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Ships and marine technology — Shipboard fire-fighters' outfits (protective clothing, gloves, boots and helmet)

Navires et technologie maritime — Équipement du marin pompier (vêtements de protection, gants, bottes et casque)

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Foreword

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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 22488 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 1, *Lifesaving and fire protection*.

Introduction

A fire on board a ship will be fought firstly and, in most cases, only by the ship's crew. Although they may have some training in fire-fighting activities, most crewmembers cannot be considered to be professional firefighters. In addition, fire-fighting operations on ships take place in environmental conditions (narrow paths, limited spaces, adverse sea conditions) in which free and easy movement is essential.

Existing International Standards for various components of firefighters' outfits, intended for use by professional firefighters in shore-based fire-fighting operations, are not well suited to use by firefighters on board ships, either in terms of the skill level of the user, or the environmental conditions typically found on ships. This International Standard, while drawing heavily on those International Standards for basic performance requirements, is intended to address the specific needs of non-professional firefighters in the shipboard environment.

Ships and marine technology — Shipboard fire-fighters' outfits (protective clothing, gloves, boots and helmet)

1 Scope

This International Standard specifies the protective clothing, gloves, boots and helmet to be used by ships' crews in fighting fires on board ships. These outfits are appropriate for the fighting of small- to medium-magnitude fires, before the operation of any installed fixed fire-fighting systems, and are not intended or suitable for entry into flames.

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 1421:1998, *Rubber- or plastics-coated fabrics — Determination of tensile strength and elongation at break*

ISO 4674-1:2003, *Rubber- or plastics-coated fabrics — Determination of tear resistance — Part 1: Constant rate of tear methods*

ISO 4920, *Textiles — Determination of resistance to surface wetting (spray test) of fabrics*

ISO 6487:2002, *Road vehicles — Measurement techniques in impact tests — Instrumentation*

ISO 6330:2000, *Textiles — Domestic washing and drying procedures for textile testing*

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

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

ISO 11612:—[1)], *Clothing for protection against heat and flame — Test methods and performance requirements for heat-protective clothing*

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

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

ISO 15383:2001, *Protective gloves for firefighters — Laboratory test methods and performance requirements*

1) To be published. (Revision of ISO 11612:2008)

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

ISO 20344:2004, *Personal protective equipment — Test methods for footwear*

ISO 20345:2004, *Personal protective equipment — Safety footwear*

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

3 Terms and definitions

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

3.1
afterflame time
length of time for which a material continues to flame, under the specified test conditions, after the ignition source has been removed

3.2
afterglow time
length of time for which a material continues to glow under specified test conditions, after cessation of flaming or, if no flaming occurs, after removal of the ignition source

3.3
closure system
method of fastening openings in the garment, including combinations of more than one method of achieving a secure closure

NOTE A closure system does not include seams.

3.4
flame-resistant
material or treatment feature which delays the transmission of flaming

3.5
flaming debris
material separating from the specimen during the test procedure with flaming

3.6
garment
single item of clothing which may consist of single or multiple layers

3.7
hardware
non-fabric components of protective clothing, including those made of metal or plastic material

EXAMPLE Zippers, hook-and-loop and other fasteners.

3.8
heat stress
rise in the wearer's temperature, caused by the restraining of radiation from the body such as sweating when protective clothing is worn, producing a range of potentially serious effects to the wearer's body

3.9
hole
break in the test specimen or material at least 5 mm by 5 mm in size caused by melting, glowing or flaming

3.10
inherently flame-resistant material
material made of fibres that are themselves non-combustible or flame-resistant

3.11
innermost material
material on the innermost face of a component assembly

3.12
innermost surface of garment
body side of the innermost material

3.13
molten debris
molten material separating from the specimen during the test procedure and falling from the specimen without flaming

3.14
multilayer clothing assembly
series of layers of garments arranged in the order as worn, which may contain multilayer materials, material combinations or separate layers of clothing material in single layers

3.15
outer material
outermost material of which the protective clothing is made

3.16
protective clothing
specific garments providing protection for the firefighter's upper and lower torso, neck, arms and legs, but excluding the head, hands and feet

3.17
retroreflective material
material which reflects in the opposite direction a beam of light directed on it

3.18
seam
junction of two edges of material which are permanently attached in the garment by sewing or any other method

3.19
self-extinguishing
feature which suspends the flaming under the specified test conditions after the ignition source has been removed

4 Design requirements

4.1 General

4.1.1 The protective clothing, gloves, boots and helmet shall be designed taking into consideration the mobility needed for shipboard fire-fighting, and the need to be able to wear breathing apparatus over the protective clothing.

4.1.2 Hardware fitted on the protective clothing, gloves, boots and helmet shall be designed and attached so as not to injure the wearer by heat transfer. Hardware shall also be designed and attached taking into consideration corrosion resistance, as well as the performance required by this International Standard for the complete outfit.

4.2 Protective clothing

4.2.1 The protective clothing, which consists of a single garment or a two-piece suit consisting of a jacket and pair of trousers, shall provide protection for the wearer's upper and lower torso, neck, arms and legs, but not head, hands and feet.

4.2.2 Where the protective clothing, gloves or boots consist of multiple layers, the layers shall be either permanently attached or else clear instructions for wearing them together shall be provided.

4.2.3 Closure systems shall be selected and installed such that they do not compromise the level of protection of the clothing.

4.2.4 The neck and cuffs of the protective clothing shall be designed and sized so as not to permit sparks or flame to enter into the protective clothing. This may be achieved in combination with the helmet and gloves. All pockets and slits with external openings shall be provided with a closure system or covered with a protective flap, which shall be stitched down or capable of fastening the pocket closed, so as to prevent sparks or flame entering.

4.2.5 The overlap between jacket and trousers shall not be less than 300 mm when worn by a test subject wearing garments of the correct size, standing upright with arms at sides. The wearer's skin at the overlap between the protective clothing and gloves or the protective clothing and boots shall not be easily exposed in use.

4.2.6 The protective clothing shall be designed to cover the upper part of the boots.

4.2.7 Protective clothing shall be fitted with combination retroreflective/fluorescent materials having a minimum combined width of 50 mm and giving all-round visibility, as specified in Annex F. When tested in accordance with EN 471:2003, 6.1, the coefficient of retroflection of retroreflective/fluorescent materials at an entrance angle of 5° and an observation angle of 0,2° shall comply with the requirements of EN 471. The fluorescent component of retroflective/fluorescent materials shall be in accordance with EN 471:2003, 5.1.1.

4.3 Gloves

Gloves shall conform to ISO 15383:2001, type 2.

4.4 Boots

Footwear for shipboard firefighters' outfits shall

— be of a boot design as specified in Annex A,

— comply with ISO 20345:2004, classification I or II, and

— comply with the additional performance and test requirements of this International Standard.

4.5 Helmets

4.5.1 The helmet shall be provided with a neck protector and visor, and shall protect the wearer's face, head and neck from heat and projections.

4.5.2 The helmet shall be designed taking into account the need to accommodate the use together with the helmet of a breathing apparatus.

4.5.3 The helmet shall be provided with a chin strap or other suitable means for fitting it securely on the wearer's head.

4.5.4 The inside of the helmet shall be provided with a means of adjusting the fit of the helmet. This means it shall be easily adjustable by the wearer without the use of tools. When this adjustment covers several sizes of head circumference, a relevant instruction shall be given in the information supplied by the manufacturer.

4.5.5 Helmet materials shall be flame-resistant or self-extinguishing.

4.5.6 The helmet shall provide protection against electric transmission to the wearer.

4.5.7 The helmet shall be designed to provide for air space between the wearer's head and the neck protector, and between the wearer's head and the helmet.

4.5.8 There shall be no sharp edges, roughness or projection on any part of the helmet in contact or potential contact with the head when worn, such as is likely to cause discomfort or injury to the wearer.

4.5.9 The visor shall be substantially colourless and transparent, and free of distortion.

5 Performance requirements and test methods for firefighter outfit components

5.1 General and sampling requirements

5.1.1 General

5.1.1.1 All tests shall be carried out on materials as received unless otherwise specified.

5.1.1.2 In all surface tests, the outermost surface is to be exposed unless otherwise specified.

5.1.2 Sampling

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

5.1.2.2 Except as otherwise specified herein, the number and size of specimens for each test shall be in accordance with the respective referenced standards.

5.2 Protective clothing

5.2.1 Pre-treatment

5.2.1.1 Metalized materials

Before carrying out the tests specified in 5.2.2, 5.2.3, 5.2.4 and 5.2.7, metalized materials shall be mechanically pre-treated in accordance with ISO 11612:—, Annex A, except that the mechanical pre-treatment shall be carried out 1 000 times.

5.2.1.2 Non-metalized materials

5.2.1.2.1 Before carrying out the tests specified in 5.2.2, 5.2.3, 5.2.4 and 5.2.7, inherently flame-resistant materials shall be washed and dried in accordance with ISO 6330:2000, procedure 2A, at (60 ± 3) °C and drying procedure E (tumble drying), or dry-cleaned in accordance with ISO 3175-1[1] for five cycles unless otherwise specified in the care labelling. If washing is permitted as well as dry cleaning, then the sample shall only be washed.

