clothing assembly are used to achieve a particular performance level, these shall be clearly labelled to this effect.

Sizing is important to the wearer, as garments should be loose fitting, and manufacturers should consult ISO 13688 or national sizing standards for sizing for further information. Additional work is being undertaken by Technical Committee ISO/TC 94/SC 14 to further define the concept “loose fitting” (see Annex B) and sizing.

4.1.2 Collar

Any collar shall be able to remain in the vertical position when it is set upright. All protective clothing which encircles the neck shall have a closure system at the level of the line of the collar.

4.1.3 Cuff overlap

The coverall or suit shall not have turn-ups or cuffs that can catch debris or burning embers.

4.1.4 Pockets

Pockets with external openings shall be constructed entirely from the outer material and the external opening shall be provided with a closure system or covered with a protective flap. The flap shall be designed such that it cannot be tucked into the pocket.

4.1.5 Hardware

Hardware penetrating the outer material shall not be exposed on the innermost surface of the component assembly.

4.1.6 Sleeves

The ends of sleeves shall be designed to protect the wrist and shall have a closure system that allows the end of the sleeve to interface with gloves that may be used for wildland firefighting. The sleeve shall extend past the wrist crease. See 5.1.2 and Figure 1 for the location of the wrist crease.

4.1.7 Retroreflective/fluorescent materials

The use of retroreflective or retroreflective/fluorescent materials is an option in this International Standard. If used, the design pattern and minimum area are for local determination. It shall provide visibility of 360°, be attached to the outermost surface of the protective clothing, and be used to mark the limbs and torso.

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4.2 Sampling

4.2.1 Samples

Samples shall be taken so as to be representative of the material and the garment construction employed.

4.2.2 Number and size of specimen

The number and the size of the specimens for the different tests shall be in accordance with the respective International Standards.

4.3 Pretreatment

4.3.1 Pretreatment before thermal tests

Carry out washing in accordance with procedure 2A of ISO 6330 at (60 ± 3) °C and drying in accordance with procedure E (tumble drying) or carry out the dry cleaning in accordance with ISO 3175-1, unless otherwise specified in the care labelling.

For fabrics with flame retardant treatment, carry out the flame spread test (see 4.5.1) after 50 cleaning cycles.

For the other materials, carry out five cleaning and drying cycles before testing to the thermal requirements (see 4.5.1, 4.5.2, 4.5.3 and 4.5.4). Materials labelled as dry cleanable only, shall be dry cleaned five times.

4.3.2 Preconditioning

After having performed the pretreatment specified in 4.3.1, precondition the specimens in accordance with ISO 139 with the following modification: relative humidity (65 ± 5) %. Test the specimens within 5 min of their removal from the conditioning atmosphere.

4.4 Exposure surface

In all surface tests, the outer surface shall be tested.

4.5 Thermal requirements

4.5.1 Flame spread

4.5.1.1 General

Each component assembly in the garment, excluding hardware, shall be tested separately in accordance with 4.5.1.2 and, optionally, 4.5.1.3, following the appropriate cleaning specified in 4.3.

All retroreflective and fluorescent materials shall be tested in combination with the outer layer to ensure that samples have the dimensions indicated in procedure A of ISO 15025. The flame should impinge on the retroreflective material.

Testing of retroreflective and fluorescent materials to 4.5.1.3 is optional. Where such materials are tested, testing shall be in combination with the outer layer to ensure that samples have the dimensions indicated in procedure B of ISO 15025.

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4.5.1.2 Face ignition

The flame spread test shall be carried out in accordance with procedure A of ISO 15025 for face ignition after the pretreatment specified in 4.3, using the surface application procedure and a flame application time of 10 s. The following requirements shall be satisfied:

a) no specimen shall form holes;

b) no specimen shall produce molten or flaming debris;

c) the mean value of the afterflame time shall be $\leqslant$ 2 s;

d) any afterglow shall not spread from the carbonized area to the undamaged area after the cessation of flaming.

4.5.1.3 Edge ignition — Optional

If required, the flame spread test shall also be carried out in accordance with procedure B of ISO 15025 for edge ignition on a hemmed fabric specimen after the pretreatment specified in 4.3, using the edge application procedure and a flame application time of 10 s. The following requirements shall be satisfied:

a) no specimen shall produce molten or flaming debris;

b) the mean value of the afterflame time shall be $\leqslant$ 2 s;

c) any afterglow shall not spread from the carbonized area to the undamaged area after the cessation of flaming;

d) the mean char length shall be $\leqslant$ 100 mm, when measured as specified in Annex C of ISO 15025:2000.

The hemmed fabric specimen shall be prepared in the same manner as used in the construction of the clothing.

Retroreflective and fluorescent materials shall be fixed to the fabric specimen with the bottom edge unstitched.

4.5.1.4 Flame behaviour test of the main seams

Main seam sewing threads as supplied in the constructed state, tested in accordance with procedure A of ISO 15025 after the pretreatment specified in 4.3, using the surface application procedure and a flame application time of 10 s, shall not open, melt, drip or ignite.

