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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.

# 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*

## ISO 16073:2011(E)

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*



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

- 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

**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).

**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.

**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

**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

**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

**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



## 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.

## 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  $(60 \pm 3)$  °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  $(65 \pm 5)$  %. 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.

#### 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  $\leq 2$  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  $\leq 2$  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  $\leq 100$  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  $20 \text{ kW/m}^2$ , the single layer, the component assembly or the multilayer clothing assembly shall have the following minimum level:

$$\text{RHTI}_{24} \geq 8$$

### 4.5.3 Heat transfer — Flame exposure

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

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

### 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  $(260 \pm 5)$  °C, shall not melt.

#### 4.5.4.2 Materials' thermal shrinkage

When tested in accordance with ISO 17493 at a temperature of  $(180 \pm 5)$  °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  $(180 \pm 5)$  °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  $(260 \pm 5)$  °C for  $5 \text{ min} \pm 15 \text{ s}$ , shall not melt, drip, ignite or shrink by more than 5 %.

The retroreflective and/or fluorescent materials, after exposure to  $(180 \pm 5)$  °C for  $5 \text{ min} \pm 15 \text{ s}$ , 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  $\geq 600 \text{ N}$ .

### 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  $\geq 25 \text{ N}$ .

#### 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  $\geq 300$  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  $\leq 0,055$  m<sup>2</sup> 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  $\leq 10$  m<sup>2</sup> 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  $\geq 540$  W/m<sup>2</sup>.

### 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<sup>2</sup> 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.

## 5 Gloves

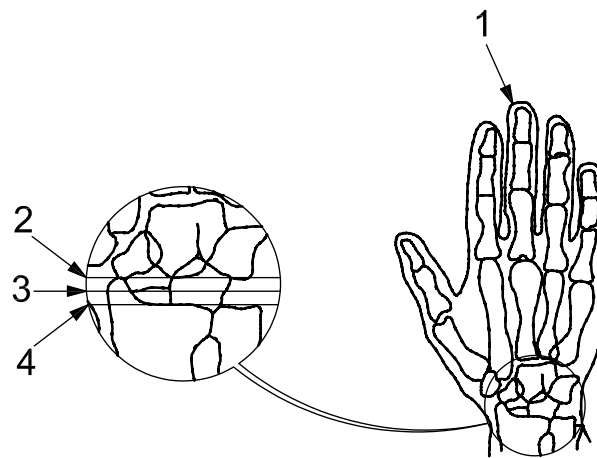
### 5.1 Design requirements

#### 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 dactyion
- 2 stylium
- 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.

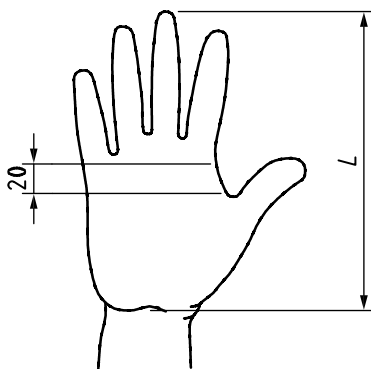
#### 5.1.4.2 Hand dimensions

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.

## 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  $(60 \pm 3)$  °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.



## 5.4 Preconditioning

### 5.4.1 Dry conditioning

Unless otherwise specified in the specific test methods, all sample gloves and sample specimens shall be conditioned at a temperature of  $(20 \pm 2)$  °C and at a relative humidity of  $(65 \pm 5)$  % for at least 24 h in accordance with ISO 139.

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

NOTE This conditioning is used in some cases after washing pretreatment to ensure that the gloves are totally dry before testing.

### 5.4.2 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  $(20 \pm 2)$  °C for 2 min. If gloves are used, the glove specimen shall be first filled with water prior to immersion.

Sample gloves or sample specimens shall be removed from the water, hung in a vertical position for 5 min with the fingers uppermost and then laid horizontal with textile blotting paper both under and over the specimen, under a pressure of 3,5 kPa for a period of 20 min.

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

## 5.5 Performance requirements

### 5.5.1 Thermal requirements — General

#### 5.5.1.1 Thermal requirements — Flame resistance

##### 5.5.1.1.1 Test on component assembly

The glove component assembly, when tested in accordance with procedure A (face ignition) of ISO 15025, after the pretreatment specified in 5.3 and preconditioning specified in 5.4.1, 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  $\leq 2$  s;
- d) any afterglow shall not spread from the carbonized area to the undamaged area after the cessation of flaming.

If the glove assembly incorporates wristlet material, this material shall be tested separately by applying the flame to the outer surface of the wristlet material.

If the glove assembly incorporates seams, specimens of the component assembly containing seams shall be tested separately by applying the flame to the seam portion of the component assembly with the seam oriented vertically.

5.5.1.1.2 Test on whole glove

If suitably sized representative materials cannot be obtained, the whole glove shall be used for testing. Use the test method in accordance with procedure A of ISO 15025 (surface ignition) on the glove mounted in a vertical position such that Point A of Figure 3 is at the midpoint of the lower edge, applying the flame at the surface of the glove.

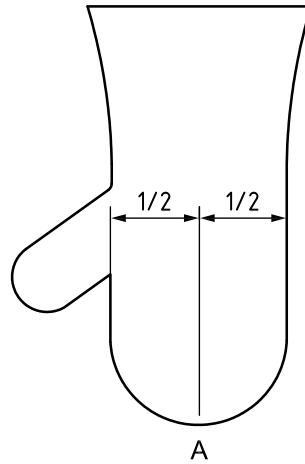


Figure 3 — Mounting of test glove

The glove 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 after-flame time shall be  $\leq 2$  s.
- d) Any afterglow shall not spread from the carbonized area to the undamaged area after the cessation of flaming.

If the glove assembly incorporates wristlet material, this material shall be tested separately, applying the flame to the outer surface of the wristlet material.

If the glove incorporates seams, the seam shall be tested separately by applying the flame to the seam portion.

The burner is placed below the glove such that it is in a plane with the vertical middle line of the middle finger and is perpendicular to the surface of the glove.

The burner is mounted at an angle of  $(30 \pm 3)^\circ$  to the vertical. The distance between the top of the burner and the lower edge of the glove or the middle finger (point A) shall be  $(20 \pm 2)$  mm.

Performance shall be determined using the poorest results from all areas of the glove that are tested.

5.5.1.2 Heat transfer — Flame exposure

The glove component assembly, when tested in accordance with ISO 9151 after the pretreatment specified in 5.3 and preconditioning specified in 5.4.1, shall give the following minimum performance:

$$HTI_{24} \geq 9$$

Where different, the palm and backside and/or fingertips of the glove shall be tested. The performance of the glove shall be determined using the lowest mean results for each part.

### 5.5.1.3 Heat transfer — Radiant exposure

When tested in accordance with method B of ISO 6942, with a heat flux density of 20 kW/m<sup>2</sup> after the pretreatment specified in 5.3 and preconditioning specified in 5.4.1, the glove shall have the following minimum level:

$$RHTI_{24} \geq 8$$

Where different, the palm and backside and/or fingertips of the glove shall be tested. The performance of the glove shall be determined using the lowest mean results for each side.

### 5.5.1.4 Heat transfer — Conductive exposure

The glove component assembly, when tested in accordance with ISO 12127-1 at a contact temperature of 250 °C after the pretreatment specified in 5.3 and preconditioning specified in 5.4.1, shall give the following minimum performance:

$$t_t \geq 6$$

Where different, the palm and backside and/or fingertips of the glove shall be tested. The performance of the glove shall be determined using the lowest mean results for each side.

## 5.5.2 Thermal requirements — Heat resistance

### 5.5.2.1 Materials' thermal stability

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

### 5.5.2.2 Materials' thermal shrinkage

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

## 5.6 Mechanical requirements

### 5.6.1 Abrasion resistance

Specimens of the outer material from the palm area of the glove body component assembly, when tested in accordance with ISO 12947-2 with a 300 g/m<sup>2</sup> finish glass paper (grade 100/F2) at a pressure of 9 kPa after the pretreatment specified in 5.4.1, shall give the following minimum performance:

No wear-through after 2 000 cycles.

Where different, the palm and backside and/or fingertips of the glove shall be tested. The performance of the glove shall be determined using the lowest mean results for each side.

### 5.6.2 Cut resistance

Specimens of the outer material from the palm and back areas of the glove body component assembly and from cuffs or wristlets where provided, when tested in accordance with ISO 13997 after the pretreatment specified in 5.4.1, shall give the following minimum performance:

$$\text{Cut force} \geq 7 \text{ N}$$

Where different, the palm, backside and fingers of the glove shall be tested. The performance of the glove shall be determined using the lowest mean results for each part and each pretreatment.

### **5.6.3 Tear resistance**

Specimens of outer material from the palm area of the glove body component assembly, when tested in accordance with 6.3 of EN 388:2003 after the pretreatment specified in 5.4.1, shall give the following minimum performance:

Tear resistance  $\geq$  25 N

Where different, the palm, backside and fingers of the glove shall be tested. The performance of the glove shall be determined using the lowest mean of the results for each side.

### **5.6.4 Puncture resistance**

Specimens of outer material from the palm area of the glove body component assembly, when tested in accordance with ISO 13996 after the pretreatment specified in 5.4, shall give the following minimum performance:

Puncture resistance  $\geq$  60 N

Where different, the palm and backside and/or fingertips of the glove shall be tested. The performance of the glove shall be determined using the lowest mean of the results for each side.

## **5.7 Ergonomic requirements**

### **5.7.1 Dexterity**

Specimen gloves, when tested for dexterity in accordance with 5.2 of EN 420:2003 after the pretreatment specified in 5.4, if required, shall have a performance level of 2 or better.

### **5.7.2 Grip**

Specimen gloves, when tested in accordance with Annex C, after the pretreatment specified in 5.4, shall not have a weight pulling capacity less than 80 % of the barehand control values.

### **5.7.3 Donning test**

Gloves shall be tested in accordance with Annex G, and shall have an average dry hand donning and doffing time for both dry and wet gloves not exceeding 10 s and an average wet hand donning and doffing time for both dry and wet gloves not exceeding 20 s. The gloves shall allow the test to be completed with no detachment of the inner liner if fitted, or the moisture barrier, and allowing full insertion of all digits.

## **6 Footwear**

Footwear shall comply with the requirements given in either

- a) EN 15090, suitable for general-purpose rescue, fire suppression, and firefighting suppression action involving a fire in vegetative fuels, such as forests, crops, plantations, grass or farmland, or
- b) NFPA 1977.

## 7 Helmets

### 7.1 Function and dimensions

#### 7.1.1 General

Wildland firefighters require helmets to minimize the impact or penetration caused by falling tree branches as well as to provide protection to the head from flames, burning embers and radiant heat. Helmets shall also be fitted with securing mechanisms to prevent them from being dislodged during wildland firefighting operations assessed by visual inspection or other commonly used means of measurement. Recommendations for general consideration of construction of helmets are given in Annex F.

#### 7.1.2 Helmet shell

There shall be no sharp edges, roughness or projection on any part of the helmet.

The profile at the front edge of the shell shall not prevent the wearing of spectacles or goggles.

#### 7.1.3 Vertical clearance

The helmet shall be designed such that the distance between the top of the helmet and the underside of the shell cannot be adjusted to less clearance than the manufacturer's requirements for that specific helmet.

#### 7.1.4 Horizontal clearance

The helmet shall be designed such that the horizontal clearance cannot be adjusted to less clearance than the manufacturer's requirements for that specific helmet.

#### 7.1.5 Wearing height

The helmet shall be designed such that the wearing height cannot be adjusted to less clearance than the manufacturer's requirements for that specific helmet.

#### 7.1.6 Mass

If the mass of a complete helmet, including harness but without accessories, exceeds 400 g, this mass, determined to the nearest 30 g, shall be shown on a label attached to the helmet.

#### 7.1.7 Retention system

The helmet shall be fitted with a retention system, including a chin strap. The chin strap shall be adjustable in length.

A three-point retention system shall have at least three separate points of attachment to the shell. That part of the chin strap which comes into contact with the jaw shall have a minimum width of 15 mm under a load of 250 N.

#### 7.1.8 Optional ventilation

Helmets may be ventilated. The sum of the cross-sectional areas of such ventilation shall not be more than 4 cm<sup>2</sup> when measured on the surface of the helmet.

## 7.2 Performance requirements

### 7.2.1 Shock absorption

When tested by the method given in 7.5 at low and high temperatures and in moist conditions, the force transmitted to the headform shall not exceed 5,0 kN or the deceleration of the 5 kg striker shall not exceed 100 g.

### 7.2.2 Resistance to penetration

When the helmet is tested by the method given in 7.6, the point of the striker shall not contact the surface of the headform.

### 7.2.3 Flame resistance

When tested by the method given in 7.7, the material of the shell shall not burn with the emission of flame after a period of 5 s has elapsed after removal of the flame.

### 7.2.4 Optional low-temperature tests

With the conditioning temperature lowered to  $-20\text{ }^{\circ}\text{C}$ , helmets tested for shock absorption in accordance with 7.5 and for resistance to penetration in accordance with 7.6 shall meet the requirements of 7.2.1 and 7.2.2, respectively.