5.2.1.2.2 Before carrying out the tests specified in 5.2.2, 5.2.3, 5.2.4 and 5.2.7, materials that are not inherently flame-resistant shall be washed and dried in accordance with ISO 6330:2000, procedure 2A, at (60 ± 3) °C and drying procedure E (tumble drying), or dry-cleaned in accordance with ISO 3175-1[1] for 50 cycles unless otherwise specified in the care labelling. If washing is permitted as well as dry cleaning, then the sample shall only be washed.

5.2.1.3 After pre-treatment, shrinkage shall not be more than 3 %.

5.2.2 Flame resistance test

5.2.2.1 Materials, including retroreflective/fluorescent materials, shall be tested in accordance with ISO 15025:2000, procedure A. All materials used for visibility shall be tested, as specified, in combination with the outer layer, in order to make possible the taking of samples with the dimensions specified in ISO 15025. The following acceptance criteria apply.

a) No specimen shall exhibit flaming on the top or either of the side edges.

b) No specimen shall exhibit hole formation in any layer, except for a layer — other than the outer material or innermost lining — used for a specific type of protection other than heat protection (e.g. a layer providing protection against liquid penetration).

c) No specimen shall exhibit flaming or molten debris.

d) The mean value of afterflame time shall not be more than 2 s.

e) The mean value of afterglow time shall not be more than 2 s.

5.2.2.2 Internal parts of the legs and sleeves which may be easily reversed, and other internal materials which may be exposed to flame, such as materials within 10 cm of the jacket hem, and which are different from external parts, shall also be tested in accordance with 5.2.2.1.

5.2.2.3 Tested specimens shall include any materials or labels fitted to the outermost surface of the clothing.

5.2.3 Heat transfer (flame) test

When tested in accordance with ISO 9151 at an incident heat flux of 80 kW/m^2, the mean heat transfer index (HTI) shall be

a) mean $HTI_{24} \geq 13$, and mean $(HTI_{24} - HTI_{12}) \geq 4$, for a component assembly or multilayer clothing assembly,

or may be reduced to

b) mean $HTI_{24} \geq 10$, and mean $(HTI_{24} - HTI_{12}) \geq 3$, for the trousers of a two-piece suit and the legs of a coverall garment below the crotch.

NOTE Heat transfer indexes HTI_{24} and HTI_{12} are the times needed to raise the temperature on the innermost surface of the garment from the temperature at start of test by 24 °C and 12 °C respectively.

5.2.4 Heat transfer (radiation) test

When tested in accordance with ISO 6942 at a heat flux density of 40 kW/m^2, the mean radiant heat transfer index (RTHI) shall be

a) mean $RHTI_{24} \geq 18$ and mean $(RHTI_{24} - RHTI_{12}) \geq 4$ for a component assembly or multilayer clothing assembly,

or may be reduced to

b) mean $RHTI_{24} \geq 10$ and mean $(RHTI_{24} - RHTI_{12}) \geq 3$, for the trousers of a two-piece suit and the legs of a coverall garment below the crotch.

NOTE Radiant heat transfer indexes $RHTI_{24}$ and $RHTI_{12}$ are the times needed to raise the temperature on the innermost surface of the garment from the temperature at start of test by 24 °C and 12 °C respectively.

5.2.5 Tensile and tear strength tests

When tested in accordance with ISO 4674-1:2003, Method B, for tear strength, and ISO 1421:1998, Method 1 (metallized materials), or ISO 13934-1 (non-metallized materials) for tensile strength, the minimum tensile and tear strengths of the outer material shall be as follows in both the machine and cross directions:

a) tensile strength ≥ 450 N;

b) tear strength ≥ 25 N.

5.2.6 Heat-resistance test

Each material used in the protective clothing assembly, when tested in accordance ISO 17493 at a temperature of 180 °C, shall not melt, drip, separate or ignite. No material shall shrink by more than 5 %. Hardware exposed on the outside of the clothing shall function and closure systems shall be capable of being opened after the test. Retroreflective/fluorescent materials shall not melt, drip, separate or ignite.

5.2.7 Water-resistance test of outer material of clothing

When tested in accordance with the method of spray test in accordance with ISO 4920, the outer material shall give a spray rating of not less than 4.

5.2.8 Sewing thread

5.2.8.1 Tensile strength

When tested at a clamp distance of 250 mm and at a rate of traverse of (300 ± 20) mm/min, ten test specimens of sewing thread used in a firefighter's outfit shall have a tensile strength not less than 20 N.

5.2.8.2 Residual tensile strength when exposed to heat

The tensile strength test specified in 5.2.8.1 shall be repeated using samples exposed in accordance with ISO 17493 at a temperature of (180 ± 5) °C for 5 min. The specimens shall have a tensile strength of not less than 16 N.

5.3 Boots

5.3.1 Sampling and conditioning

The minimum number of samples (i.e. separate items of footwear) to be tested, together with the minimum number of test pieces taken from each sample, shall be in accordance with ISO 20344 and Table 1. Wherever possible, and unless otherwise stated, test pieces shall be taken from the whole footwear. If it is not possible to obtain a large enough test piece from the footwear, then a sample of the material from which the component has been manufactured may be used instead; this should be noted in the test report. Where samples are required from each of three sizes, these shall comprise the largest, smallest and a middle size of the footwear under test. All test pieces shall be conditioned in a standard atmosphere of (23 ± 2) °C and (50 ± 5) % relative humidity for a minimum of 48 h before testing unless otherwise stated in the test method. The maximum time elapsing between removal from the conditioning atmosphere and the start of testing shall be not greater than 10 min, unless otherwise stated in the test method.

Each test piece shall individually satisfy the specific requirement, unless otherwise stated in the test method.

Table 1 — Minimum number of samples and test specimens or test pieces

Test	Subclause of this International Standard	Number of samples	Number of test pieces from each sample
Laces melting	5.3.2.2.1	three laces	1
Thread melting	5.3.2.2.2	three threads	1
Contact heat	5.3.2.2.2.1	one pair	one pair
Radiant heat	5.3.2.2.2.2	one pair	one pair
Flame	5.3.2.2.2.3	one pair	one pair

5.3.2 Requirements

5.3.2.1 General requirements

Boots for shipboard firefighters' outfits shall be in accordance with Table 2 and one of the five options given in Table 3.

Footwear without a permanent insole is non-compliant with this International Standard.

Table 2 — General requirements for shipboard fire-fighters' boots

Classification	Requirement	International Standard		Classification (ISO 20345)		Marking or symbol
		ISO 20345	ISO 22488	I	II	
General whole footwear	Height of upper	5.2.1		X	X	
	Specific ergonomic features	5.3.4		X	X	
	Leak-proofness	5.3.3		N/A	X	
	Water resistance	6.2.5		X	N/A	
	Flame resistance		5.3.2.2.2.3	X	X	
Sole performance	Construction	5.3.1.1		X	N/A	
	Upper/outsole bond strength	5.3.1.2		X	N/A	
	Contact heat resistance	6.4.4		X	X	
	Heat insulation of the sole	6.2.3.1		X	X	
	Energy absorption of seat region	6.2.4		X	X	
	Penetration resistance	6.2.1		X	X	P
Toe protection	General	5.3.2.1		X	X	T
	Toe cap length	5.3.2.2		X	X	T
	Impact resistance	5.3.2.3		X	X	T
	Compression resistance of toe	5.3.2.4		X	X	
	Corrosion resistance of					
	— metal toe caps	5.3.2.5		X	X	
	— non-metallic toe caps	5.3.2.6		X	X	

Table 2 (*continued*)

Classification	Requirement	International Standard		Classification (ISO 20345)		Marking or symbol
		ISO 20345	ISO 22488	I	II	
Accessories	Thread/laces melting		5.3.2.2.1 5.3.2.2.2	O	N/A	
	Zipper		5.3.3.5	O	N/A	ϑ
	Eyelet and stud post attachment		5.3.3.6	O	N/A	
	Metatarsal protection	6.2.6		*	*	M
	Ankle protection	6.2.7		*	*	AN
Upper	Tear strength	5.4.3		X	X	
	Tensile properties	5.4.4		X	X	
	Water vapour permeability and coefficient	5.4.6		X	N/A	
	Chromium VI content	5.4.9		X	N/A	
	Water penetration and water absorption	6.3.1		X	N/A	
	Radiant heat resistance		5.3.2.2.2.2	X	X	
	Upper construction	6.3.2		X	X	
	Thread melting		5.3.3.1	O	N/A	
	Radiant heat		5.3.3.3	X	X	
	Flame resistance		5.3.3.4	X	X	
Vamp/quarter lining	Tear strength	5.5.1		X	N/A	
	Abrasion resistance	5.5.2		X	N/A	
	Water vapour permeability and coefficient	5.5.3		X	N/A	
	Chromium VI content	5.5.5		X	N/A	
Quarter lining	Tear strength	5.5.1		O	N/A	
	Abrasion resistance	5.5.2		O	N/A	
	Water vapour permeability and coefficient	5.5.3		O	N/A	
	Chromium VI content	5.5.5		X	N/A	
Tongue	Tear strength	5.6.1		O	N/A	
	Chromium VI content	5.6.3		O	N/A	
Insole	Chromium VI content		Table 3	X	N/A	
	Water absorption and desorption		Table 3	X	N/A	
	Abrasion resistance		Table 3	X	N/A	