Specimens shall be oriented with the seam running up the centreline of the test specimen, such that the burner flame impinges directly upon it.

4.5.2 Heat transfer — Radiant exposure

The single layer, the component assembly or the multilayer clothing assembly, excluding any retroreflective or fluorescent materials, shall be tested. Tests shall be carried out after five cleaning cycles as specified in 4.3.1. When tested in accordance with method B of ISO 6942, with a heat flux density of 20 kW/m^2, the single layer, the component assembly or the multilayer clothing assembly shall have the following minimum level:

$$RHTI_{24} \geqslant 8$$

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4.5.3 Heat transfer — Flame exposure

The garment, when tested in accordance with ISO 9151, shall give the following minimum performance:

$HTI_{24} \geqslant 3{,}5$

4.5.4 Heat resistance

4.5.4.1 Materials' thermal stability

All yarns, fibres and sewing threads utilized in the construction of the protective fabrics and garments, when tested in accordance with ISO 3146 at a temperature of (260 ± 5) °C, shall not melt.

4.5.4.2 Materials' thermal shrinkage

When tested in accordance with ISO 17493 at a temperature of (180 ± 5) °C, no material shall melt, drip, ignite or shrink by more than 5 % in length or width.

4.5.4.3 Hardware

Hardware and closure systems, not in contact with the skin and protected on the outside, shall be tested in accordance with ISO 17493 at a temperature of (180 ± 5) °C and shall not melt, drip or ignite, and shall remain functional.

4.5.4.4 Retroreflective/fluorescent materials

Retroreflective and/or fluorescent materials shall be tested in accordance with ISO 17493 after five cleaning cycles, as specified in 4.3.1.

The retroreflective and/or fluorescent materials, after exposure to (260 ± 5) °C for 5 min ± 15 s, shall not melt, drip, ignite or shrink by more than 5 %.

The retroreflective and/or fluorescent materials, after exposure to (180 ± 5) °C for 5 min ± 15 s, shall comply with the visibility requirements of 6.2.2, 6.2.3 or 6.2.4 of EN 471:2003, and shall comply with the colour performance requirements of 5.1 of EN 471:2003.

Where retroreflective and/or fluorescent materials are attached to the clothing, these materials shall be pretreated as in 4.3 and then tested according to 4.5.1, this subclause (4.5.4.4) and 4.9.

If retroreflective/fluorescent material is used, it should be attached to the outermost surface of the protective clothing and should give all-round visibility by encircling the arms, legs and torso regions of the garments.

4.6 Mechanical requirements

4.6.1 Tensile strength

When tested in accordance with ISO 13934-1, the outer material shall give a breaking load in both machine and cross direction ⩾ 600 N.

4.6.2 Tear strength

When tested in accordance with method B of ISO 4674-1, at a rate of traverse of 5 mm/s, the outer material shall give a tear strength in both machine and cross direction ⩾ 25 N.

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4.6.3 Main seam strength

Main seams in the outer garment, when tested in accordance with ISO 13935-2, shall give a seam strength $\geqslant$ 300 N.

4.7 Ergonomic and comfort requirements

4.7.1 General

Testing shall be done in accordance with 4.7.2 and 4.7.3 or, alternatively, 4.7.4.

4.7.2 Thermal resistance

When tested in accordance with ISO 11092, the material or material combination shall give a thermal resistance $\leqslant$ 0,055 m^2 K/W.

4.7.3 Water vapour resistance

When tested in accordance with ISO 11092, the material or material combination shall give a water vapour resistance $\leqslant$ 10 m^2 Pa/W.

4.7.4 Total heat loss

When tested in accordance with Part C of ASTM F 1868-02, the material or material combination shall give a total heat loss requirement of $\geqslant$ 540 W/m^2.

4.8 Dimensional change after washing and/or dry cleaning

Dimensional changes shall be measured in accordance with ISO 5077.

Garments labelled for washing only: five cleaning cycles shall be carried out in accordance with ISO 6330, washing procedure 2A, each with a drying cycle according to procedure E.

Garments labelled as dry cleanable: five dry cleaning cycles shall be carried out in accordance with ISO 3175-1.

Dimensional change shall not exceed 3 % in both the machine and cross direction.

4.9 Retroreflective/fluorescent performance

Photometric requirements of the retroreflective/fluorescent combined performance material shall be determined in accordance with test method CIE 54.2. The minimum coefficient for new retroreflective/fluorescent combined performance material shall be in accordance with EN 471:2003, Table 4 or 6.

The reflectivity after testing in accordance with EN 471:2003, Table 7, shall be greater than or equal to the value in EN 471:2003, 6.2.2, 6.2.3 or 6.2.4, with the observing angle at 12 min and the entrance angle at 5°.

4.10 Optional clothing testing

The complete clothing assembly intended for use to provide protection in accordance with the requirements of this International Standard shall be tested in accordance with ISO 13506, using a heat flux of 84 kW/m^2 and an exposure time of 4 s.

If this test is carried out, the test results shall be reported according to the requirements of 14.2.