Helmets claiming to meet these requirements shall state this fact on the label attached to the helmet.

### 7.2.5 Optional electrical insulation

When tested by the method given in 7.8, the leakage current shall not exceed 1,2 mA.

This requirement is intended to ensure protection from voltages of up to 440 V. Helmets claimed to meet this requirement shall state this fact on the label attached to the helmet.

### 7.2.6 Optional lateral rigidity

When tested by the method given in 7.9, the maximum lateral deformation of the helmet shall not exceed 40 mm, and the residual deformation shall not exceed 15 mm.

Helmets claiming to meet this requirement shall state this fact on the label attached to the helmet.

### 7.2.7 Optional high-temperature stability

Head protective devices, when tested in accordance with D.4 (test 1), shall show no visible distortion of the shell. Head protective devices under test shall have been previously conditioned at  $50\text{ }^{\circ}\text{C}$ .

Any failure of headbands or other internal components during this test (e.g. melting or collapse of the headband) shall not be the basis for rejection of the head protective device.

NOTE The purpose of this test is to ensure the suitability of the shell material when it is exposed to radiant heat sources capable of raising the temperature of the shell of the head protective device to  $120\text{ }^{\circ}\text{C}$ . Headbands within the head protective device and in contact with the wearer's head are not in contact with or exposed to such sources.

### 7.2.8 Optional high radiant heat environments

Head protective devices, when tested in accordance with D.5 (test 2), shall meet the following requirements.

a) No part of the head protective device shell shall touch the headform.

- b) No shell distortion in the posterior portion of the headform shall extend more than 20 mm below the original position of the head protective device.
- c) No distortion of the anterior and lateral portions of the head protective device shall extend more than 15 mm below the original position of the device.
- d) No ignition of any part of the head protective device assembly shall occur.
- e) No melting or dripping is allowed.

Any failure of headbands or other internal components during this test (e.g. melting or collapse of the headband) shall not be the basis of rejection of the head protective device.

NOTE The purpose of this test is to ensure the suitability of the shell material when it is exposed to radiant heat sources capable of raising the temperature of the shell of the head protective device to 200 °C for a short period of time. Headbands within the head protective device and in contact with the wearer's head are not in contact with or exposed to such sources.

### 7.3 Test requirements

#### 7.3.1 Samples

Helmets shall be submitted for testing in the condition in which they are offered for sale, including any requisite holes in the shell and other means of attachment of any accessories for special purposes.

No helmet that has been subjected to testing shall be offered for sale. The minimum number of samples required for one set of tests is the following:

- a) one helmet for the shock absorption test at  $-10\text{ °C}$  (or at  $-20\text{ °C}$ );
- b) one helmet for the shock absorption test in moist conditions;
- c) one helmet for the shock absorption test at  $50\text{ °C}$ , then for flammability test;
- d) one helmet for the resistance to penetration test;
- e) one helmet for the electrical insulation test;
- f) one helmet for the lateral rigidity test;
- g) one helmet for the test for resistance to penetration at low temperature.

#### 7.3.2 Conditioning for testing

##### 7.3.2.1 Conditioning cabinet

This shall be sufficiently large to ensure that the helmets can be positioned such that they touch neither one another nor the sides. It shall be fitted with a fan to provide effective air circulation.

##### 7.3.2.2 Preconditioning

All helmets shall be preconditioned for at least 7 d at a temperature of  $(20 \pm 2)\text{ °C}$  and a relative humidity of  $(65 \pm 5)\%$  before applying the following individual conditioning treatments.

#### 7.3.3 Low temperature

The helmet shall be exposed to a temperature of  $(-10 \pm 2)\text{ °C}$  for not less than 4 h. When especially required (see 7.2.4), the temperature shall be reduced to  $(-20 \pm 2)\text{ °C}$ .

#### 7.3.4 High temperature

The helmet shall be exposed to a temperature of  $(50 \pm 2)$  °C for a period of not less than 4 h.

#### 7.3.5 Moisture

The helmet shall be sprayed externally with water at  $(20 \pm 2)$  °C at the rate of 1 l/min for not less than 4 h.

### 7.4 Headforms

#### 7.4.1 Construction

Headforms used in the tests shall be either hardwood or metal.

The profile above the reference line shall be as defined in Figure E.1 and Table E.1.

The profile below the reference line may be varied to suit the method of mounting.

A recommended method of constructing wooden headforms is given in Annex E.

#### 7.4.2 Selection of size

Helmets with adjustable harnesses shall be tested on the appropriate headform, selected by adjusting the harness to the middle size of the adjustment range.

Helmets with non-adjustable harnesses shall be tested on the appropriate size of headform.

### 7.5 Shock absorption test

#### 7.5.1 Principle

Shock absorption is measured by the direct measurement of the maximum force transmitted to a rigidly mounted helmeted headform, or by the measurement of the maximum deceleration of the striker.

#### 7.5.2 Apparatus

**7.5.2.1 Base of the apparatus**, monolithic and sufficiently large to offer full resistance to the effect of the blow. It shall have a mass of at least 500 kg and shall be suitably installed to obviate the return compression wave.

**7.5.2.2 Headform**, rigidly mounted in a vertical position on the base.

**7.5.2.3 Striker**, having a mass of 5 kg and a hemispherical striking face of  $(50 \pm 2)$  mm radius, positioned above the headform such that its axis coincides with the vertical axis of the headform and such that it may be dropped in a guided fall with a minimum retardation from the guides.

**7.5.2.4 Non-inertial force transducer**, firmly attached to the base, or accelerometer, firmly attached to the striker, to measure the impact force. They shall be so positioned that the axis is co-axial with the path of the striker.

**7.5.2.5 System of measurement**, able to measure, without distortion, forces of up to 40 kN and with a flat frequency response within  $\pm 5\%$  between 5 Hz and 1 000 Hz. It should be noted that, where a force transducer is used in conjunction with the headform, the headform and its mount form part of the measuring system; where an accelerometer is used in the striker, the striker forms part of the measuring system.



### 7.5.3 Test procedure

Each of the requisite sample helmets specified in 7.3.1 shall be conditioned appropriately in accordance with 7.3.2. Within 1 min of its removal from the conditioning atmosphere, the helmet shall be placed firmly, and fastened securely, on the appropriate headform (see 7.4) at its greatest possible wearing height and with a total clearance of approximately 10 mm between the headband and the headform, measured by the insertion of a 10 mm diameter rod. The striker shall be allowed to fall on the centre of the crown of the helmet shell with an impact energy of 50 J, attained by the striker falling from a height of  $(1\ 000 \pm 5)$  mm. The height of the fall shall be measured from the point of impact on the helmet shell to the underside of the striker.

A recording shall be made allowing the determination of the maximum force of impact.

## 7.6 Penetration test

### 7.6.1 Apparatus

**Test striker**, allowed to fall freely on to a helmet securely fastened to a suitable headform. The contactable surface of the headform shall be of a metal that readily permits detection should contact by the striker occur, and that can be restored after contact, if necessary.

The striker has the following characteristics:

- a) mass:  $(3,0 \pm 0,05)$  kg;
- b) angle of point:  $60^\circ$ ;
- c) radius of point: 0,5 mm;
- d) minimum height of cone: 40 mm;
- e) hardness of tip: between 45 and 50 Rockwell.

### 7.6.2 Test procedure

The helmet shall be conditioned in the manner that gave the worst result in the shock absorption tests. Within 1 min of its removal from the conditioning atmosphere it shall be placed firmly, and fastened securely, on the appropriate headform (see 7.4) at its greatest possible wearing height and with a total clearance of approximately 10 mm between the headband and the headform, measured by the insertion of a 10 mm diameter rod.

The striker shall be allowed to fall on to the top of the helmet, within a circular area of 100 mm diameter, through a distance of  $(1\ 000 \pm 5)$  mm measured from the top of the helmet to the point of the striker. The striker may fall freely or may be guided, but the speed of impact of a guided striker shall equal that of a free fall.

Note is taken of whether or not contact is made between the striker and the headform. Contact may be verified electrically, but a physical check shall be made on the contact surface. If necessary, the surface shall be restored prior to a subsequent test.

## 7.7 Flammability test

### 7.7.1 General

The test shall be carried out after preconditioning at  $50\ ^\circ\text{C}$ , on the helmet used for the shock absorption test.

## 7.7.2 Apparatus

**7.7.2.1 Bunsen burner**, suitable for propane gas, with a 10 mm diameter bore, an adjustable air vent and an appropriate size of jet; the system shall incorporate a pressure control device and a tap.

**7.7.2.2 Propane gas**, having a minimum purity of 95 %.

## 7.7.3 Test procedure

The gas pressure shall be adjusted to 3 430 Pa (350 mm H<sub>2</sub>O), as measured by a suitable manometer.

The flame shall be adjusted by means of the air vent, such that the blue cone is clearly defined, although turbulent, and is approximately 15 mm long.

With the helmet upside down, and the burner angled at 45° to the vertical, the end of the flame shall be applied to the outside of the shell, at any suitable point between 50 mm and 100 mm from the crown, for a period of 10 s. The plane tangential to the test point shall be horizontal.

The shell shall be examined for flaming 5 s after removal of the flame.

## 7.8 Electrical insulation test

The complete helmet shall be placed for 24 h before testing in a 3 g/l solution of sodium chloride at a temperature between 10 °C and 30 °C. The helmet shall then be removed, wiped and placed upside down in a container of appropriate size. The container and the helmet shall then be filled with the sodium chloride solution, up to 30 mm below the plane in which the brim is connected to the shell.

A voltage, linearly and gradually increasing within 1 min to 1 200 V at 50 Hz to 60 Hz, shall be applied between an electrode immersed in the solution inside the helmet and the other electrode in the container. The maximum voltage shall be maintained for 1 min and the leakage current measured.

## 7.9 Lateral rigidity test

The helmet shall be tested transversely (ear to ear) between two guided parallel plates having their lower edges radiused to 10 mm.

The helmet shall be preconditioned in accordance with 7.3.2, and then placed between the plates such that the brim lies outside, but as close to the plates as possible. An initial force of 30 N shall be applied to the plates at right angles, such that the helmet is subjected to a lateral pressure. After 30 s, the distance between the plates shall be measured.

The force shall be increased by 100 N/min up to 430 N, which shall be held for 30 s, after which the distance between the plates (maximum lateral deformation) shall again be measured.

The force shall be decreased to 25 N and then immediately increased to 30 N, which shall be held for 30 s, after which the distance between the plates (residual deformation) shall again be measured. Measurements shall be made to the nearest millimetre, and the extent of damage, if any, shall be noted.

## 8 Eye protectors

### 8.1 General

Wildland firefighters' eyes are exposed to irritants, such as smoke particles and off-gassing chemicals, which cause severe irritation and discomfort to the eyes. Eye protectors should protect the eyes from the ingress of smoke particles and other irritants. The complete eye protector should also resist fogging. Activities associated with wildland firefighting, such as chainsaw use, may require alternative forms of eye protection, such as mesh visors.

### 8.2 Design and manufacturing requirements

#### 8.2.1 General construction

Eye protectors shall be free from projections, sharp edges or other defects, which are likely to cause discomfort or injury during use.

#### 8.2.2 Materials

No part of the eye protector in contact with the wearer shall be made of materials that are known to cause any skin irritation.

#### 8.2.3 Headbands

Headbands, if used as the principal means of retention, shall be at least 10 mm wide over any portion which may come into contact with the wearer's head. Headbands shall be adjustable or self-adjusting.

### 8.3 Basic, particular and optional requirements for non-mesh eye protectors

#### 8.3.1 Basic requirements

##### 8.3.1.1 General

All non-mesh eye protectors shall meet the basic requirements given in this subclause (8.3.1).

Furthermore, according to their intended use, non-mesh eye protectors shall, if appropriate, meet one or more of the particular requirements given in 8.3.2.

Optional requirements related to additional properties of non-mesh eye protectors are given in 8.3.3.

##### 8.3.1.2 Field of vision

The size of the field of vision shall be defined in conjunction with the appropriate headform described in Clause 17 of EN 168:2001.

Eye protectors shall exhibit a minimum field of vision defined by the two ellipses in Figure 4, when placed and centred at a distance of 25 mm from the surface of the eyes of the appropriate headform. The horizontal axis shall be parallel to, and 0,7 mm below, the height of the line connecting the centres of the two eyes. The horizontal length of the ellipses shall be 22,0 mm; the vertical width of the ellipses shall be 20,0 mm. The centre distance of the two ellipses shall be  $d = c + 6$  mm, where  $c$  is the pupillary distance. The pupillary distance is 64 mm for the medium headform and 54 mm for the small headform, if not specified differently by the manufacturer.

The test shall be carried out in accordance with Clause 18 of EN 168:2001.