Table 2 (*continued*)

Classification	Requirement	International Standard		Classification (ISO 20345)		Marking or symbol
		ISO 20345	ISO 22488	I	II	
Outsole	Tear strength	5.8.2		X	X	
	Abrasion resistance	5.8.3		X	X	
	Flexing resistance	5.8.4		X	X	
	Hydrolysis	5.8.5		X	X	
	Interlayer bond strength	5.8.6		O	O	
	Resistance to fuel oil	5.8.7		X	X	
	Cleated area and cleat design	6.4.1		X	X	
	Cleat height	6.4.3		X	X	
	Breast heel		5.3.2.3.1	X	X	
	Resistance to hot contact	6.4.4		X	X	

The applicability of a requirement to a particular classification in the table is indicated as follows:

X indicates an applicable requirement. In some cases, the requirement will relate only to particular materials within the classification (e.g. pH value of leather components). This does not mean that other materials are precluded from use.

O indicates a requirement is applicable provided the particular component part exists.

* indicates a requirement is applicable when the particular property is claimed.

N/A not applicable.

The absence of X, O or * indicates that there is no applicable requirement.

Table 3 — Basic requirements for insoles and insocks

Component to be assessed (insole present)		Requirement (ref. ISO 20345)					
			pH[a] (5.7.2)	Water absorption/ desorption (5.7.3)	Abrasion (5.7.4.1)	Chromium VI content[a] (5.7.5)	Abrasion (5.7.4.2)
1	No insock Seat sock present	Insole	X	X	X	X	
2	Full insock, non-removable	Insock and insole together		X			
		Insock	X			X	X
3	Full insock, removable and water permeable[b]	Insole	X	X	X	X	
		Insock	X			X	X
4	Full insock, removable, not water-permeable[b]	Insole	X	X	X	X	
		Insock	X	X		X	X

X indicates an applicable requirement.

[a] Leather only.

[b] A water-permeable sole is one that, when tested in accordance with ISO 20344:2004, 7.2, lets water through in 60 s or less.

5.3.2.2 Whole footwear

5.3.2.2.1 Laces and thread

When tested in accordance with 5.3.3.1, the laces and thread shall not melt, drip or ignite and shall remain functional.

5.3.2.2.2 Thermal behaviour

5.3.2.2.2.1 Contact heat

When tested in accordance with ISO 20344:2004, 8.7, at a temperature of 300 °C, rubber and polymeric outsoles shall not melt and shall not develop any cracks when bent around the mandrel. When tested in the same way, leather outsoles shall develop no cracks or charring which extend into the corium when bent around the mandrel.

5.3.2.2.2.2 Radiant heat

When tested in accordance with 5.3.3.3, the value of $RHTI_{24}$ shall be ≥ 35 s.

5.3.2.2.2.3 Flame resistance

When tested in accordance with 5.3.3.4, the footwear shall neither flame for more than 2 s (afterflame time) nor glow for more than 2 s (afterglow time). When the flame is removed, the footwear shall remain functional in accordance with Annex G.

5.3.2.2.2.4 Heat insulation of the sole

When footwear is tested in accordance with ISO 20344:2004, 5.12, the temperature increase on the upper surface of the insole shall be not greater than 22 °C. There shall be no distortion or embrittlement of the sole that reduces its functionality. The insulation shall be incorporated in the footwear such that it cannot be removed without damaging the footwear.

5.3.2.2.3 Impact and compression resistance of toe

When safety footwear is tested in accordance with ISO 20344:2004, 5.4 and 5.5, it shall comply with ISO 20345:2004, 5.3.2.3 and 5.3.2.4.

5.3.2.2.4 Electrical properties

Footwear shall be of rubber or other non-conducting material, as specified in ISO 20345:2004, 6.2.2.3.

5.3.2.3 Outsole

5.3.2.3.1 Heel breast

The outsole shall have an inclined-breast heel.

5.3.2.4 Accessories

5.3.2.4.1 Zipper (slide fastener)

When tested in accordance with 5.3.3.5.1, the attachment strength of the puller shall be greater than 250 N and the lateral strength shall be greater than 370 N.

5.3.2.4.2 Eyelet and stud post attachment

When tested in accordance with 5.3.3.6, the attachment strength shall be greater than 400 N.

5.3.3 Test methods

5.3.3.1 Thread and lace heat resistance test

5.3.3.1.1 Principle

This test method determines the melting point of thread, using a hot contact plate and magnifying glass.

5.3.3.1.2 Test apparatus

5.3.3.1.2.1 Electrically heated stage, having a circular depression large enough to insert a micro cover glass (5.3.3.1.2.3) and with a variable transformer for controlling the rate of input into the stage and an armoured stem thermometer with a range of (150 to 300) °C, accurate to ± 1 °C.

5.3.3.1.2.2 Low-powered magnifying glass (at least 10×).

5.3.3.1.2.3 Two micro cover glasses.

5.3.3.1.2.4 Spatula/pick needle or other instrument for applying pressure to the cover glasses.

5.3.3.1.2.5 Soxhlet extraction apparatus.

5.3.3.1.3 Specimen

The specimen shall be extracted with chloroform for a minimum of 20 extractions in a Soxhlet extractor (5.3.3.1.2.5) and dried. The specimen shall then be cut into lengths of 0,2 cm or less.

5.3.3.1.4 Test procedure

The apparatus shall be calibrated by determining the melting point of a pure material of known melting point. The melting point of the pure material shall be in the range of 240 °C to 260 °C. In subsequent determinations immediately following the initial determination, the stage (5.3.3.1.2.1) in each case shall be cooled to approximately 200 °C before the specimen is placed for testing. The specimen shall be placed in a small mound on a cover glass (5.3.3.1.2.3) and covered with another cover glass. The cover glasses shall be pressed together gently but firmly, and placed in a circular depression on the stage. The temperature of the stage shall be quickly raised to a temperature 240 °C below the expected melting point, and thereafter at a rate of 3 °C/min to 4 °C/min until a temperature of 260 °C is reached. Slight pressure shall be applied to the top cover glass using the spatula or pick needle (5.3.3.1.2.4) to ensure that it remains in contact with the complete fibre. The specimen shall be observed with the aid of a magnifying glass (5.3.3.1.2.2) and a determination made at 260 °C as to whether the specimen has ignited, melted or charred. Two different specimens shall be tested.

5.3.3.1.5 Report

Specimens which show ignition, melting or charring at or below 260 °C shall be reported as having failed the test. Specimens which do not show these characteristics at 260 °C shall be reported as having passed the test.

5.3.3.2 Contact heat test

Condition the samples for at least two days at a temperature of (23 ± 2) °C and a relative humidity of (50 ± 2) %. The test shall be conducted according to ISO 20344:2004, 5.12.

5.3.3.3 Radiant heat test

All different materials, including the seams and the closing mechanisms, shall be tested. At least three test pieces from the upper of one pair of footwear, with dimensions of at least 80 mm × 80 mm, shall be tested.

NOTE Test pieces include lining and padding.

The test pieces shall be tested according to ISO 6942:2002, Method B, at a heat flux density of 20 kW/m^2, exposing the outer surface of each test piece to the radiant heat. The result is the lowest value of t_{24}, as defined in ISO 6942:2002.

5.3.3.4 Flame resistance test

5.3.3.4.1 Conditioning

All different external materials, including external seams, as provided as a complete sample of footwear, shall be tested in accordance with ISO 15025 after being conditioned at (23 ± 2) °C and (50 ± 5) % relative humidity for at least 48 h. Testing shall be carried out within 10 min of the sample's removal from the conditioning atmosphere.

5.3.3.4.2 Test procedure

The test procedure is as follows.

a) Place the Bunsen burner on a flat surface with the burner and flame in a vertical position.

b) Secure the boot so that the appropriate part of the boot to be tested is (17 ± 1) mm directly above the top of the Bunsen burner.

c) Ignite the burner, preheat it for 2 min, and adjust the flame to (35 ± 2) mm in height in accordance with ISO 15025.

d) Ensure the burner is positioned as described in step b) above and apply the flame for 10 s to the designated area.

e) Remove the flame, and measure and record the after-flame and after-glow as defined in ISO 15025.

f) Repeat the procedures given in steps b) to e) for all the different external materials used in the construction of the footwear and external seams.