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5 Gloves

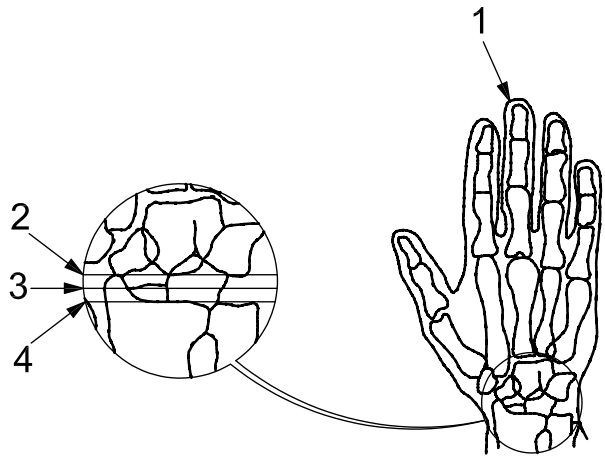
5.1 Design requirements

5.1.1 Component assembly

Gloves shall consist of a component assembly meeting the performance requirements of this International Standard. This component assembly shall be permitted to be configured as a continuous or joined single layer or as continuous or joined multiple layers.

5.1.2 Glove body length

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



Key

1 dactylion
2 stylion
3 wrist crease
4 proximal edge of navicular

Figure 1 — Anatomical landmarks at the base of the hand

5.1.3 Wristlet or cuff

Where gloves are provided with a cuff or a wristlet or both, the sample glove body and the cuff and/or wristlet shall extend circumferentially at least 50 mm beyond the wrist crease, taking into consideration the requirement specified in 5.1.2.

Where gloves are not provided with a cuff or a wristlet, the sample glove shall extend circumferentially at least 50 mm beyond the wrist crease, which is a 25 mm addition to the requirement in 5.1.2.

5.1.4 Glove sizing

5.1.4.1 Minimum sizing

Gloves shall be provided in a minimum of six unique and distinct sizes. The manufacturer shall indicate the range in hand circumference and hand length for wearers of each glove size, as determined in 5.1.4.2.

NOTE The intent of this requirement is to allow manufacturers to report information to the user, which assists in their selection of the appropriate size. Standard sizes are not defined by this International Standard.

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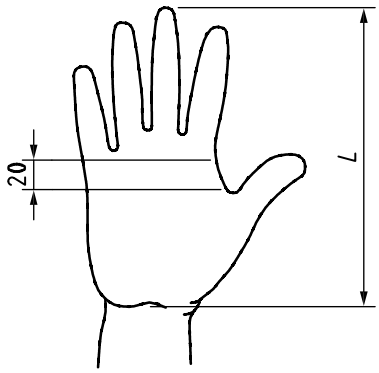
5.1.4.2 Hand dimensions

Hand dimensions for selection of proper glove size shall consist of measuring two dimensions, 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 thumb and middle 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



Key

L hand length

Figure 2 — Method of measuring hand dimensions for selection of proper glove size

5.1.5 Leather chromium VI content

The quantity of chromium VI in gloves containing leather shall not exceed 3,0 mg/kg, determined in accordance with the test method described in ISO 17075.

If the glove includes different types of leather, whether in contact with the skin or not, each leather type shall be tested separately and comply with the above requirement. At least two samples shall be taken from different gloves for each leather type.

5.1.6 Determination of pH value

Leather and other materials used in the construction of gloves shall have a pH value greater than 3,5 and less than 9,5 when tested in accordance with ISO 4045 for leather components and ISO 3071 for other material components. The following provisions also apply.

— The test piece shall be cut out from the palm area of the glove. If other parts of the glove are made of different materials, each material shall be tested separately.

— If gloves are made of more than one layer, test all layers together.

— ISO 4045 shall be used if the sample contains leather.

— ISO 4045:1998, 8.4, does not apply.

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5.2 Sampling

5.2.1 Inspection

Inspection for determining compliance with the design requirements specified in 5.1 shall be performed on whole gloves.

5.2.2 Testing

5.2.2.1 Specimens

Testing for determining material and component compliance with the requirements specified in 5.5 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, samples from the glove shall be used as specified in the performance requirement.

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

5.2.2.2 Exposure surface

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

5.2.2.3 Interpretation criteria

In all tests involving measurements, the determination of compliance shall be based on the mean value, unless specified in the specific test methods.

5.3 Pretreatments

5.3.1 Pretreatment by laundering or dry cleaning

5.3.1.1 Laundering

When pretreatment is specified as part of the test procedure or performance requirements, the test materials shall be cycled through five cleaning cycles. Washing shall be carried out in accordance with procedure 2A of ISO 6330 at (60 ± 3) °C using a front-loading horizontal drum machine with a detergent which achieves a pH of 7,0. Drying shall be carried out in accordance with procedure E (tumble drying), unless otherwise specified in the care labelling. A total of five cleaning cycles shall be used.

A laundry bag shall not be used.

5.3.1.2 Dry cleaning

Materials that are labelled as dry cleaning only shall be dry cleaned five times in accordance with ISO 3175-1.

A laundry bag shall not be used.

5.3.2 Flexing

After the five cleaning cycles, 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.

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