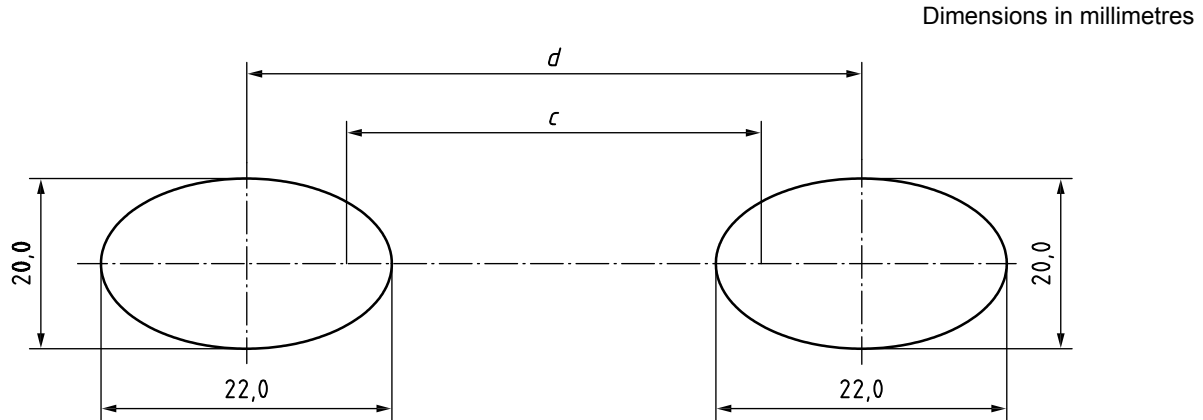


Figure 4 — Definition of the field of vision

8.3.1.3 Optical requirements

8.3.1.3.1 Spherical, astigmatic and prismatic refractive powers

The refractive powers of oculars shall be measured by the reference methods specified in Clause 3 of EN 167:2001. Clause 3 of EN 167:2001 also refers to an optional method for use in specific circumstances; the details of this method are given in Annex A of EN 167:2001.

8.3.1.3.2 Mounted oculars and unmounted oculars covering both eyes

The refractive power characteristics of mounted oculars or unmounted oculars covering both eyes shall be measured by the method specified in 3.2 of EN 167:2001 at the visual centre of the ocular.

The permissible tolerances for oculars without corrective effect are given in Table 1.

The difference in prismatic refractive power specified for an eye protector depends not only on the prismatic refractive power of each ocular, but also on the position of the optical axis of the ocular in relation to the axis of vision and, therefore, the shape of the frame. It is, therefore, necessary to use replacement oculars for which the difference in prismatic power remains within the permissible tolerance limits for the frame in question.

Table 1 — Permissible tolerances for refractive powers of mounted oculars without corrective effect and unmounted oculars without corrective effect covering both eyes

Optical class	Spherical refractive power $\frac{(D_1 + D_2)}{2}$	Astigmatic refractive power $ D_1 - D_2 $	Difference in prismatic refractive power (cm/m)		
			Horizontal		Vertical
	(m <sup>-1</sup> )	(m <sup>-1</sup> )	Base out	Base in	
1	± 0,06	± 0,06	0,75	0,25	0,25
2	± 0,12	± 0,12	1,00	0,25	0,25

NOTE  $D_1$  and  $D_2$  are the refractive powers in the two principal meridians.

### 8.3.1.3.3 Transmittance

#### 8.3.1.3.3.1 Oculars without filtering action

Oculars intended to protect the eyes against mechanical or chemical hazards only, and cover plates, shall have a luminous transmittance greater than 74,4 % when measured as given in Clause 6 of EN 167:2001 [based on CIE source A (2 856 K)].

#### 8.3.1.3.3.2 Oculars with filtering action (filters) and housings for oculars with filtering action

The transmittance of oculars with filtering action shall meet the requirements given in the specific standards relating to the various types of ocular, i.e. EN 170 or EN 172.

Housings of goggles and face shields which claim to provide protection against optical radiation shall provide at least the same level of protection against optical radiation as given by a filter of any scale number declared usable with the eye protector by the manufacturer or supplier. Testing shall be in accordance with Clause 6 of EN 167:2001.

#### 8.3.1.3.3.3 Variations in transmittance — Oculars without corrective effect

NOTE Oculars without filtering action are exempt from this requirement.

Variations in luminous transmittance shall be measured in accordance with Clause 7 of EN 167:2001.

The relative variations of the luminous transmittance around the visual centre(s) P1 and P2 shall not exceed the values of Table 2. The relative difference in luminous transmittance P3 between left and right eye shall not exceed the values of Table 2 or 20 %, whichever is the greater.

**Table 2 — Variations in luminous transmittance**

Luminous transmittance		Permissible relative variation %
Less than %	Up to %	
100	17,8	± 5
17,8	0,44	± 10
0,44	0,023	± 15
0,023	0,001 2	± 20
0,001 2	0,000 023	± 30

#### 8.3.1.3.4 Diffusion of light

The diffusion of light shall be measured in accordance with one of the reference methods specified in Clause 4 of EN 167:2001.

The maximum value of the reduced luminance factor shall be

- a) 0,75 cd/(m<sup>2</sup>·lx) for oculars used in eye protectors against high-speed particles, and
- b) 0,50 cd/(m<sup>2</sup>·lx) for all other oculars.

**8.3.1.4 Quality of material and surface**

Except for a marginal area 5 mm wide, oculars shall be free from any significant defects likely to impair vision in use, such as bubbles, scratches, inclusions, dull spots, pitting, mould marks, scouring, grains, pocking, scaling and undulation.

The assessment shall be carried out in accordance with the method specified in Clause 5 of EN 167:2001.

**8.3.1.5 Resistance to ageing**

**8.3.1.5.1 Stability at an elevated temperature**

Assembled eye protectors shall show no apparent deformation when tested by the method specified in D.4 (test 1).

**8.3.1.5.2 Resistance to ultraviolet radiation — Oculars only**

Oculars shall be subjected to the test for resistance to ultraviolet radiation in accordance with the method specified in Clause 6 of EN 168:2001. At the end of the test, oculars shall meet the following requirements.

- a) The relative change of luminous transmittance shall not be greater than the values specified in Table 3.
- b) The value of the reduced luminance factor shall not exceed the permissible limits given in 8.3.1.3.4.

**Table 3 — Permissible relative change in luminous transmittance following the ultraviolet radiation test**

Luminous transmittance		Permissible relative change %
Less than %	Up to %	
100	17,8	± 5
17,8	0,44	± 10
0,44	0,023	± 15
0,023	0,001 2	± 20
0,001 2	0,000 023	± 30

**8.3.1.6 Resistance to corrosion**

After having undergone the test for resistance to corrosion specified in Clause 8 of EN 168:2001, all metal parts of the eye protector shall display smooth surfaces, free from corrosion, when examined by a trained observer.

**8.3.1.7 Resistance to ignition**

Eye protectors shall be tested in accordance with the method specified in Clause 7 of EN 168:2001 and shall be considered to be satisfactory if no part of the eye protector ignites or continues to glow after removal of the steel rod.

### 8.3.2 Particular requirements

#### 8.3.2.1 Protection against high-speed particles

Eye protectors intended to provide protection against high-speed particles shall withstand the impact of a 6 mm nominal diameter steel ball of 0,86 g minimum mass, striking the oculars and the lateral protection at one of the speeds given in Table 4.

**Table 4 — Requirements relating to protection against high-speed particles**

Type of eye protector	Impact speed of ball		
	Low-energy impact, F $45^{+1,5}_0$ m/s	Medium-energy impact, B $120^{+3}_0$ m/s	High-energy impact, A $190^{+5}_0$ m/s
Goggles	+	+	Not applicable
Face shields	+	+	+

The test shall be in accordance with the method specified in Clause 9 of EN 168:2001.

It shall not be possible for the ball to strike the lateral impact point without first striking the lateral protection.

On so testing, the following defects shall not occur.

- Ocular fracture: an ocular shall be considered to have fractured if it cracks through its entire thickness into two or more pieces, or if more than 5 mg of the ocular material becomes detached from the surface away from the one struck by the ball, or if the ball passes through the ocular.
- Ocular deformation: an ocular shall be considered to have been deformed if a mark appears on the white paper on the opposite side to that struck by the ball.
- Ocular housing or frame failure: an ocular housing or frame shall be considered to have failed if it separates into two or more pieces, or if it is no longer capable of holding an ocular in position, or if an unbroken ocular detaches from the frame, or if the ball passes through the housing or frame.
- Lateral protection failure: the lateral protection shall be considered to have failed if it fractures through its entire thickness into two or more separate pieces, or if one or more particles becomes detached from the surface remote from the impact point, or if it allows the ball to penetrate completely, or if it partially or totally detaches from the eye protector, or if its component parts become separated.

Eye protectors offering protection against high-speed particles shall provide lateral protection.

#### 8.3.2.2 Protection against droplets and splashes of liquids

Eye protectors for use against droplets (goggles) and splashes of liquids (face shields) shall be tested in accordance with the methods specified in Clause 12 of EN 168:2001. The results shall be considered to be satisfactory if:

- no pink or crimson colouration appears in the ocular regions defined by the two circles when assessing goggles for protection against droplets; no account shall be taken of any such coloration up to a distance of 6 mm inside the edges of the eye protector;
- face shields cover the eye-region rectangle of the appropriate headform, as described in 10.2.2.2 of EN 168:2001 and as assessed in accordance with 10.2 of EN 168:2001.

Additionally, face shields for protection against splashes of liquids shall have a viewing area with a minimum vertical centreline depth of 150 mm when mounted in the appropriate housing.

### 8.3.2.3 Protection against large dust particles

Eye protectors for use against large dust particles shall be tested in accordance with the method specified in Clause 13 of EN 168:2001. The result shall be considered to be satisfactory if the reflectance after the test is not less than 80 % of its value before the test.

### 8.3.2.4 Protection against gases and fine dust particles

Eye protectors for use against gases and fine dust particles shall be tested in accordance with the method specified in Clause 14 of EN 168:2001. They shall be regarded as satisfactory if no pink or crimson coloration appears in the area covered by the eye protector. No account shall be taken of any such coloration up to a distance of 6 mm inside the edges of the eye protector.

### 8.3.2.5 Lateral protection

Eye protectors claiming to provide lateral protection shall pass the lateral region coverage assessment detailed in Clause 19 of EN 168:2001.

## 8.3.3 Optional requirements

### 8.3.3.1 General

Optional requirements are specified for additional characteristics of eye protectors which can be found to be beneficial to the user for operational reasons.

### 8.3.3.2 Resistance to surface damage by fine particles

If oculars are described as resistant to surface damage by fine particles, they shall have a reduced luminance factor of not more than 5 cd/(m<sup>2</sup>·lx) following the test specified in Clause 15 of EN 168:2001.

NOTE This procedure does not assess resistance to abrasion.

### 8.3.3.3 Resistance to fogging of oculars

If oculars are described as resistant to fogging, they shall remain free from fogging for a minimum of 8 s when tested in accordance with Clause 16 of EN 168:2001.

NOTE This test applies to the surface properties of the ocular material only and might not provide a reliable measure of eye protector performance in real use. Methods that assess the performance of complete devices are under development and might be incorporated in a future revision of this International Standard.

### 8.3.3.4 Oculars with enhanced reflectance in the infrared

Oculars that are claimed to have enhanced reflectance in the infrared shall have a mean spectral reflectance greater than 60 % within the wavelength range 780 nm to 2 000 nm when measured in accordance with Clause 8 of EN 167:2001.

### 8.3.3.5 Protection against high-speed particles at extremes of temperature

Eye protectors intended to provide protection against high-speed particles at extremes of temperature shall withstand the impact of a 6 mm nominal diameter steel ball of 0,86 g minimum mass, striking the oculars and the lateral protection at one of the speeds given in Table 4. The impacts are carried out within one minute after the eye protectors have been conditioned at extremes of temperature (55 ± 2) °C and (–5 ± 2) °C using the method specified in Clause 9 of EN 168:2001.

It shall not be possible for the ball to strike the lateral impact point without first striking the lateral protection.



On so testing, the following defects shall not occur.

- a) Ocular fracture: an ocular shall be considered to have fractured if it cracks through its entire thickness into two or more pieces, or if more than 5 mg of the ocular material becomes detached from the surface away from the one struck by the ball, or if the ball passes through the ocular.
- b) Ocular deformation: an ocular shall be considered to have been deformed if a mark appears on the white paper on the opposite side to that struck by the ball.
- c) Ocular housing or frame failure: an ocular housing or frame shall be considered to have failed if it separates into two or more pieces, or if it is no longer capable of holding an ocular in position, or if an unbroken ocular detaches from the frame, or if the ball passes through the housing or frame.
- d) Lateral protection failure: the lateral protection shall be considered to have failed if it fractures through its entire thickness into two or more separate pieces, or if one or more particles becomes detached from the surface remote from the impact point, or if it allows the ball to penetrate completely, or if it partially or totally detaches from the eye protector, or if its component parts become separated.

Eye protectors offering protection against high-speed particles at extremes of temperature shall provide lateral protection.