5.3.3.5 Zipper tests

5.3.3.5.1 Puller attachment strength

5.3.3.5.1.1 Principle

The puller is subjected to tension whilst the slider is rigidly supported.

5.3.3.5.1.2 Apparatus

Tensile testing machine which produces a constant rate of jaw separation of (100 ± 20) mm/min and which has a plate to mask the slider so that tension is confined to the puller and its attachment to the slider.

5.3.3.5.1.3 Procedure

Mount the slider in the lower jaw of the tensile testing machine (5.3.3.5.1.2) with the puller passed through the masking plate, clamping the end of the puller in the upper jaw of the machine so that tension is applied perpendicular to the slider. Set the testing machine in motion until failure occurs. Record the maximum force needed to induce failure. Three specimens shall be tested and the mean value recorded.

5.3.3.5.2 Lateral strength

5.3.3.5.2.1 Principle

The zipper is subjected to a lateral force to measure the resistance of the closed zipper to opening. The force needed to induce failure of the zipper is measured and the type of failure recorded.

5.3.3.5.2.2 Apparatus

Tensile testing machine with a jaw separation rate of (100 ± 20) mm/min, able to record the force throughout the test, and with gripping jaws 25 mm wide, constructed and finished so as not to damage the tape of the zipper.

5.3.3.5.2.3 Test specimens

The test specimens shall be three test pieces from one or more zippers, such that the minimum length of closed chain for each test is 75 mm.

5.3.3.5.2.4 Procedure

Clamp the test specimen in the jaws of the tensile testing machine (5.3.3.5.2.2) so that there is at least 25 mm of closed chain on either side of the jaws. The jaws shall be positioned 3 mm from the chain. See Figure 1.

Dimensions in millimetres

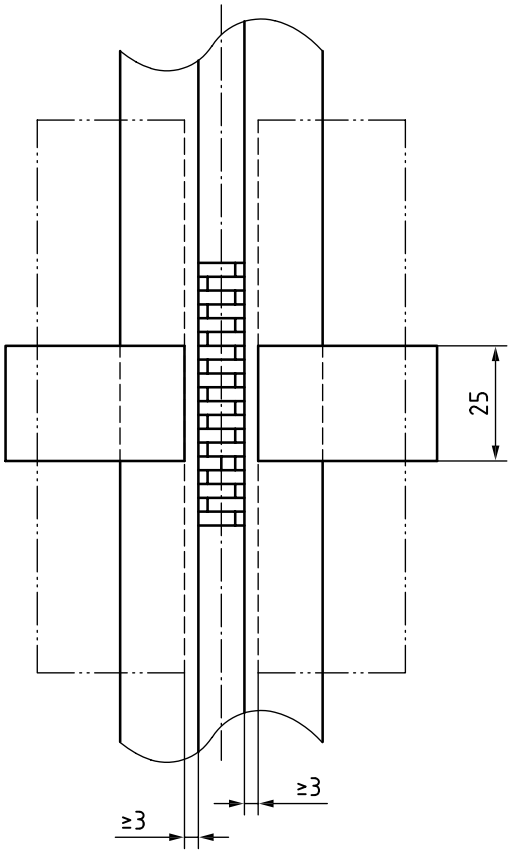


Figure 1 — Zipper test

Set the machine in operation and measure the force needed to induce failure. Three test pieces shall be tested and the mean value of the three test results reported.

5.3.3.6 Eyelet and stud post attachment

5.3.3.6.1 Principle

A test specimen which includes the eyelet or stud post is cut from the footwear. The test specimen is clamped in one jaw of a tensile testing machine, and a length of lace is inserted through the fastening and clamped in the second jaw. The force required to cause failure of the fastening is measured and the type of failure recorded.

5.3.3.6.2 Apparatus

5.3.3.6.2.1 Tensile testing machine with

a) a jaw separation rate of (100 ± 20) mm/min, and

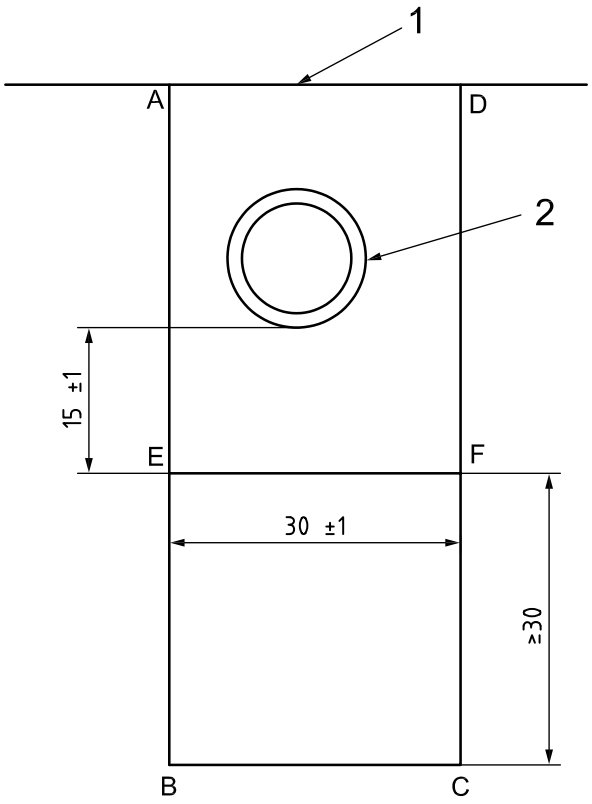
b) the capability of measuring tensile forces up to 1 kN.

5.3.3.6.2.2 Strong nylon or polyester lace of a mass that might be used with the fastening in the footwear.

5.3.3.6.3 Preparation of test specimens

Cut at least three test specimens from the footwear. Cut a rectangle from the facing as shown in Figure 2. Mark the clamping line (E–F in Figure 2) onto the test specimen (15 ± 1) mm from the eyelet or stud post.

Dimensions in millimetres



Key

1	edge of facing (also represented by line A–D)	E–F	clamping line
2	eyelet or other fastening	B–C	cut end of rectangular test specimen
		A–B, D–C	edges of 30 mm wide rectangular test sample

Figure 2 — Eyelet and stud sample

5.3.3.6.4 Procedure

Clamp the test specimen in one jaw of the tensile testing machine (5.3.3.6.2.1). Cut a piece of lace (5.3.3.6.2.2) of a length of at least 200 mm. Insert the lace through the eyelet or around the stud post, equalize the length of the two ends of the lace and insert side by side in the second jaw of the testing machine. Operate the tensile testing machine and stop the machine when any failure occurs that would make the fastener inoperative in wear. This may be

— tearing of the upper,

— distortion or breakage of the stud post,

— pulling out of the stud post eyelet or attachment rivets, or

— breakage of the lace.

Record the force, in newtons, at which failure occurs to the nearest 5 N. If breakage of the lace occurs, the result is invalid unless the result obtained is well above specification. If necessary, use a stronger lace. Calculate the arithmetic mean of the three test specimens and record this value together with the type of failure.

5.4 Helmet

5.4.1 Headform

A headform, constructed of hardwood or any material with equivalent thermal conductivity and complying with a recognized national or regional standard[2)], shall be used for the tests given in 5.4.3 to 5.4.7.

5.4.2 Pre-treatment

Prior to conducting the tests given in 5.4.3 to 5.4.7, the helmet under test shall be subjected to the following pre-treatment, as appropriate:

a) exposure to high temperature: the helmet shall be left in an atmosphere of (50 ± 2) °C for at least 2 h;

b) exposure to low temperature: the helmet shall be left in an atmosphere of (−10 ± 2) °C for at least 2 h;

c) water immersion: the helmet shall be left in water of temperature of (20 ± 2) °C for at least 4 h.

5.4.3 Exposure to UV light test

5.4.3.1 The test shall be carried out using a high-pressure Xenon 450 W lamp with quartz casing, operated in accordance with the manufacturer's instructions. Means shall be provided to support the helmet so that it is exposed to the radiation.

5.4.3.2 Secure the helmet so that the vertical axis through the crown of the helmet (as worn) is perpendicular to the axis of the lamp, and the distance between the crown of the helmet and the axis of the lamp is (150 ± 5) mm. The helmet shall be exposed to the radiation for (400 ± 4) h and then removed and allowed to return to laboratory ambient conditions.

5.4.3.3 After the test, there shall be no damage to, or deterioration of, the helmet.

5.4.4 Penetration test

5.4.4.1 When a test striker falls on a safety helmet securely worn on a headform, it is observed as to whether the striker touches the headform or leaves a visible scar on the surface of the headform.

5.4.4.2 A suitable apparatus is shown in Figure 3. The base of the apparatus shall be monolithic and sufficiently large to offer full resistance to the effect of the blow. The headform specified in 5.4.1, suitable for the size of test sample, shall be securely mounted in a vertical position on the base surface. Pressure-sensitive film, capable of directly detecting the point of contact, shall cover the surface of the headform with which the striker could come into contact[3)].