## 8.4 Mesh eye and face protectors

### 8.4.1 Basic requirements

#### 8.4.1.1 Materials

##### 8.4.1.1.1 Resistance to corrosion

No metal parts of a mesh-type eye protector, including the mesh if made from metal, shall show a significant sign of corrosion when examined by a trained observer after having undergone the test for resistance to corrosion specified in Clause 8 of EN 168:2001.

##### 8.4.1.1.2 Resistance to ignition

When tested in accordance with Clause 7 of EN 168:2001, no part of a mesh-type eye protector shall ignite or continue to glow after removal of the heated rod.

##### 8.4.1.1.3 Cleaning and disinfection

All parts of a mesh-type eye protector shall withstand cleaning and disinfection in accordance with the agents and procedures recommended by the manufacturer.

##### 8.4.1.1.4 Skin irritation

Materials that come into contact with the wearer's skin shall not be known to be likely to cause irritation or any other adverse effect to health.

### 8.4.1.2 Number of apertures in a mesh

The minimum number of apertures in the mesh shall be 15/cm<sup>2</sup>.

## 8.4.2 Design and manufacture

### 8.4.2.1 Construction

#### 8.4.2.1.1 General

Mesh eye protectors shall be free from projections, sharp edges or other defects which are likely to cause discomfort or injury to the wearer during use.

#### 8.4.2.1.2 Headbands and harnesses

Headbands or head harnesses where provided and used as the principal means of support shall be at least 10 mm wide where in direct contact with the head.

#### 8.4.2.1.3 Adjustability and/or replacement of components

Adjustable parts or components incorporated in mesh eye protectors shall be easily adjustable and, where intended to, shall be easily replaceable without the use of special tools.

#### 8.4.2.1.4 Basic dimensions of a mesh face screen

A mesh face screen with or without ocular(s) shall be such that a rectangle with minimum dimensions of 160 mm (horizontal length) × 130 mm (vertical length) can be described in full on the surface of the face screen.

### 8.4.2.2 Minimum dimension of ocular area(s)

The ocular area of a mesh face screen, a mesh goggle, mesh spectacle or a mesh face screen with ocular(s) shall be such that a rectangle with minimum dimensions of 32 mm (horizontal length) × 25 mm (vertical depth) can be described in full for each eye (pupillary distance: nominally 64 mm).

## 8.4.3 Performance

### 8.4.3.1 Luminous transmittance of the mesh ocular area

The luminous transmission of the mesh ocular area shall be greater than 20,0 % when measured in accordance with Clause 6 of EN 167:2001.

### 8.4.3.2 Variations in luminous transmittance

Variations in luminous transmittance shall be in accordance with 8.3.1.3.3.3.

### 8.4.3.3 Additional or alternative oculars

Additional or alternative oculars fitted to a mesh-type eye protector shall comply with 8.3.1.

### 8.4.3.4 Robustness of construction — Increased robustness

The complete mesh-type eye protector shall be submitted to the impact of a steel ball striking the ocular area and the lateral protection at a specified speed. Test in accordance with 3.2 of EN 168:2001.

The following defects shall not occur during testing.

- a) Mesh fracture in the ocular area: the mesh shall be considered to have fractured if the steel ball passes through the mesh or if, at any point in the ocular area, a gap or tear is produced which allows a (300 ± 3) mm long and (3,0 ± 0,1) mm diameter steel rod, with end faces that are flat and perpendicular to its longitudinal axis, to pass through under its own weight in any orientation.

- b) Ocular area deformation: the mesh ocular area shall be considered to have been deformed if a mark appears on the white paper on the opposite side to that struck by the steel ball.
- c) Failure of ocular housing, mesh face screen or frame: an ocular housing or mesh face screen or frame shall be considered to have failed if it separates into two or more pieces, or if it is no longer capable of holding an ocular in position, or if an unbroken ocular detaches from the frame, or if the ball breaks through the housing, mesh face screen or frame.

A mesh face screen tested with an additional or alternative ocular shall be fitted with an ocular meeting the increased robustness requirements. If the use of any cover and/or backing lens is recommended by the manufacturer, the test shall be performed with a mesh face screen conforming to this recommendation.

#### **8.4.4 Requirements for eye protectors with special characteristics**

##### **8.4.4.1 Mesh-type eye protectors protecting against high-speed particles**

This requirement is only applicable to mesh eye protectors which comply with 8.3.2.1.

##### **8.4.4.2 Prolonged high-temperature stability**

The complete eye protective device, when tested in accordance with D.4 (test 1), shall show no breakage or visible distortion of the body. The complete eye protective device under test shall have been previously conditioned at 50 °C.

##### **8.4.4.3 Extreme high-radiant heat environments**

The complete eye protective device, when tested in accordance with D.5 (test 2), shall show no breakage or visible distortion of the body. The complete eye protective device under test shall have been previously conditioned at 50 °C.

### **8.5 Allocation of requirements, test schedules and application**

#### **8.5.1 Requirements, test methods and schedules**

##### **8.5.1.1 Non-mesh eye protectors**

The individual requirements and test methods to the different types of non-mesh eye protector are allocated and the required number of test specimens defined.

Table 5 specifies those requirements and tests which apply to frames and complete eye protectors.

##### **8.5.1.2 Mesh eye protectors**

The individual requirements and test methods for the different types of mesh eye protector are allocated and the required number of test specimens defined.

Table 6 specifies those requirements and tests which apply to mesh-type eye protectors.

#### **8.5.2 Application of eye protector types**

The application of eye protector types to the various fields of use is shown in Table 7.

Table 5 — Type examination test schedule for complete eye protectors

Requirement			Test in accordance with		Quantity of sample
			EN	(sub)clause	
Marking			Visual inspection		All
Information			Visual inspection		All
Construction and materials			Visual inspection		All
Head bands			By measuring		3
Quality of material and surface <sup>b</sup>			167:2001	5	3
Field of vision			168:2001	18	3
Refractive properties			167:2001	3	3
Thermal stability <sup>c</sup>			168:2001	5	3
Transmittance of oculars			167:2001	6	3
Transmittance of frames			167:2001	6	3
Variations in transmittance <sup>b</sup>			167:2001	7	3
Diffusion of light <sup>b</sup>			167:2001	4	3
Ocular reflectance <sup>b</sup>			167:2001	8	3
Lateral protection			168:2001	19	3
UV stability <sup>c</sup>			168:2001	6	3
Minimum robustness <sup>b</sup>			168:2001	4	8
Increased robustness <sup>a</sup> Impact point/test temperature (°C)	1	+55	168:2001	3.2	2
	1	-5	168:2001	3.2	2
	2	+55	168:2001	3.2	2
	2	-5	168:2001	3.2	2
	3	+55	168:2001	3.2	1
	3	-5	168:2001	3.2	1
	4	+55	168:2001	3.2	1
	4	-5	168:2001	3.2	1
Corrosion			168:2001	8	3
Ignition			168:2001	7	3
High-speed particles Impact point	1		168:2001	9	4
	2		168:2001	9	4
	3		168:2001	9	2
	4		168:2001	9	2
High-speed particles at extremes of temperature Impact point/test temperature (°C)	1	+55	168:2001	9	2
	1	-5	168:2001	9	2
	2	+55	168:2001	9	2
	2	-5	168:2001	9	2
	3	+55	168:2001	9	1
	3	-5	168:2001	9	1
	4	+55	168:2001	9	1
	4	-5	168:2001	9	1
Molten metals and hot solids			168:2001	10, 11	3
Droplets and splashes			168:2001	12	3
Surface damage by fine particles <sup>b</sup>			168:2001	15	4
Large dust			168:2001	13	3
Gas and fine dust particles			168:2001	15	4
Fogging <sup>b</sup>			168:2001	16	4

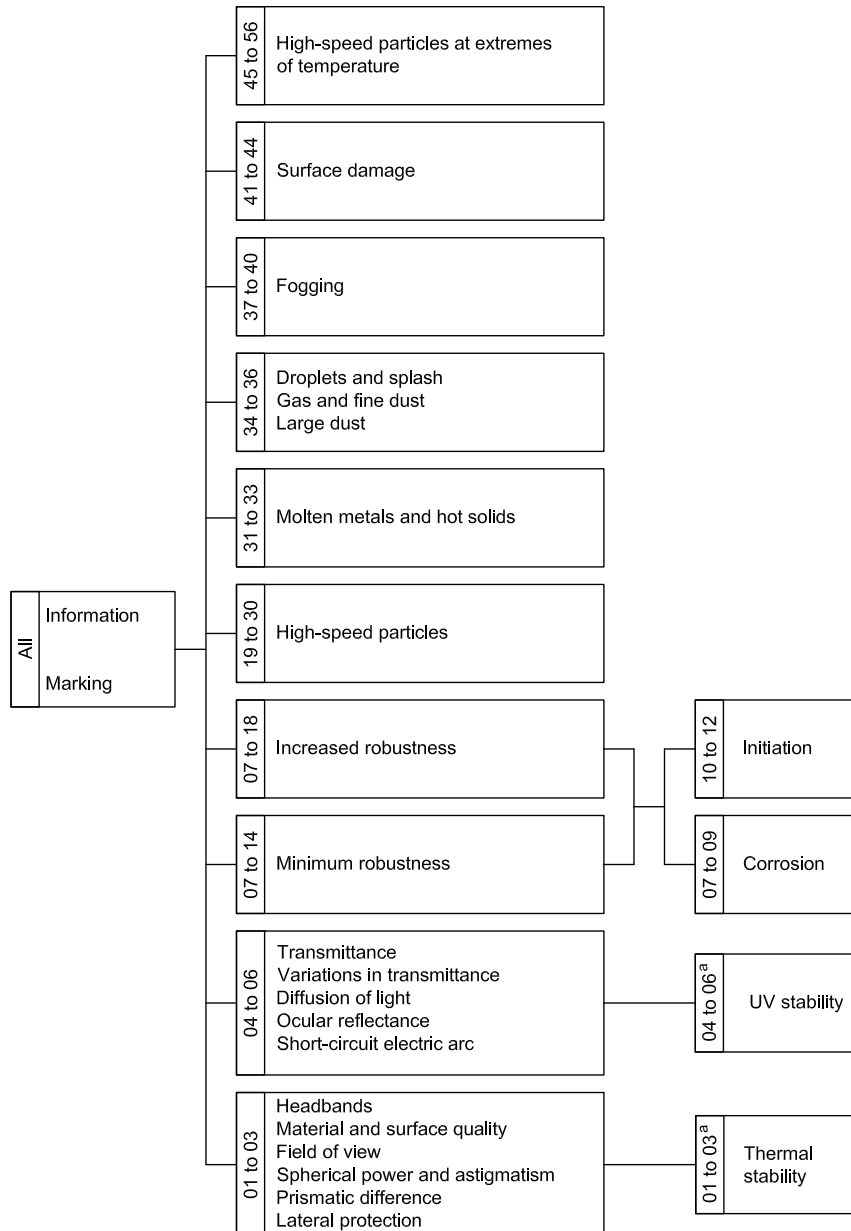
It is recommended that testing be performed in the order shown in Figure 5.

The type test evaluation shall allow no defectives and no account shall be taken of measurement uncertainties.

<sup>a</sup> Frames fitted with oculars meeting only the minimum robustness requirements shall only be tested for lateral impact.

<sup>b</sup> If the oculars have been tested for the requirements (see Table 6), these tests on the oculars need not be repeated.

<sup>c</sup> Ensure that each test is performed on two samples for one eye position and on one sample for the other, e.g. one left, two right.



NOTE If the properties being determined at samples 4 to 6 and samples 37 to 44 were already measured on the oculars, measurements need not be repeated.

<sup>a</sup> Ensure that each test is performed in 2 samples for 1 eye position and on 1 sample for the other eye position (e.g. 1 left, 2 right).

Figure 5 — Flowchart — Testing of complete eye protectors

**Table 6 — Allocation of test requirements and type examination test schedule for mesh-type eye protectors**

Test order	Requirement (Clause)	Test specimen no.											Allocation of test	
		1	2	3	4	5	6	7	8	9	10	11	Mesh goggles and face screens	Mesh eye protectors against high-speed particles
1	Marking	X											Yes	Yes
2	Information	X											Yes	Yes
3	Cleaning and disinfection	X											Yes	Yes
4	Number of apertures	X											Yes	Yes
5	Design and manufacture	X											Yes	Yes
6	Luminous transmittance		X										Yes	Yes
7	Variations in luminous transmittance			X									Yes	Yes
8	Increased robustness				X	X	X	X					Yes	Yes
9	High-speed particles								X	X	X	X	No	Yes
10	Corrosion		X										Yes	Yes
11	Ignition			X									Yes	Yes

X Testing shall be carried out on indicated specimen  
 Empty field No testing specified

If testing requires the oculars to be mounted, appropriate frames shall be used.  
 For testing, frames supplied without oculars fitted shall, where necessary, be fitted with appropriate oculars.  
 The sequence of tests 1 to 5 is not important and can be changed by the testing laboratory.  
 A specimen on which the high-speed particle test is being conducted need not be subjected to the increased robustness test.  
 Type test evaluation shall allow no defectives, and no account shall be taken of measurement uncertainty.

Table 7 — Application of eye protector types for the various fields of application

Field of use		Symbol	Type of eye protector		
			Non-mesh		Mesh
			Goggles	Face shield	
Basic use		None	+	+	+
Increased robustness		S	+	+	+
Optical radiation		a	+	+	O
High-speed particles <sup>b</sup>	Low-energy impact	+	+	+	+
	Medium-energy impact	+	+	+	+
	High-energy impact	O	O	O	+
Liquid droplets		3	+	O	O
Liquid splashes		3	+	+	O
Large particles		4	+	O	O
Gas and fine dust particles		5	+	O	O
Molten metals and hot solids		9 <sup>c</sup>	+	+	O
High-speed particles at extremes of temperature <sup>d</sup>		T	+	+	+
+ Allowable application					
O Prohibited application					
<p><sup>a</sup> The symbol for optical radiation consists of the scale number for the various types of filter and is marked on the ocular. If optical radiation is the only field of use for which protection is required, the frame need only comply with the requirements for basic use. Goggle and face shield housings, if applicable, shall be marked with the maximum compatible filter scale number.</p> <p><sup>b</sup> If the symbols F, B and A (see Table 4) are not common to both the ocular and the frame, it is the lower level which shall be assigned to the complete eye protector.</p> <p><sup>c</sup> For an eye protector to comply with field of use symbol 9, both the frame and the ocular shall be marked with this symbol together with one of the symbols F, B or A.</p> <p><sup>d</sup> Symbol T is used in conjunction with either F, B or A to indicate that the eye protector conforms to the high-speed particle classification at extremes of temperature.</p>					

## 9 Hearing protectors

### 9.1 General

Hearing protectors may be required to protect wildland firefighters from mechanically generated noise produced from equipment such as chainsaws, pumps and blowers. A risk assessment should be carried out to determine the need, if any, for the provision of hearing protectors.

These should not be used during firefighting.

### 9.2 Earmuff requirements

#### 9.2.1 Sizing

Earmuffs shall be classified into three size ranges:

- a) Small-sized range: earmuffs shall be so classified if their adjustability complies with 9.3.2.2 a) and 9.3.2.2 b), as appropriate.

- b) Medium-sized range: earmuffs shall be so classified if their adjustability complies with 9.3.2.3 a) and 9.3.2.3 b), as appropriate.
- c) Large-sized range: earmuffs shall be so classified if their adjustability complies with 9.3.2.4 a) and 9.3.2.4 b), as appropriate.

NOTE Any model of earmuff might fall into more than one size range.

## 9.2.2 Materials and construction

### 9.2.2.1 Materials

9.2.2.1.1 Those parts of the earmuffs that may come into contact with the skin shall be non-staining, soft, pliable and not known to be likely to cause skin irritation, allergic reaction or any other adverse effect on health.

9.2.2.1.2 All materials shall be visibly unimpaired after cleaning and disinfection by the methods specified by the manufacturer.

### 9.2.2.2 Construction

9.2.2.2.1 All parts of the earmuffs shall be rounded, smooth-finished and be free from sharp edges.

9.2.2.2.2 Earmuffs whose cushions and/or liners are intended by the manufacturer to be replaced by the wearer shall not require the use of tools for this purpose.

9.2.2.2.3 All universal earmuffs that have a mass in excess of 150 g shall be provided with a headstrap.

9.2.2.2.4 Earmuffs that are suitable for wearing only in the behind-the-head or under-the-chin modes, and that have a mass in excess of 150 g, shall be provided with a headstrap.

## 9.3 Performance

### 9.3.1 General

The requirements of 9.3.2 to 9.3.12 shall be satisfied.

Earmuffs shall be conditioned and tested in accordance with 4.1.1, 4.1.2 and 4.1.3 of EN 13819-1:2002.

### 9.3.2 Sizing and adjustability

#### 9.3.2.1 General

Sizing and adjustability shall be tested in accordance with 4.2 of EN 13819-1:2002 and the following requirements satisfied, as appropriate.

In the case of earmuffs incorporating a means of adjusting the headband force, these requirements shall be satisfied at both the maximum and the minimum force setting.

#### 9.3.2.2 "Small-sized range" earmuffs

- a) Over-the-head earmuffs: for each of the combinations of test dimensions shown by the letter S in EN 13819-1:2002, Table 1, the range of adjustment of the cups/headband and of the width between the cushions shall enable the earmuffs to be fitted to the fixture.
- b) Behind-the-head and under-the-chin earmuffs: for each of the combinations of test dimensions shown by the letter S in EN 13819-1:2002, Table 2, the range of adjustment of the cups/headband and of the width between the cushions shall enable the earmuffs to be fitted to the fixture.



### 9.3.2.3 “Medium-sized range” earmuffs

- a) Over-the-head earmuffs: for each of the combinations of test dimensions shown by the letter M in EN 13819-1:2002, Table 1, the range of adjustment of the cups/headband and of the width between the cushions shall enable the earmuffs to be fitted to the fixture.
- b) Behind-the-head and under-the-chin earmuffs: for each of the combinations of test dimensions shown by the letter M in EN 13819-1:2002, Table 2, the range of adjustment of the cups/headband and of the width between the cushions shall enable the earmuffs to be fitted to the fixture.

### 9.3.2.4 “Large-sized range” earmuffs

- a) Over-the-head earmuffs: for each of the combinations of test dimensions shown by the letter L in EN 13819-1:2002, Table 1, the range of adjustment of the cups/headband and of the width between the cushions shall enable the earmuffs to be fitted to the fixture.
- b) Behind-the-head and under-the-chin earmuffs: for each of the combinations of test dimensions shown by the letter L in EN 13819-1:2002, Table 2, the range of adjustment of the cups/headband and of the width between the cushions shall enable the earmuffs to be fitted to the fixture.

### 9.3.3 Cup rotation

When tested in accordance with 4.3 of EN 13819-1:2002, the contact between the cushions and the plates of the fixture shall be continuous insofar as it provides an unbroken barrier between the inside and outside perimeter of the cushions.

### 9.3.4 Headband force

When tested in accordance with 4.4 of EN 13819-1:2002, the headband force of each specimen shall not be greater than 14 N. In the case of earmuffs incorporating means of adjusting this force, it shall be possible to adjust the force to 14 N or less.

### 9.3.5 Cushion pressure

When tested in accordance with 4.5 of EN 13819-1:2002, the cushion pressure of each specimen shall be not greater than 4 500 Pa. For earmuffs incorporating means of adjusting the headband force, this requirement shall apply to the maximum force setting or 14 N, whichever is the lower.

### 9.3.6 Resistance to damage if dropped

The earmuffs (except for replaceable cushions) shall not crack when tested in accordance with 4.6 of EN 13819-1:2002. Neither shall any part of the earmuffs become detached, such that correct re-assembly requires the use of either a tool or a replacement part.

### 9.3.7 Resistance to damage if dropped at low temperature

When tested in accordance with 4.7 of EN 13819-1:2002, the earmuffs (except for replaceable cushions) shall not crack. Neither shall any part of the earmuffs become detached, such that correct re-assembly requires the use of either a tool or a replacement part.

### 9.3.8 Change in headband force, including optional water immersion — Headband under stress

The headband force of each specimen shall not change by more than  $\pm 15\%$  from that reported in 9.3.4 after the earmuffs have been subjected to the appropriate conditioning and tests specified in 4.1.3.7 a) to 4.1.3.7 j) of EN 13819-1:2002. If the headband force is reported in 9.3.4, at more than one size adjustment, the  $\pm 15\%$  limit shall apply only to the size adjustment that gave the highest initial force. Additionally, and in all cases, the final headband force of each specimen shall not exceed 14 N.

**9.3.9 Insertion loss**

The standard deviations reported in accordance with 4.1 of EN 13819-2:2002 shall be no greater than 4,0 dB in four or more adjacent one-third octave bands, and no greater than 7,0 dB in any individual one-third octave band.

**9.3.10 Resistance to leakage**

In the case of fluid-filled cushions, they shall not leak when the earmuffs are tested in accordance with 4.12 of EN 13819-1:2002.

**9.3.11 Ignitability**

When tested in accordance with 4.13 of EN 13819-1:2002, no part of the earmuffs shall ignite upon application of the heated rod nor continue to glow after removal of the heated rod.

**9.3.12 Minimum attenuation**

When tested in accordance with 4.2 of EN 13819-2:2002, the values (Mf – sf) of the earmuffs shall be not less than the values given in Table 8.

**Table 8 — Minimum attenuation requirement of earmuffs and earplugs**

<b>Frequency</b> Hz	125	250	500	1 000	2 000	4 000	8 000
<b>(Mf – sf)</b> dB	5	8	10	12	12	12	12
NOTE Mf are the mean attenuation data and sf the standard deviations as measured in accordance with EN 13819-2.							

**9.4 Earplug requirements**

**9.4.1 Sizing and adjustability**

**9.4.1.1 Aural earplugs**

The nominal diameter or, if appropriate, the range of nominal diameters of the earplugs shall be tested in accordance with 5.2 of EN 13819-1:2002 and reported.

Custom-moulded and semi-aural earplugs shall not be subjected to this test.

**9.4.1.2 Headband earplugs**

Adjustability shall be tested in accordance with 5.3 of EN 13819-1:2002 and the following requirements satisfied, as appropriate.

In the case of earplugs incorporating a means of adjusting the headband force, these requirements shall be satisfied at both the maximum and the minimum force setting.

- a) Over-the-head headband earplugs: for each of the combinations of test dimensions shown in Table 6 of EN 13819-1:2002, the range of fitting of the headband shall enable the earplugs to be fitted to the fixture.
- b) Behind-the-head and under-the-chin earplugs: for each of the combinations of test dimensions shown in Table 7 of EN 13819-1:2002, the range of fitting of the headband shall enable the earplugs to be fitted to the fixture.

## 9.4.2 Materials and construction

### 9.4.2.1 Materials

Those materials used in parts of earplugs coming into contact with the wearer's skin shall comply with the following requirements.

- a) The materials shall not be known to be likely to cause skin irritation, skin disorders, allergic reactions nor any other adverse effects to health within the lifetime of the use of the earplugs.
- b) If subject to contact with sweat, ear wax or other materials likely to be found in the ear canal, the materials shall not be known to undergo changes within the lifetime of the use of the earplugs, which would result in significant alteration to those properties of the earplugs that are required to be assessed when the earplugs are examined for compliance with 9.2 and 9.3.

### 9.4.2.2 Construction

**9.4.2.2.1** All parts of earplugs shall be designed and manufactured such that they are not liable to cause physical damage to the wearer if fitted and used according to the manufacturer's instructions.

**9.4.2.2.2** Any part of the earplugs that is likely to protrude outside the ear canal when fitted in accordance with the manufacturer's instructions shall be of such a construction that mechanical contact with the earplugs is unlikely to cause any injury to the ear.

**9.4.2.2.3** If inserted in accordance with the manufacturer's instructions, earplugs shall be capable of being readily and completely removed from the ear canal by the user, without the use of tools or instruments, when tested using a test panel of 16 subjects.

**9.4.2.2.4** If earplugs are marked re-usable, re-closable packaging suitable for ensuring hygienic storage between use shall be supplied with each pair of earplugs.

NOTE Information concerning compliance with this subclause and 9.2.2 may be derived from observations arising during the course of, or following, tests performed in order to determine compliance with 9.3.6.

## 9.4.3 Performance

### 9.4.3.1 General

The requirements specified in 9.4.3.2 to 9.4.3.6 shall be satisfied.

Earplugs shall be conditioned and tested in accordance with 5.1.1, 5.1.2 and 5.1.3 of EN 13819-1:2002.

### 9.4.3.2 Resistance to damage if dropped

The earplugs shall not crack when tested in accordance with 5.4 of EN 13819-1:2002; neither shall any part of the earplugs become detached, such that correct re-assembly requires the use of either a tool or a replacement part.

### 9.4.3.3 Resistance to damage if dropped at low temperature — Optional

The earplugs shall not crack when tested in accordance with 5.5 of EN 13819-1:2002; neither shall any part of the earplugs become detached, such that correct re-assembly requires the use of either a tool or a replacement part.

#### 9.4.3.4 Cleaning and disinfection

If earplugs are marked re-usable, after the earplugs have been cleaned and disinfected once in accordance with the manufacturer's instructions, there shall be

- a) no significant alteration to those initial properties of the earplugs that are required to be assessed when the earplugs are examined for compliance with 9.2 and 9.3, and
- b) no changes that would be expected to cause any significant alteration to the attenuation characteristics stated in accordance with 4.2 of EN 13819-2:2002.

#### 9.4.3.5 Ignitability

When tested in accordance with 5.6 of EN 13819-1:2002, no part of the earplugs shall ignite upon application of the heated rod nor continue to glow after the removal of the heated rod.

#### 9.4.3.6 Minimum attenuation

When tested in accordance with 4.2 of EN 13819-2:2002, the values ( $M_f - s_f$ ) of the earplugs shall be not less than the values given in Table 8.

## 10 Fire hood

### 10.1 General requirements

#### 10.1.1 Yoke interface area

The fire hood shall have a yoke creating an interface area with the PPE, the integrity of which shall be maintained.