5.4.4.3 The striker shall have the following characteristics:

— mass: $3{,}0\ ^{+0{,}05}_{-0}$;

— angle of tip: (60 ± 0,5)°;

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2) EN 960[3] or JIS T 8131[4] is suitable for this purpose.

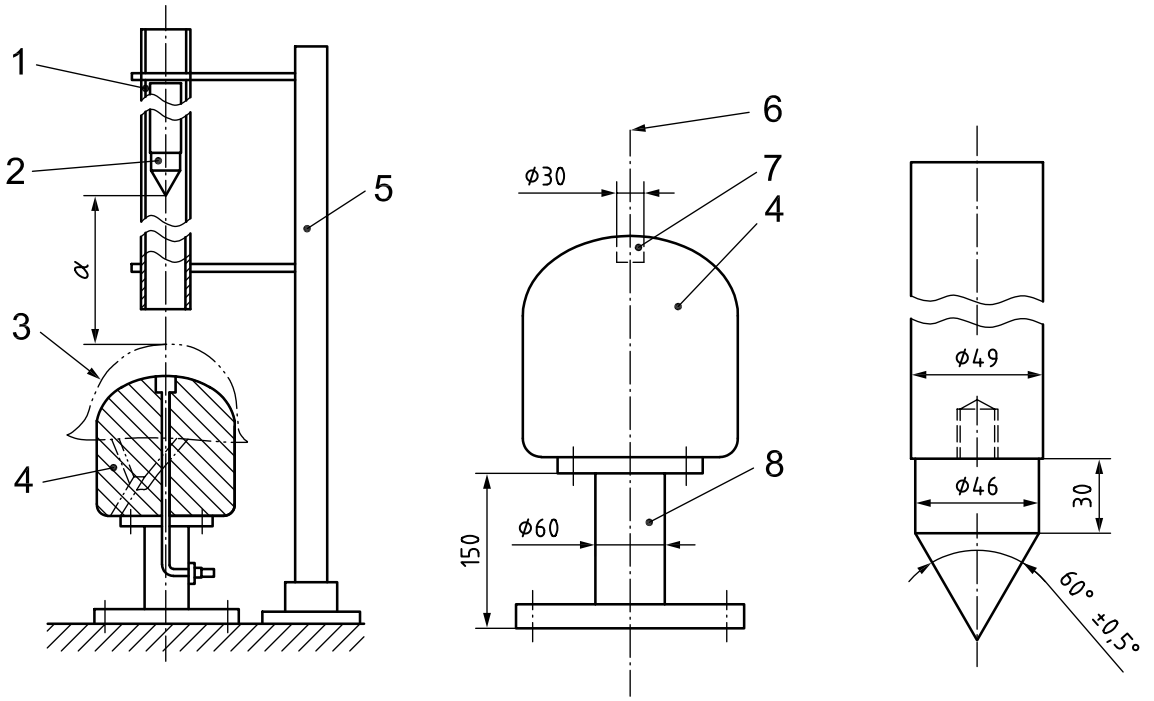
3) For additional test apparatus details, see EN 960[3] or JIS T 8131[4].

— radius of tip: (0,5 ± 0,1) mm;

— height of cone: approx. 40 mm;

— hardness of tip: min. 45 HRC.

Dimensions in millimetres



Key

1 guide pipe for dropping of steel striker
2 steel striker
3 safety helmet
4 headform
5 support
6 axis of striker
7 detecting part
8 support metal
α falling height

Figure 3 — Apparatus for penetration test

5.4.4.4 Position the striker above the headform so that the axis of the striker coincides with the vertical axis of the headform. The striker shall be arranged to fall in either free or guided fall. If guided fall, retardation due to the guide shall be minimized.

5.4.4.5 Test one sample after carrying out each of the pre-treatment procedures specified in 5.4.2, within 1 min of the removal of the sample helmet from the temperature-conditioning chamber or water bath. Then place the sample on the headform and adjust the means of fitting the helmet so as to maximize the space between helmet and headform. The striker shall be allowed to fall on the top of the helmet through a distance of (1 000 ± 5) mm, measured from the top of the helmet to the tip of the striker.

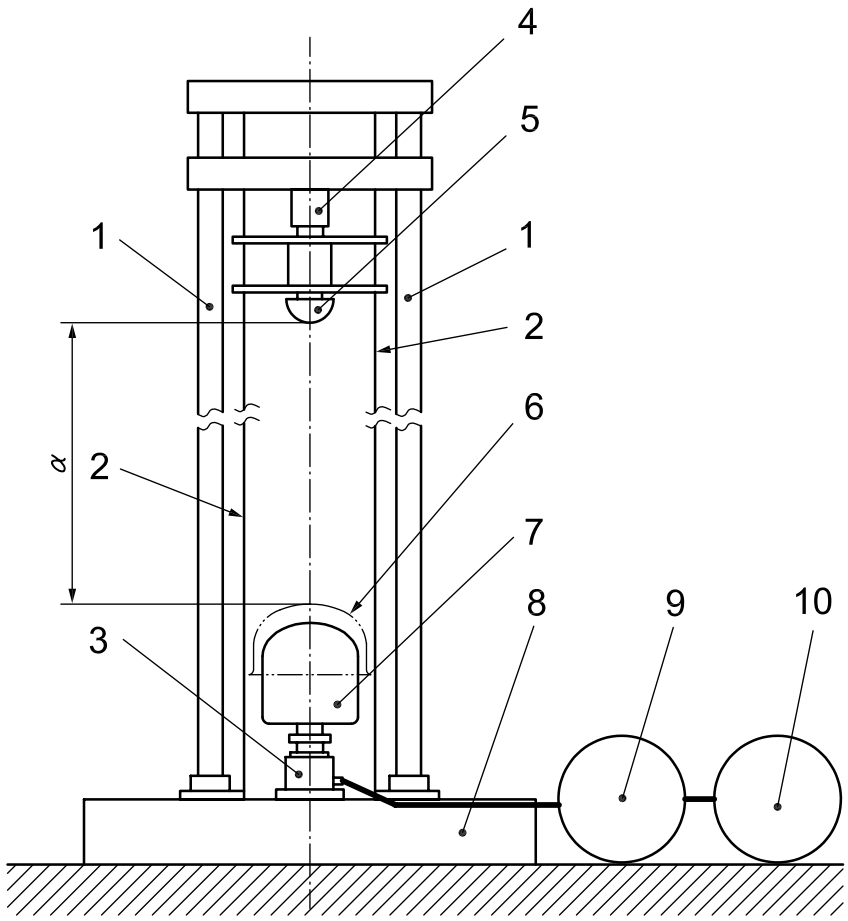
5.4.4.6 The striker shall not come into contact with the headform.

5.4.5 Shock absorption test

5.4.5.1 The shock absorption test is used to measure the force of the shock transmitted to the helmet rigidly mounted on a headform and the time elapse of the shock.

5.4.5.2 A suitable apparatus is shown in Figure 4. The base of the apparatus shall be 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. The headform shall be rigidly mounted so that the striking point is positioned vertically on the force transducer.



Key

1	support	7	headform
2	guide wire	8	concrete block
3	load meter	9	dynamic resistance strain gauge
4	electric magnet	10	recorder
5	hemisphere/plane striker	α	falling height
6	safety helmet		

Figure 4 — Apparatus for shock absorption test

5.4.5.3 Position a striker having a mass of (5,0 ± 0,1) kg and hemispherical face of 48 mm striking radius above the headform so that its axis coincides with the vertical axis of the headform. It may be dropped either freely or in guided fall; when guided fall is selected, the retardation due to the guide shall be minimized.

5.4.5.4 A non-inertial force transducer firmly attached to the base shall be used to measure the impact force. The force transducer shall be so positioned that its axis is coaxial with the path of the striker. The load meter shall be able to measure a force up to 40 kN.

5.4.5.5 The system of measurement, including the headform and its installation, shall be of a frequency response performance in accordance with ISO 6487:2002, frequency class (CFC) 600.

5.4.5.6 Test one sample after each pre-treatment procedure specified in 5.4.2, within 1 min of the removal of the sample helmet from the temperature-conditioning chamber or water bath. Then place the sample on the headform and adjust the means of fitting the helmet so as to maximize the space between

helmet and headform. The striker shall be allowed to fall on the helmet from a height of (1 000 ± 5) mm, measured between the striking point of the helmet and the lower end of the striker. The measurement shall be made by recording the waveform of the impact load transmitted to the headform.

5.4.5.7 The impact load to the headform shall not exceed 5,0 kN.

5.4.6 Radiant heat exposure test

5.4.6.1 Heat radiation of known intensity from an infrared source is allowed to fall onto the outer surface of a helmet mounted on an instrumented headform. The temperature of the headform surface is measured. After the exposure to heat, again subject the helmetto the shock absorption test specified in 5.4.5.

5.4.6.2 The apparatus consists of the following.

5.4.6.2.1 Heater or bank of heaters.

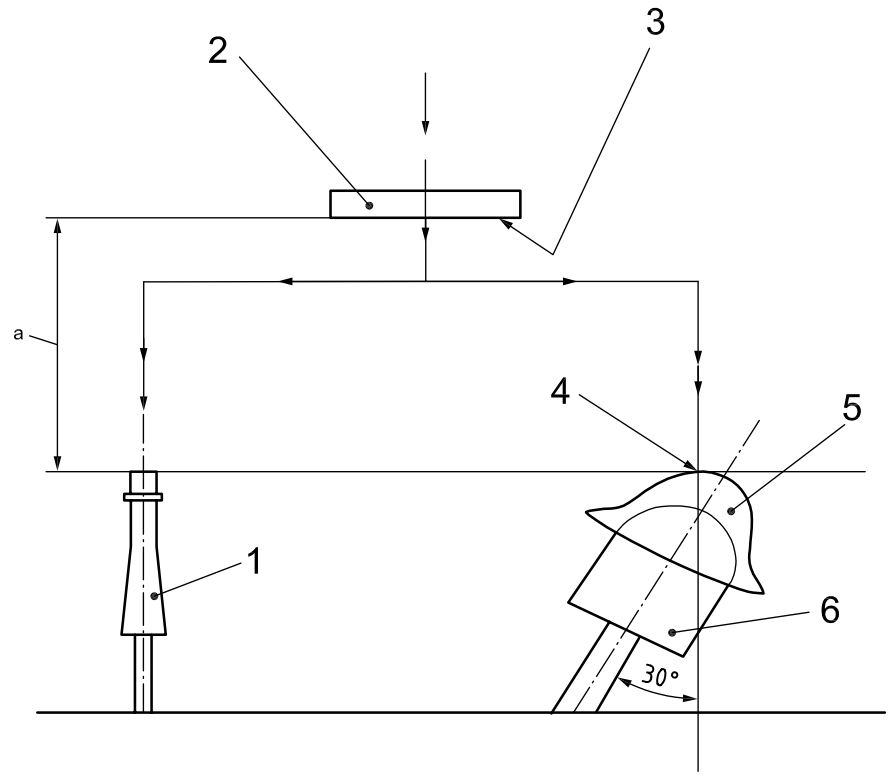
5.4.6.2.2 Calibrated radiometer/calorimeter.

5.4.6.2.3 Wooden headform (see 5.4.1).

5.4.6.2.4 Set of temperature-sensing elements.

See the schematic representation shown in Figure 5.

NOTE Suitable apparatus are also described in EN 443[2].



Key

1	radiometer/calorimeter	3	radiating surface	5	helmet
2	heater	4	test site	6	headform

[a] Parallel.

Figure 5 — Radiant heat exposure test schematic

5.4.6.3 Mount the heater or bank of heaters (5.4.6.2.1) with radiating surface horizontal and facing downwards. The radiating surface shall be flat and of dimensions (250 ± 5) mm $\times$ (250 ± 5) mm. The peak wavelength of the emitted heat radiation shall be between 2 µm and 3 µm. The intensity of radiation shall be uniform and adjustable.

5.4.6.4 Mount a radiometer/calorimeter (5.4.6.2.2), calibrated to a suitable International Standard or national or regional standard and having a measurement range of at least 10 kW/m^2, on a movable and adjustable device, with its sensing surface parallel to the heater or bank of heaters and facing upwards. The centre of the sensing surface shall be adjusted on the vertical axis of the heater/bank of heaters.

5.4.6.5 Mount the helmeted headform (5.4.6.2.3) on a movable and adjustable device. The test shall be carried out exposing one side of the helmet at a 30° lateral inclination of the headform to vertical. The exposed lateral point shall be in accordance with L2, L3, L4 or L5 as shown in Figures 6 and 7.

5.4.6.6 Three temperature-sensing elements (5.4.6.2.4), preferably consisting of thermocouples mounted on circular copper discs of (7 ± 1) mm diameter and $(0{,}2 \pm 0{,}02)$ mm thickness and calibrated to a suitable International Standard or national or regional standard, shall be secured by electrically insulating adhesive to the headform surface. Their centre shall be within 5 mm of a transverse vertical plane passing through the test location in accordance with 5.4.6.5, at the following positions as shown in Figures 6 and 7:

a) L1;

b) on the A–A' plane;

c) mid-way between positions a) and b), measured along the headform surface.

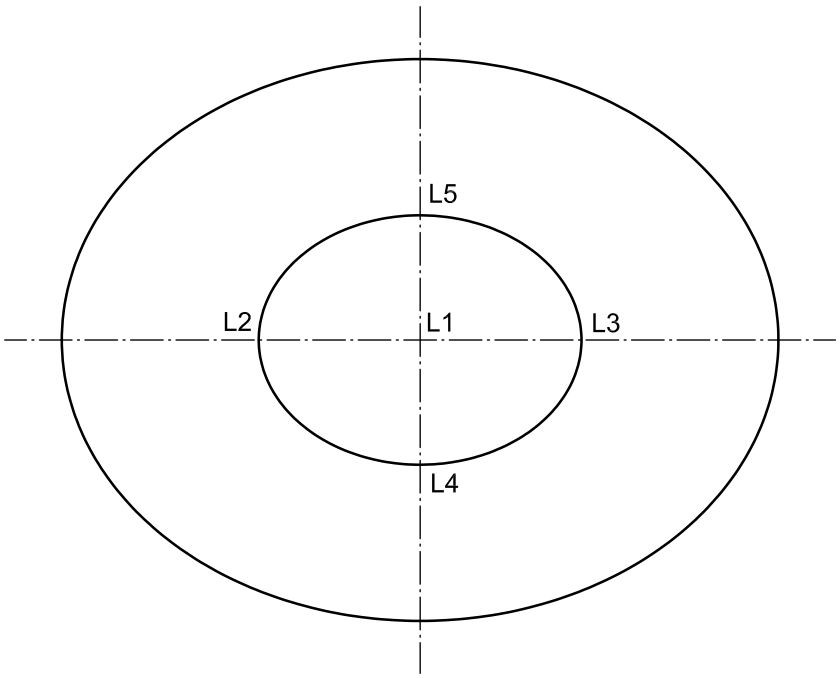
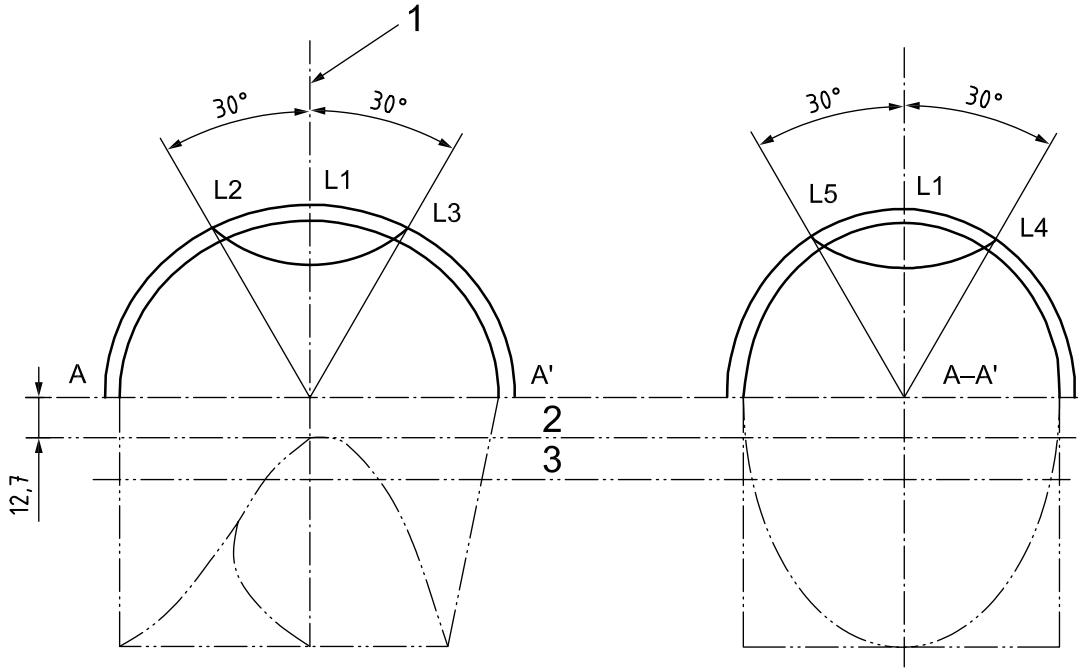


Figure 6 — Exposed lateral points on helmet

Dimensions in millimetres



Key

1 central vertical axis
2 reference plane
3 basic plane

Figure 7 — Helmet-protected area

5.4.6.7 Surfaces adjacent to the test equipment should not reflect the radiant heat falling on them or allow passage of measurable quantities of heat into the test equipment area. The effects of draughts should be minimized. All supports for the headform and the radiometer/calorimeter should be of low heat conductivity and reflectivity.