#### 10.1.2 Sizing

The fire hood shall be manufactured in various sizes or shall vary in size, such that, when worn, the hood is close fitting to the head and neck without overstretching the material.

#### 10.1.3 Flexibility

The fire hood shall have flexibility to take up the shape of the wearer's head without discomfort and shall not restrict head movement.

#### 10.1.4 Comfort area

The fire hood shall be continuous except for the facial opening and, optionally, the top of the head; this area (top of the head) shall not exceed 100 cm<sup>2</sup>.

Due note shall be taken regarding the fit and compatibility between the helmet and the fire hood.

### 10.2 Pretreatment

#### 10.2.1 Washing

Where specified, test samples shall be subjected to five cleaning cycles in a front-loading horizontal drum machine, using 1 g/l IEC detergent in soft water, in accordance with the procedures of ISO 6330.

Washing shall be carried out in accordance with procedure 2A at  $(60 \pm 3)^\circ\text{C}$  and drying in accordance with procedure E (tumble drying), unless otherwise specified in the care labelling.

A laundry bag shall not be used.

### 10.2.2 Dry cleaning

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

A laundry bag shall not be used.

### 10.2.3 Preconditioning

Unless otherwise specified in the specific test methods, all specimens shall be conditioned for a minimum of 24 h by exposure to a temperature of  $(20 \pm 2)^\circ\text{C}$  and a relative humidity of  $(65 \pm 5)\%$  prior to testing.

## 10.3 Performance requirements

The performance requirements shall be met after preconditioning in accordance with 10.2.

### 10.3.1 Flame resistance — Surface ignition

#### 10.3.1.1 General

Flame resistance shall be tested in accordance with procedure A of ISO 15025 and shall satisfy the following requirements:

- a) no specimen shall exhibit hole formation;
- b) no specimen shall produce molten or flaming debris;
- c) the mean value of afterflame time shall be  $\leq 2$  s;
- d) any afterglow shall not spread from the carbonized area to the undamaged area after the cessation of flaming.

#### 10.3.1.2 Materials' thermal stability

All yarns, fibres and sewing threads utilized in the construction of the protective fabrics and firehood, when tested in accordance with ISO 3146 at a temperature of  $(260 \pm 5)^\circ\text{C}$ , shall not melt.

#### 10.3.1.3 Materials' thermal shrinkage

When tested in accordance with ISO 17493 at a temperature of  $(180 \pm 5)^\circ\text{C}$ , no firehood material shall melt, drip, ignite or shrink by more than 5 % in length or width.

### 10.3.2 Heat transfer — Flame exposure

When tested in accordance with ISO 9151, the hood shall achieve the performance given in Table 9.

**Table 9 — Heat transfer — Flame exposure**

Heat transfer index	Result
HTI <sub>24</sub>	$\geq 3,5$

**10.3.3 Heat transfer — Radiant exposure**

When tested in accordance with method B of ISO 6942 at a heat flux density of 20 kW/m<sup>2</sup>, the hood shall achieve the result given in Table 10.

**Table 10 — Heat transfer — Radiant exposure**

Heat transfer	Result
RHTI <sub>24</sub>	≥ 8

**10.3.4 Residual burst strength of material following radiant heat exposure**

Two specimens taken from the fire hood shall have a burst strength ≥ 300 kPa, after pretreatment of the material by method A of ISO 6942 at a heat flux density of 10 kW/m<sup>2</sup>, when tested in accordance with ISO 13938-2 using a test area of 7,3 cm<sup>2</sup> and a test time to burst of (30 ± 10) s.

**10.3.5 Seam burst strength**

One specimen of each seam type used in the construction of the fire hood shall have a burst strength ≥ 200 kPa when tested in accordance with ISO 13938-2 using a test area of 7,3 cm<sup>2</sup> and a test time to burst of (30 ± 10) s.

**10.3.6 Dimensional change**

The material or component assembly shall have a dimensional change ≤ 5 % when tested in accordance with ISO 5077.

**11 Respiratory protection**

For performance requirements for respiratory protective devices (RPD) for wildland firefighting, see EN 136, EN 137, EN 140, EN 143, EN 149, EN 405, EN 1827, EN 12941, EN 12942, EN 14387 or NFPA 1981.

If escape devices are also included, see ISO 1061, ISO 14529 (all parts), EN 13794, EN 402, EN 403, EN 404 and EN 1146.

NOTE Technical Committee ISO/TC 94/SC 15 is developing an International Standard for RPD for wildland firefighting.

**12 Compatibility**

**12.1 General**

Evaluations shall be made using two test subjects: one male, one female.

**12.2 Sizing**

Items being evaluated shall fit the test subjects according to the manufacturer's sizing information.

## 12.3 Compatibility for helmet, fire hood, clothing and eyewear interface

### 12.3.1 General

This subclause specifies the requirements for an ensemble of compatible items. However, the requirements shall not limit any agency's prerogative to choose individual items compliant if tested in accordance with this International Standard or any other standard deemed by that agency following a risk assessment to be fit for purpose.

In order to protect the wearer's eyes from harmful exposures, the wearing of the helmet shall not compromise the wearing and operation of the eyewear. This presupposes that the eyewear can be correctly positioned without taking off the helmet or the eyewear can only be positioned by taking off the helmet. In addition, after having correctly placed the eyewear, the wearer shall be able to easily and rapidly adjust the helmet.

NOTE Further assistance in the determination of compatibility is given in Annex A.

### 12.3.2 Donning evaluation

After donning the clothing and gloves and with the fire hood in the ready position (down around the neck), with the eye protectors in their recommended out-of-use position and the helmet within easy reach while standing, the wearer shall be able to don the eyewear, fire hood and helmet, and properly turn up and secure the clothing collar in position within 60 s.

At the end of the donning, a check needs to confirm that the eyewear is properly seated, all the items are properly donned and secured and that, while standing, the fire hood lies flat and there is at least a 25 mm overlap of the clothing collar and the helmet or helmet ear flaps and that there are no gaps in protection, otherwise the test shall be repeated.

Observe and report the procedures that are time-consuming and that are caused by items of equipment interfering with each other.

## 12.4 Compatibility for glove and clothing interface

Gloves shall be compatible with the sleeves of the firefighter's protective clothing. The glove cuff or wristlet shall not cover any trim (if applied) on the sleeve of the clothing.

There shall be no gap between the end of the sleeves of the protective clothing (not including any wristlets) and the glove body (not including any wristlets or cuffs). The gap shall be determined by measuring the clothing and glove on the wearer in the following positions:

- a) standing, hands together reaching overhead as high as possible;
- b) standing, hands together reaching forward, with body bent forward as far as possible;
- c) standing, hands together reaching to the side, with body bent to the side as far as possible;
- d) standing, hands together reaching back, with body bent back as far as possible.

## 12.5 Compatibility for coat and trouser interface

There shall be at least a 5 cm overlap of all layers of the protective suit, such that there is no gaping of the thermal protection when the protective garments are worn. The minimum overlap shall be determined by measuring the garments on the wearer in the following positions:

- a) standing, hands together reaching overhead as high as possible;
- b) standing, hands together reaching forward, with body bent forward as far as possible;

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- c) standing, hands together reaching to the side, with body bent to the side as far as possible;
- d) standing, hands together reaching back, with body bent back as far as possible.

### 12.6 Compatibility for footwear and trouser interface

The trousers shall extend below the top of the footwear at least 150 mm in the following positions:

- a) standing, hands together reaching overhead as high as possible;
- b) standing, hands together reaching forward, with body bent forward as far as possible;
- c) standing, hands together reaching to the side, with body bent to the side as far as possible;
- d) standing, hands together reaching back, with body bent back as far as possible.

## 13 Marking and labelling

### 13.1 General marking requirements

Any labels or accessories shall not adversely affect the performance of any item to which they are attached or present a hazard to the wearer.

Labels shall be tested for flammability in accordance with 4.5.1.1, only where placed on the exterior of the PPE. Marking requirements shall be in accordance with ISO 13688.

### 13.2 Label durability and legibility

Labels, when examined at a distance of 300 mm in a well-illuminated area by a person with 20/20 vision or vision corrected to 20/20, shall remain legible after the following pretreatments:

- a) laundering as specified in 4.3.1;
- b) melt resistance, as specified in 4.5.4.1, if located on the interior of the PPE next to the skin;
- c) abrasion for 200 cycles in accordance with ISO 12947-2, with a 12 kPa pressure and using a wetted felt abrasive.

### 13.3 Compliance marking requirements

Each article of PPE, except for footwear, for which compliance with this International Standard is claimed, shall have a label permanently and conspicuously attached, upon which the following information is printed in letters at least 1,5 mm high:

- a) designation of type as appropriate;
- b) name, trademark or other means of identifying the manufacturer;
- c) style/model designation;
- d) size;
- e) reference to this International Standard, i.e. ISO 16073:2011;
- f) the pictogram given in Figure 6 with "ISO 16073" printed as shown.



The language used in the pictogram should be the language of the country of publication.



Figure 6 — Pictogram

## 13.4 Additional marking requirements

### 13.4.1 Helmets

A label shall be attached to each helmet stating the following.

- a) “For adequate protection, this helmet must fit or be adjusted to the size of the user’s head.

This helmet is made to absorb the energy of a blow, by partial destruction or damage to the shell and the harness and, even though such damage may not be readily apparent, any helmet subjected to severe impact should be replaced.

The attention of users is also drawn to the danger of modifying or removing any of the original component parts of the helmet.”

- b) The mass, if this exceeds 400 g.
- c) The optional requirements complied with. These may be marked as:
- “-20 °C” for the low temperature requirement;
  - “LD” for the lateral deformation requirement;
  - “440 V” for the electrical insulation requirement.

### 13.4.2 Eye protectors

#### 13.4.2.1 General

The marking shall be fully visible when the complete eye protector is assembled and shall not encroach into the minimum field of vision. Outside of this area, the marking shall not impede vision when worn.

The reference to this International Standard (i.e. ISO 16073) shall be applied to frames and housings, but need not be applied to oculars.

The frame and ocular shall be marked separately. If the ocular and frame form a single unit, the complete marking shall be applied to the frame.

**13.4.2.2 Ocular marking**

The marking of oculars shall contain the relevant technical information presented in a horizontal line in the following order:

- a) scale number (filters only);
- b) identification of the manufacturer;
- c) symbol for mechanical strength (if applicable);
- d) symbol for non-adherence of molten metal and resistance to penetration of hot solids (if applicable);
- e) symbol for resistance to surface damage by fine particles (if applicable);
- f) symbol for resistance to fogging of oculars (if applicable);
- g) symbol for enhanced reflectance (if applicable);
- h) symbol for original or replacement ocular (optional);
- i) possible inclusion of a mark to assist correct fitting of laminated oculars.

**13.4.2.3 Optical class**

One of the two optical classes shall be included in the marking in the position shown.

**13.4.2.4 Mechanical strength**

Symbols relating to oculars that withstand one of the various mechanical strength tests shall be included in the marking. The identification of the symbols is given in Table 11.

**Table 11 — Identification symbols for mechanical strength**

Symbol	Mechanical strength requirement
F	Low-energy impact
B	Medium-energy impact
A	High-energy impact

**13.4.2.5 Resistance to surface damage by fine particles**

Oculars that meet the requirements shall be marked with the symbol K.

**13.4.2.6 Resistance to fogging of oculars**

Oculars that meet the requirements shall be marked with the symbol N.

**13.4.2.7 Original/replacement oculars**

To identify whether an ocular is an original or a replacement, the manufacturer may use the symbols “O” (original) or “∇” (replacement).

### 13.4.2.8 Resistance to high-speed particles at extremes of temperature

Oculars that meet the requirements shall be marked with one of the impact symbols followed by the letter “T”, i.e. FT, BT or AT. See Table 11.

### 13.4.2.9 Frame marking

The marking of frames shall contain the relevant technical information presented in a horizontal line in the following order:

- a) identity of the manufacturer;
- b) reference to this International Standard, i.e. ISO 16073:2011;
- c) field(s) of use (if applicable);
- d) symbol for increased robustness/resistance to high-speed particles/extremes of temperature (if applicable);
- e) symbol indicating that the eye protector is designed to fit a small head (if applicable);
- f) highest ocular scale number(s) compatible with the frame (if applicable).

### 13.4.2.10 Field of use

The frames of eye protectors shall be marked to indicate their intended field of use. The marking symbol shall comprise a single digit number, as defined in Table 12. If the eye protector covers more than one field of use, the appropriate numbers shall be applied consecutively on the frame in ascending numerical value.

**Table 12 — Symbols for field of use**

Symbol	Designation	Description of fields of use
No symbol	Basic use	Unspecified mechanical hazards and hazards arising from ultraviolet, visible, infra-red and solar radiation
3	Liquids	Liquids (droplets or splashes)
4	Large dust particles	Dust with a particle size > 5 µm
5	Gas and fine dust particles	Gases, vapours, sprays, smoke and dust with a particle size < 5 µm

### 13.4.2.11 Increased robustness and resistance to high-speed particles

Frames that satisfy the requirements shall be marked with the appropriate symbol given in Table 13.