5.4.6.8 The test procedure is as follows.

a) Mount the helmet on the headform. Place the helmeted headform in the test position under the heater/bank of heaters. Measure the distance from the radiating surface.

b) Move the helmeted headform aside to allow setting of the radiant heat intensity.

c) Move the radiometer/calorimeter under the heater/heater bank until their vertical axes are coincident and adjust the distance from the radiating surface to equal the distance measured in a). Adjust the heater controls until the flux intensity measured is (7 ± 1) kW/m^2. Remove the radiometer/calorimeter.

d) Replace the helmeted headform in the position determined in a) and expose the helmet to the radiant heater for (180 ± 2) s. Record the temperature.

e) After removal, allow the helmet to cool to ambient temperature for at least 4 h. After inspection, subject the helmet to a blow on the exposed lateral point, using the procedure given in 5.4.5, but excluding the conditioning pre-treatment specified in 5.4.2.

5.4.6.9 The test result shall be in accordance with 5.4.5.

5.4.7 Flame resistance test

5.4.7.1 A standard flame is applied to the outside of the helmet and any tendency of the helmet to drip, glow or to continue burning after removal of the flame is observed.

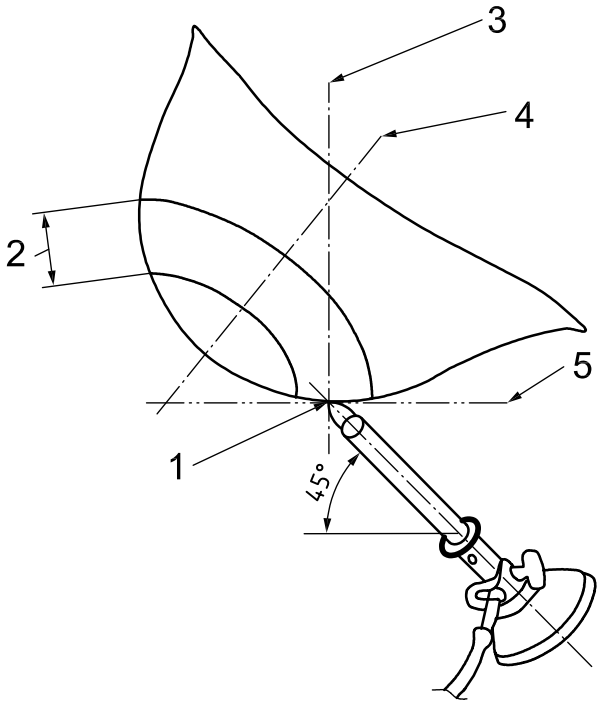
5.4.7.2 The apparatus, shown schematically in Figure 8, consists of the following.

5.4.7.2.1 Gas supply.

5.4.7.2.2 Gas burner, with a bore diameter of (8,5 ± 0,5) mm and an adjustable air vent.

5.4.7.2.3 Pressure control device.

5.4.7.2.4 Pressure gauge.



Key

1 test point
2 test range
3 vertical line at test point
4 centre line of helmet
5 tangential plane at test point (horizontal)

Figure 8 — Apparatus for flame resistance test schematic

5.4.7.3 The test procedure is as follows.

a) Adjust the pressure (5.4.7.2.3/5.4.7.2.4) of the gas (5.4.7.2.1) to (3 450 ± 50) Pa and the air vent of the burner (5.4.7.2.2) so that the blue cone is clearly defined, although turbulent, and (45 ± 5) mm long. The outer flame shall be entirely free of visible yellow area.

b) Support the burner at an angle of (45 ± 10)° to the vertical.

c) Support the complete helmet, so that at the point to be tested the plane tangential to the surface is horizontal. Maintaining these angles, apply the outer part of the flame to the test point for (10 ± 2) s.

d) The test point shall be any suitable point inside the areas defined by the intersection of the surface of the shell with

   1) a 100 mm diameter cylinder centred on the vertical axis of the helmet,

   2) a 200 mm diameter cylinder centred on the vertical axis of the helmet, and

   3) planes parallel to the vertical front-to-back, mid-section (sagittal) plane of the helmet that are 25 mm distant from this plane.

5.4.7.4 There shall be no holes produced in the helmet. After the removal of the flame, there shall be no flaming on the helmet; or, if flaming occurs, the flaming time shall not exceed 5 s at any test point.

5.4.8 Insulation test

5.4.8.1 Place the helmet shell in a $(3 \pm 0{,}2)$ g/L solution of sodium chloride at a temperature of (20 ± 2) °C. Remove the helmet shell, wipe and place upside down in a container of appropriate size. Fill the container and the helmet shell with the sodium chloride solution to 10 mm below the lower edge of the shell. The orientation of the helmet shell should be adjusted if necessary, to accommodate shells whose lower edge is not straight.

5.4.8.2 Apply an alternating test voltage, at a nominal 50 Hz or 60 Hz, between an electrode immersed in the solution inside the helmet shell and another electrode in the container, outside the helmet shell. Increase the voltage at a steady rate within 1 min to $(1\,200 \pm 25)$ V a.c. and maintain at this value for 15 s.

5.4.8.3 The leakage current at this voltage shall be recorded, together with any evidence of breakdown. There shall be no breakdown of the helmet shell, and the leakage current shall not exceed 1,2 mA.

For the purposes of this test it is permissible to plug any holes in the shell.

5.4.9 Requirements for neck protectors

5.4.9.1 The materials of neck protectors shall be in accordance with 5.2.1, 5.2.4, 5.2.5 and 5.2.6.

5.4.9.2 Neck protectors shall be in accordance with 4.1.2, 4.2.3 and 4.2.4.

5.4.10 Requirements for visors

5.4.10.1 When tested in accordance with Annex E, there shall be no holes produced in the visor.

5.4.10.2 When tested in accordance with Annex C, the visor shall remain in a normal condition and shall show no signs of damage or deterioration.

5.4.10.3 The visor shall be tested in accordance with 5.2.6 and shall not melt, drip, separate or ignite.

Immediately after this test, immerse the visor in water at ambient temperature: the visor shall remain in a normal condition and shall show no signs of damage or deterioration.

5.4.11 Field of vision test

The field of vision through a visor, if fitted, shall be tested in accordance with Annex D; it shall be more than 60° on both sides and downwards.

6 Additional requirements

6.1 Mass measurement

6.1.1 The protective clothing, gloves and boots should be selected so that the total mass in combination is not more than 7 kg.

6.1.2 The production mass of the helmet, including visor, neck protector and any other accessories, shall be not more than 1,5 kg.

6.2 Donning test

It shall be demonstrated that the total time needed to don the protective clothing, together with boots complying with this International Standard, without assistance, shall be not more than 60 s. This test shall be carried out using at least three test subjects of different sizes.

6.3 Mobility tests

6.3.1 The tests specified in Annex B shall be carried out by three test subjects in accordance with 6.2. The mean time to complete the test wearing the garment under test as part of a complete outfit consisting of protective clothing, gloves, boots and helmet complying with this International Standard shall not be more than 1,5 times the mean time to complete the test without the outfit.

6.3.2 The following operations shall be able to be carried out easily by three test subjects in accordance with 6.2, wearing the protective clothing and gloves:

a) open and shut a door by turning the knob;

b) operate a dual-purpose nozzle;

c) operate necessary breathing apparatus functions.

6.4 Retroreflective/fluorescent material tests

When tested in accordance with Annex E, the materials shall not continue flaming after removal of the ignition source.

7 Care and maintenance instructions

The manufacturer of the outfit, or of any component of the outfit, shall provide suitable instructions for operation, maintenance, storage and eventual replacement. The instructions shall include suitable precautions related to the possibility of heat stress while wearing the outfit. The instructions, as a minimum, shall be provided in a format suitable to be included in the ship's training manual.

NOTE ISO 13688 is suitable for this purpose.