**Table 13 — Symbols for resistance to increased robustness and high-speed particles**

Symbol	Description of the level of impact
S	Increased robustness
F	Low-energy impact
B	Medium-energy impact
A	High-energy impact
NOTE	<p>Symbols S and F can be applied to all types of eye protectors.</p> <p>Symbol B can be applied to goggles and face shields only.</p> <p>Symbol A can be applied to face shields only.</p>

#### 13.4.2.12 Resistance to high-speed particles at extremes of temperature

Frames that meet the requirements shall be marked with one of the impact symbols followed by the letter T, i.e. FT, BT or AT. See Table 11.

#### 13.4.2.13 Frames designed to fit a small head

If the frame is designed to fit a small head it shall be marked with the letter H.

#### 13.4.2.14 Highest ocular scale number

Housings of goggles and face shields intended to provide protection against optical radiation shall be marked with the maximum scale number(s) of filtering ocular which may be fitted.

#### 13.4.2.15 Marking of eye protectors where the frame and ocular form a single unit

Eye protectors in which the frame and ocular form a single unit shall be marked on the frame. The marking shall comprise the full ocular marking, a hyphen, reference to this International Standard (i.e. ISO 16073) and any appropriate symbols for field of use and level of impact.

The following example illustrates this principle.

**EXAMPLE** Single-unit eye protector with ultraviolet filter effect resistant to low-energy impact, resistant to adherence of molten metal and penetration of hot solids, with the frame offering protection against liquids, molten metals and hot solids and being resistant to low-energy impact.

**2-4 X 2 F 9-16073 3 9 F**

2-	Code number for ultraviolet filters
4	Shade number
X	Identity of the manufacturer
2	Optical class
F	Symbol for low-energy impact
9	Symbol for molten metals and hot solids
-16073	reference to this International Standard
3	Symbol for liquids
9	Symbol for molten metals and hot solids
F	Symbol for low-energy impact

#### 13.4.3 Hearing devices

In the case of earmuffs intended by the manufacturer to be worn in a particular orientation, there shall be an indication of the FRONT and/or TOP of the cups, and/or an indication of LEFT and RIGHT cup.

The earplugs or the smallest packaged quantity supplied by the manufacturer shall carry the following additional information:

- whether the earplugs are disposable or re-usable;
- instructions for fitting and use, which shall indicate the need for proper fitting;
- for custom-moulded earplugs, a specific marking or colour coding on each earplug to differentiate between left and right;
- the nominal diameter designations of the earplugs (except for custom moulded and semi-aural earplugs).

#### 13.4.4 Fire hood

Labels shall be positioned in the area defined as the yoke of the fire hood.

### 14 Manufacturer's information

#### 14.1 General

The PPE shall be supplied to the client accompanied by instructions written at least in the official language(s) of the country of use. All this information shall be clear. It shall comprise (if possible or applicable):

- a) name, trademark or other means of identification of the manufacturer or their authorized representative;
- b) designation of the product type, commercial name or code;
- c) pictograms and levels of performance, if applicable;
- d) care labelling;
- e) name and full address of the manufacturer and/or their authorized representative;
- f) name and full address and identification number of the notified body involved in type approval and/or quality control;
- g) reference to this International Standard, i.e. ISO 16073:2011;
- h) explanation of any pictograms and level of performance; a basic explanation of the tests that have been applied to the PPE and a corresponding list of performance levels, preferably in a table of performance;
- i) all main constituent materials of all layers of PPE;
- j) instructions for use as appropriate for the specific standard:
  - 1) tests that shall be carried out by the wearer before use;
  - 2) fitting: how to don and doff;
  - 3) instructions concerning appropriate use of the product to minimize the risk of injury;
  - 4) limitations on use (temperature range, etc.);
  - 5) instructions for storage and maintenance, with maximum periods between maintenance checks;
  - 6) complete instructions for cleaning and/or decontamination (e.g. cleaning temperature, drying process, pH value, mechanical action, maximum number of cleaning cycles);
  - 7) warnings against problems likely to be encountered (e.g. domestic washing of contaminated clothing);
  - 8) details of additional items of protective equipment that need to be used to achieve the protection intended;
  - 9) information about any materials used in the product that may cause allergic responses or may be carcinogenic, toxic or mutagenic;
  - 10) details of any significant ergonomic penalties incurred by using the product, such as a reduction of the field of vision, acuity of hearing or a risk of heat stress;

- 11) instructions on how to recognise ageing and loss of performance in the product;
- 12) if helpful, illustrations, part numbers, etc., shall be added;
- 13) instructions concerning repair;
- k) reference to accessories and spare parts, if relevant;
- l) type of packaging suitable for transport, if relevant.

## **14.2 Manikin testing information**

### **14.2.1 General**

The information in 14.2.2, 14.2.3 and 14.2.4 shall be available to the user from the manufacturer upon request.

### **14.2.2 Optional clothing testing — General information**

The results of the optional testing in 4.10 with at least the following details:

- a) name and address of the laboratory in which the testing of 4.10 was carried out;
- b) any special pretreatment of any part of the component or clothing assembly prior to the testing in 4.10 or, alternatively, a statement that the garment ensemble did not have any special pretreatment;
- c) a description of any holes or cuts that were necessary to be made in the component or clothing assembly to accommodate cable connections or other necessary parts of the test manikin;
- d) the total number and general arrangement of the burners used to create the flash fire exposure;
- e) the nominal heat flux density level, the duration of the exposure and the duration of the data acquisition time for the test.
- f) Identification of the software and burn prediction model used to process the data from the sensors.

### **14.2.3 Test results**

The results of the testing according to 4.10 described in the test report (see 14.2.2) as follows:

- a) predicted area of second-degree burn injury (%) on manikin;
- b) predicted area of third-degree burn injury (%) on manikin;
- c) predicted total area of burn injury (sum of the second-degree and third-degree burn injury in percent and associated variation statistics such as standard deviation) on manikin.

### **14.2.4 Comments**

Comments on the test results given in 14.2.3 shall include the following:

- a) intensity and duration of afterflame;
- b) amount of smoke generated during and after the test, if measured;
- c) stability of the component or clothing assembly during and after the test, with particular reference to the amount of dimensional change;

d) any adverse behaviour of any components of the assembly (e.g. melting, dripping, prolonged afterflame).

Any other information relating to the test may be included to assist in interpretation of the test results.

Measurements shall be taken from the innermost and outermost layers.

After testing, it is possible that the materials in the specimen may be so badly damaged that accurate measurement is not possible. In this case, observations shall be made with regard to the amount of change in dimensional stability seen as a result of the test.

NOTE Results of the whole garment testing performed by different laboratories cannot be compared directly because there is currently too much variation in results between different laboratories.

## **Annex A** **(informative)**

### **Compatibility**

#### **A.1 Compatibility for entire ensemble**

This annex is designed to further assist in the determination of compatibility of wildland firefighting PPE.

The complete PPE ensemble that is used to meet the performance requirements of this International Standard should be comprised of all items.

If items of the ensemble have different levels of flame and thermal performance and are not compatible, the agency should undertake the assessment itself.

The coat collar should be compatible with the head and face protection.

The fire hood should fit around the eyewear without reducing the field of view.

#### **A.2 Whole ensemble thermal resistance**

The complete PPE ensemble that is used to meet the performance requirements of this International Standard shall be tested in accordance with ISO 13506 using a heat flux density of  $84 \text{ kW/m}^2$  and exposure time of 4 s. If this test is carried out, the test results shall be reported in accordance with 14.2.

Accessories for use with the PPE shall be included in the testing.

If modifications of the mannequin permit the testing of PPE other than garments, this should be carried out. Interlaboratory trials shall indicate a good reproducibility and repeatability of the test.



## **Annex B** (informative)

### **Guidelines for personal protective equipment design**

#### **B.1 Materials**

The materials used for the different items of the firefighter's PPE should not induce any risk or other inherent nuisance factors.

#### **B.2 Design**

The PPE should be designed to avoid as much as possible any restriction in movement during the tasks undertaken by firefighters.

#### **B.3 Donning and doffing**

PPE should be designed to allow the firefighter to get dressed or undressed easily and as quickly as possible.

#### **B.4 Loose-fitting garments**

Loose-fitting garments are as important as the fire resistance of materials in minimizing the risk of injury. A garment that is tight fitting poses a danger to the wildland firefighter from radiant heat and heat stress while, at the same time, diminishing the firefighter's ability to perform.

#### **B.5 Weight**

Garments should be light and flexible in order to be effective without inducing excessive heat stress in the wearer.

#### **B.6 Coat/trouser overlap**

As a guide, the coat/trouser clothing assembly should be equipped with an interface area of a minimum of 5 cm overlap between the two-piece coat and trouser clothing assembly, which should be maintained, for example, during stooping, reaching or turning movements.

#### **B.7 Neck protection**

The garment should be designed to protect the neck area and should join well with the hood and head protection.

#### **B.8 Accessories**

Closure systems, any label, accessory, touch-and-close fastener, retroreflective/fluorescent material, etc. attached to the protective clothing should not adversely affect the clothing's performance.

## **B.9 Pockets**

Pocket flaps should be able to maintain a pocket as being closed. As a guide, a pocket flap may be 20 mm larger than the opening in order to avoid the flap being placed inside the pocket.

## **B.10 Prevention of entry of burning debris**

All closure systems should be designed to prevent the entry of burning debris.

## **B.11 Closure systems**

Trousers and sleeves should have a closure system that allows the ends of the trousers and sleeves to interface sufficiently well with footwear and gloves that may be used for wildland firefighting.

## **B.12 Gloves**

Gloves should be compatible with the sleeves of the firefighter's protective clothing.

## **B.13 Labels**

Any label or accessory should not adversely affect the performance of the gloves or present a hazard to the wearer.

## **B.14 Training**

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

## Annex C (normative)

### Grip test — Gloves

#### C.1 Principle

The barehanded lifting capacity of a test subject using a halyard and a set of weights is compared with the same test subject wearing wet gloves on a dry and wet halyard.

#### C.2 Equipment

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

#### C.3 Specimens

A minimum of three pairs of gloves each from the smallest and largest size within the manufacturer's range shall be used for testing by at least two different test subjects. Each pair of gloves, as a complete set of gloves, shall be tested in the new, as-distributed condition.

The laboratory shall ensure that glove specimens do not receive special softening treatments prior to tests. Glove specimens shall be conditioned as specified in 5.4, if required, and in accordance with the pretreatment specified in 5.3.

#### C.4 Procedure

**C.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 to the hand circumference for small and large gloves.

**C.4.2** Each test subject shall make three successive attempts to lift as much weight as possible using the halyard and both hands, keeping both feet firmly planted on the ground while pulling downward on the halyard. The average weight hoisted over the three trials shall be the barehanded weight-lift capability.

**C.4.3** Dry-conditioned specimen gloves shall be tested on a dry rope and then on a wet rope.

**C.4.4** Wet-conditioned specimen gloves shall be tested on a dry rope and then on a wet rope.

**C.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.

**C.4.6** The weight-pulling capacity of a test subject with gloves shall be compared with the barehanded weight-lift capability. The percentage of weight-pulling capacity with gloves to barehanded weight-lift capability shall be calculated using the following equation:

$$C_{\text{bare}} = \frac{m_{\text{wp}}}{m_{\text{lift}}} \times 100$$

where

$C_{\text{bare}}$  is the barehand control, as a percentage;

$m_{\text{wp}}$  is the weight-pulling capacity with gloves, as a percentage;

$m_{\text{lift}}$  is the barehanded weight-lift capacity, as a percentage.

## C.5 Rope conditioning

### C.5.1 Dry rope

The rope shall be stored for 20 h to 24 h at standard temperature ( $20 \pm 2$ ) °C and standard relative humidity ( $65 \pm 5$ ) %.

### C.5.2 Wet rope

The rope shall be preconditioned in accordance with method 1 given in 4.6 of EN 13087-1:2000. Grip testing on the wet rope shall be completed within 15 min of removal of the rope from the water.

## C.6 Report

The percentage of barehand control for each glove pair specimen, condition and test subject tested shall be reported.

One or more glove pair specimens failing this test shall constitute a failing performance.

## Annex D (normative)

### Thermal stability of helmets and eyewear at elevated temperatures

#### D.1 General

This annex sets out two methods for determining the thermal stability of head protective devices and eye protective devices.

#### D.2 Principle

Items of head protective devices and eye protective devices are examined after exposure to elevated temperatures under the following conditions.

- a) TEST 1: Sample items of head protective devices and eye protective devices are heated in an oven over a specified prolonged period of time.
- b) TEST 2: Sample items of head protective devices and eye protective devices are heated at a higher temperature than in test 1, for a specified very short period of time.

#### D.3 Apparatus

**D.3.1 Headform**, constructed of rigid non-metallic material.

**D.3.2 Oven for test 1**, circulating-air type in accordance with ISO 17493, having a minimum volume of 0,28 m<sup>3</sup>, capable of maintaining a temperature of  $(180 \pm 3)$  °C.

**D.3.3 Oven for test 2**, circulating-air type in accordance with ISO 17493, having a minimum volume of 0,28 m<sup>3</sup>, capable of maintaining a temperature of  $(260 \pm 6)$  °C.

#### D.4 Test 1

##### D.4.1 Procedure

- a) Preheat the rigid headform to  $(180 \pm 3)$  °C for a period not less than 1 h.
- b) Place a sample head protective device and eye protective device on the headform in the oven for a period of  $4 \text{ h} \pm 30 \text{ min}$ . The temperature of the oven throughout this period shall be maintained at  $(180 \pm 3)$  °C.
- c) After removal from the oven and being left to cool to ambient temperature, the head protective device and eye protective device shall be examined for signs of visible deformation, including any streaking or buckling of the outer surface.

#### D.4.2 Test report

The test report shall contain the following information:

- a) identity of the test samples;
- b) any sample preparation or prior conditioning;
- c) the name of the test laboratory or authority responsible for performing the tests;
- d) date on which the test was carried out;
- e) any visible distortion of the item noted;
- f) any observation, in relation to either the test sample or the performance of the test, which might assist in the correct interpretation of the test results;
- g) reference to the test method, i.e. test 1 of Annex D of ISO 16073.

#### D.5 Test 2

##### D.5.1 Procedure

- a) Mount the head protective device and eye protective device on the headform at ambient temperature.
- b) Note the position of the item on the headform.
- c) Preheat the oven to a temperature of  $(260 \pm 6)$  °C.
- d) Place the sample item on the headform in the oven and close the door within 15 s.
- e) Remove the item and the headform after  $(90 \text{ s} \pm 15 \text{ s})$ . Timing shall commence immediately the door is closed.
- f) Allow to cool for not less than 2 min.
- g) Examine the item for signs of visible deformation. Any deformation shall be measured at the sides, back and front, in relation to the previously noted position of the item on the headform [see b)].

##### D.5.2 Report

The test report shall contain the following information:

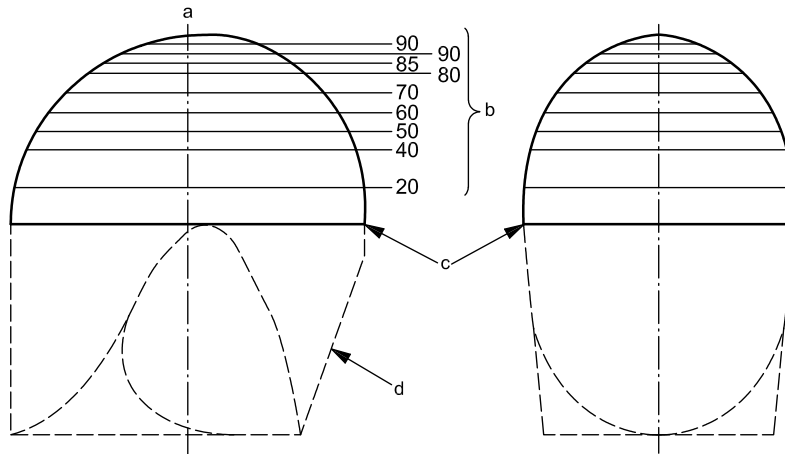
- a) identity of the test sample;
- b) any sample preparation or prior conditioning;
- c) the name of the test laboratory or authority responsible for performing the tests;
- d) date on which the test was carried out;
- e) any visible distortion of the item, and the amount of deformation;
- f) any observation, in relation to either the test sample or the performance of the test, which might assist in the correct interpretation of the test results;
- g) reference to the test method, i.e. test 2 of Annex D in ISO 16073.

## Annex E (informative)

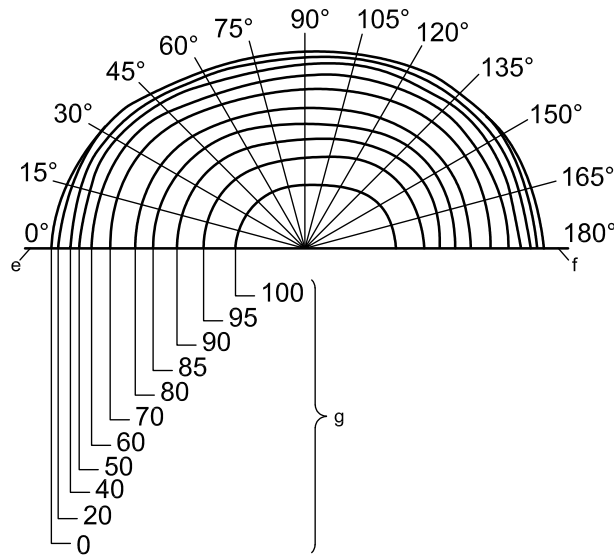
### Recommended method of construction of wooden headforms

- E.1** Each headform is built up from layers of hardwood having a density of 640 kg/m<sup>3</sup> to 720 kg/m<sup>3</sup> at a moisture content of 12 %.
- E.2** Above the reference line, the layers are planed to a thickness to match the datum levels and are cut to outlines plotted from the dimensions given in Table E.1, the grain being displaced by 90° from layer to layer.
- E.3** Below the reference line, the same procedure is recommended, but the layer thickness and profile are optional to suit the method of mounting.
- E.4** The layers are glued and screwed together.
- E.5** Accurate assembly is facilitated by making transverse and longitudinal axes on each piece and by drilling a small-diameter hole through its centre.
- E.6** The assembled headform is held in a press until the glue has hardened, after which the final shaping may be undertaken.
- E.7** The headform should be sealed with several coats of shellac polish. See Figure E.1.

Dimensions in millimetres



a)



b)

NOTE 1 For dimension *h*, see Table E.1.

NOTE 2 For polar coordinates of horizontal sections, see Table E.1.

- a Vertical axis.
- b Datum levels above the reference line.
- c Reference line.
- d Profile below the reference line (may be amended to suit the method of mounting).
- e Front face.
- f Rear face.
- g Reference lines.

Figure E.1 — Horizontal half-sections at datum levels



**Table E.1 — Polar coordinates of horizontal half-sections of headforms lettered D, G and K**

**Headform D — Dimension  $h = 94,5$**

Dimensions in millimetres

Datum level	0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180°
0	93	91	88	81	74,5	71,5	71	74	78	84	89,5	92	93
20	91	89,5	87	81	74,5	71,5	71	74	78	84	89,5	92	92,5
40	85	85	83,5	77,5	72	68,5	69	71	75	80,5	86	87	87,5
50	81	80,5	80	74	69	66	66	69	72	77,5	82,5	83	83,5
60	75	75	74	68	63,5	61	61	63,5	67,5	72	76	77	77,5
70	64,5	64,5	64,5	60	55,5	53	53,5	56	60	64,5	68	68,5	69
80	48,5	48,5	48,5	47	44,5	43	43	45	48,5	53,5	57,5	58	58
85	39	39	39	37	37	36	36	28	41	45,5	48,5	49	49
90	23	23	23	24	24,5	25	25	27	30	33	37	37	37

**Headform G — Dimension  $h = 99$**

Dimensions in millimetres

Datum level	0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180°
0	97,5	95,5	93	85,5	79,5	76	76	78,5	83	88,5	94	97	97,5
20	95,5	94	92	85,5	79,5	76	76	78,5	83	88,5	94	96,5	97
40	90	89	88	83	77	74,5	74	76,5	81	86	91	92	92
50	86,5	86	85	79,5	74	71,5	71,5	73,5	78,5	83,5	87,5	88,5	88,5
60	80,5	80	79,5	74	70	66,5	66	68,5	73	78	82	82	82,5
70	71	71	71	67	62,5	60	59,5	61,5	66,5	71,5	74,5	75	75
80	57,5	57,5	57,5	55	52	50	50	53	57	62	65	65	65
85	48	48	48	47	45	44	44	46	50	55,5	59	59	59
90	37	37	37	36	36,5	36	36	38	42	48	50	51	51
95	21	21	21	22	23	24	24	26	29	34	38	39,5	39,5

**Headform K — Dimension  $h = 104$**

Dimensions in millimetres

Datum level	0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180°
0	102,5	101	97	90	84	81,5	81	83,5	88	93	98,5	101,5	102,5
20	100,5	99	97	90	84	81,5	81	83,5	88	93	98,5	101	102
40	95	95,5	93	87	82	79	79	81,5	85	90	95	97	97,5
50	91,5	91	90	84,5	79	76,5	76,5	79	83	88	92,5	93	93,5
60	86	86	85	79,5	74,5	72	72,5	75	78,5	83	86,5	88	88,5
70	77,5	77,5	77,5	73	68,5	66	66	68,5	72	77	80	81,5	81,5
80	67	67	67	65,5	60,5	58	57,5	59,5	63	68	72	72,5	72,5
85	59,5	59,5	59,5	58	55	53	52	54	57	62,5	66	66,5	66,5
90	50	50	50	50	47	45,5	45,5	47,5	50,5	55,5	60	60	60
95	39	39	39	39	38	36,5	37,5	39	43	48	52	52,5	52,5
100	25	25	25	25,5	26	26	25	26,5	30	35	39	41	41

## Annex F (informative)

### Recommendations for the materials and construction of helmets

- F.1** The materials used in the manufacture of helmets should be of durable quality, i.e. their characteristics should not undergo appreciable alteration under the influence of ageing or of the circumstances of use to which the helmet is normally subjected (exposure to sun, rain, cold, dust, vibrations, contact with the skin, effects of sweat or of products applied to the skin or hair).
- F.2** For those parts of the harness coming into contact with the skin, the manufacturers should not use materials that are known to cause irritation.
- F.3** For a material not in general use, advice as to its suitability should be sought before use.
- F.4** The construction of the helmet should be essentially in the form of a hard shell having a smoothly finished outer surface (i.e. one which can be traversed without check) and necessary additional means of absorbing impact energy, such that not more than the prescribed force is transmitted when tested in accordance with this International Standard. The smooth profile of the helmet shell does not exclude reinforcing ribs.
- F.5** The helmet is intended to give the wearer protection against impact and penetration damage down to the headband level all around. Where appropriate, however, some type of suspension padding may be required between the headband and the shell so that protection identical to that given at the test point is effective elsewhere.
- F.6** Any devices fitted to the helmet should be so designed that they are unlikely to cause any injury to the wearer in the event of an accident. In particular, there should be no metallic or other rigid projections on the inside of the helmet such as might cause injury.
- F.7** No part of the helmet should have sharp protruding edges.
- F.8** Where stitching is used to secure the harness to the shell, it should be protected against abrasion.
- F.9** It should not be possible for the user to easily modify any part of the shock-absorbing device.

## Annex G (normative)

### Ease of donning and doffing test

#### G.1 Principle

The times for donning and doffing of one repeatedly washed glove shall be measured for the following combinations: dry hand with dry glove, wet hand with dry glove, dry hand with wet glove, wet hand with wet glove.

#### G.2 Specimens

A minimum of three glove pairs each for the smallest and largest size within the manufacturer's range shall be used for testing by at least two different test subjects. Specimens shall be pretreated as specified in 5.4.

#### G.3 Procedure

##### G.3.1 Hand sizes

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

##### G.3.2 Preliminary

Each donning and doffing trial shall start with the glove lying in front of the test subject and shall end when the glove is again lying in front of the test subject.

##### G.3.3 Timing

The time to don and doff one glove of the specimen pair shall be determined by measuring the time it takes for the test subject to don and doff the single glove on three consecutive trials without altering the specimen glove linings between trials.

The time to don and doff the glove shall be the average of all 18 trials (i.e. three trials times three gloves times two test subjects, one large and one small)

##### G.3.4 Donning and doffing instructions

The glove shall be donned in accordance with the manufacturer's donning procedure. The glove shall then be removed by grasping the finger tip(s) of the middle finger(s), while pulling the hand out of the glove.

The test subject shall be permitted to don and doff either the right hand or left hand glove according to the test subject's preference.

Where the glove cannot be donned because of detachment of the inner liner, or moisture barrier where fitted, then the trial for that glove shall be stopped. If any fingers cannot be fully inserted into the glove, then the trial for that glove shall be stopped.

### G.3.5 Trial conditions

The time to don and doff the glove shall be determined for four conditions:

- a) dry hands and gloves pretreated according to 5.4.1.
- b) dry hands and gloves pretreated according to 5.4.2.
- c) hands conditioned according to G.3.6 and gloves pretreated according to 5.4.1.
- d) hands conditioned according to G.3.6 and gloves pretreated according to 5.4.2.

### G.3.6 Wet hands test

The test subject's hands shall be completely submerged in room-temperature water ( $21 \pm 3$ ) °C for 10 s. Immediately thereafter, the test subject shall begin the trials required by G.3.5 c) or d).

## G.4 Report

The average donning and doffing times for the four conditions of dry hand with dry glove, dry hand with wet glove, wet hand with dry glove, and wet hand with wet glove shall be reported, as shall any incidence of inner liner or moisture barrier detachment or inability to fully insert all digits, which causes the test not to be completed.

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