8 Marking

8.1 General

As a minimum, each component of the outfit shall be marked with the following:

a) the identification of the manufacturer;

b) the equipment type and size range;

c) the month and year of manufacture;

d) approval information;

e) any necessary operational instruction and use precautions;

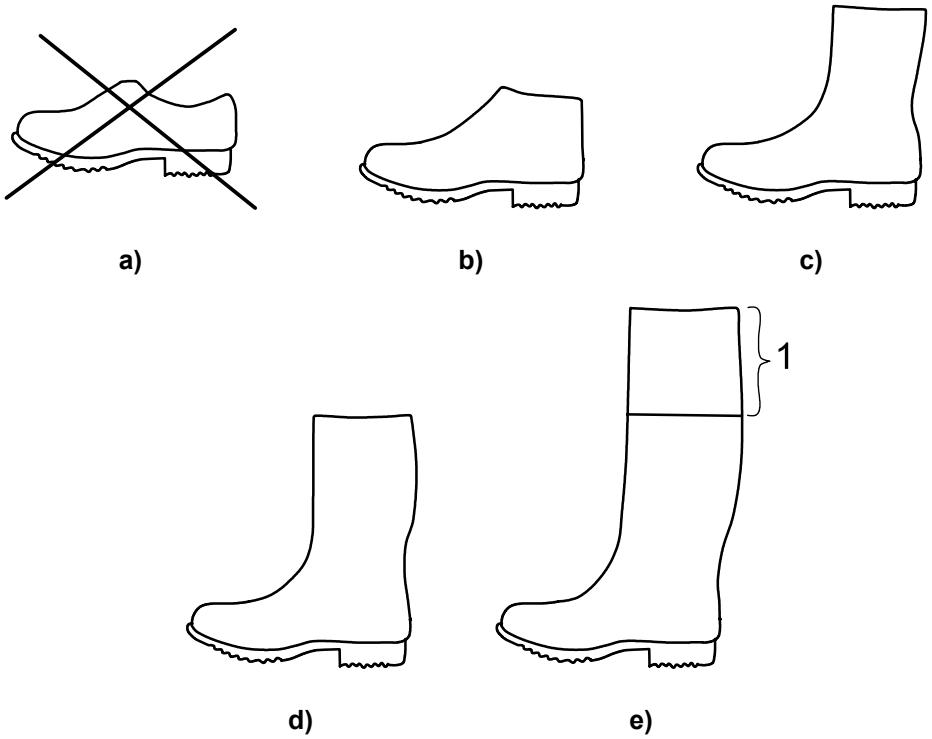
f) for boots, the appropriate marking symbol specified in Table 2;

g) reference to this International Standard, i.e. “ISO 22488”.

Annex A
(normative)

Footwear designs

Footwear for shipboard firefighters shall be selected in accordance with Figure A.1.



Key

1 variable extension which can be adapted to the wearer

a) low shoe (not an acceptable option; shown for visual comparison only)

b) ankle boot

c) half-knee boot

d) knee-height boot

e) thigh boot

Design a) shall not be used.

NOTE Design e) is a knee-height boot [design d)] equipped with a thin impermeable material which extends the upper and which can be cut to adapt the boot to the wearer.

Figure A.1 — Footwear design styles

Annex B
(normative)

Mobility tests

B.1 Test subjects

For this test, a group of three adults in the large, medium and small size ranges of the protective clothing shall be selected as the test subjects.

B.2 Test method

B.2.1 Climbing vertical ladder test

B.2.1.1 Each test subject, wearing only normal clothing and without any protective clothing, shall climb up and down a vertical ladder of 5 m height. The time required for this work shall be measured for each test subject and recorded as the time *without* protective clothing.

B.2.1.2 Then, while wearing the protective clothing (including gloves, boots and helmet), each test subject shall climb up and down the same vertical ladder. The time required for this work shall be measured for each test subject and recorded as the time *with* protective clothing.

B.2.2 Work simulation test

B.2.2.1 Each test subject, wearing only normal clothing and without any protective clothing, shall perform the series of activities specified in Figure B.1. Each time required for climbing up and down a ladder or staircase and the time for the series of activities in total shall be measured for each test subject and recorded as the time *without* protective clothing.

B.2.2.2 Then, while wearing the protective clothing (including gloves, boots and helmet), each test subject shall perform the same activities. Each time required for climbing up and down a ladder or staircase and the time for the series of activities in total shall be measured for each test subject and recorded as the time *with* protective clothing.

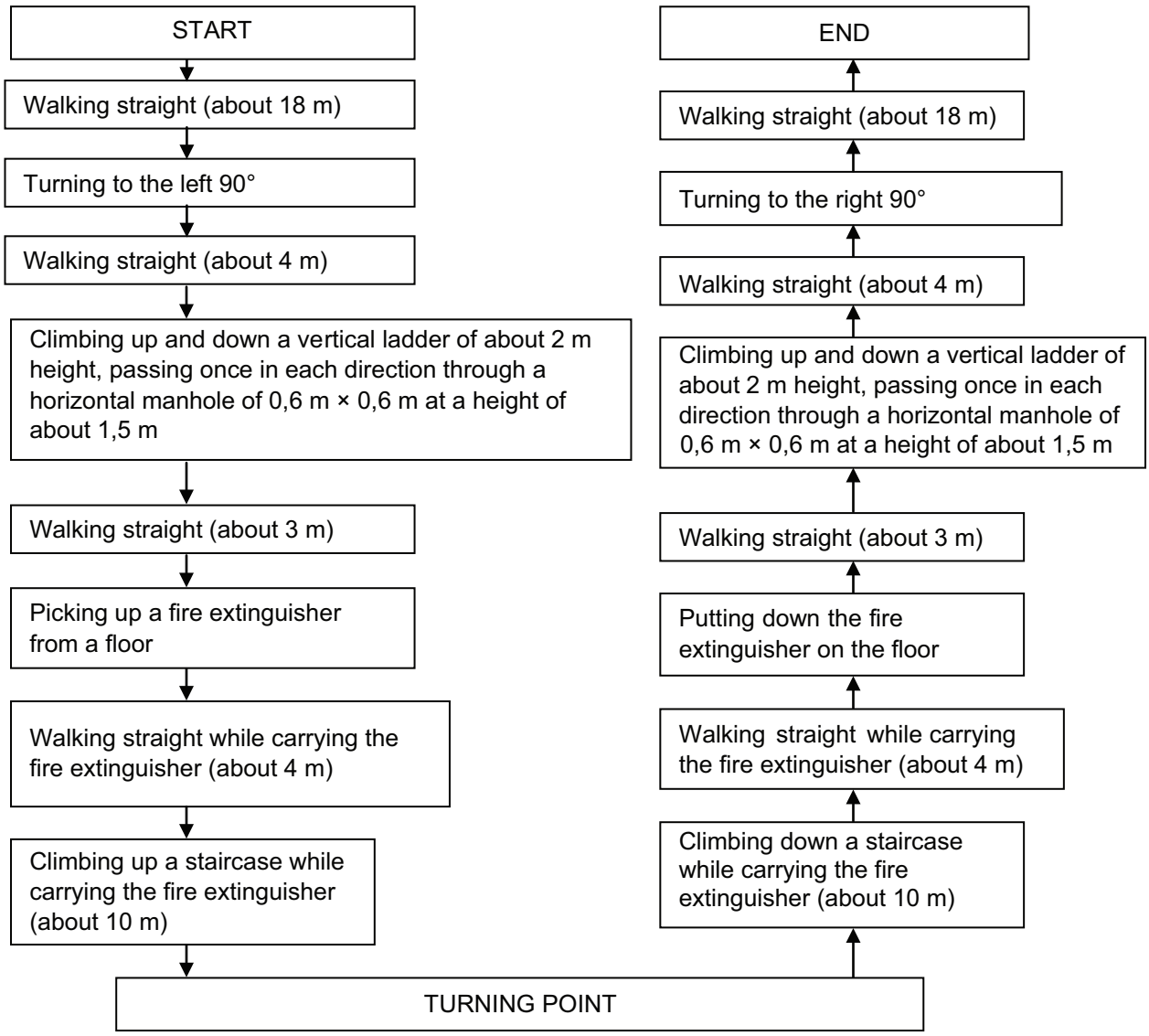


Figure B.1 — Standard procedure for work simulation test

Annex C
(normative)

Impact resistance test for visor

C.1 Test method

C.1.1 After detaching the visor from the fixing frame, the visor shall be placed on a supporting test frame made of hard wood. The supporting test frame shall have a shape coinciding with the curve of the visor in order that the centre of the visor be placed horizontally and the frame support only the peripheral part of the visor, with a rubber sheet of about 3 m thick inserted between the visor and the test frame.

C.1.2 A steel ball of about 22 mm in diameter and about 45 g in mass shall be dropped from a height of 1,3 m to impact on the centre of the visor mounted on the test frame. The visor shall then be examined visually for any cracks or damage.

Annex D
(normative)

Field of vision test

D.1 Test subjects

For this test, a group of three adults in the large, medium and small size ranges of the protective clothing shall be selected as the test subjects.

D.2 Test method

D.2.1 Measurement for lateral field of vision

D.2.1.1 A protractor plate for measurement with radial lines drawn every 10° from the centre shall be set on the floor. Then each test subject wearing the helmet and visor in operating condition shall be seated on a chair so as to be positioned with the subject's eyes at the centre of the angles on the plate.

D.2.1.2 The test subject shall be positioned so as to look forward with the head fixed and eyes allowed to move. The lateral field of vision shall be measured for each test subject with a suitable moving visible target at the same height as the subject's eyes above the protractor plate.

D.2.2 Measurement for downward field of vision

D.2.2.1 A protractor plate for measurement with radial lines drawn every 10° from the centre shall be stood vertically on the floor. Then each test subject wearing the helmet and visor in operating condition shall stand next to the protractor plate so as to be positioned with the subject's eyes at the centre of the angles on the plate.

D.2.2.2 The test subject shall be positioned to look forward with the head fixed and eyes allowed to move. The downward field of vision shall be measured for each test subject with a suitable moving visual target on the same vertical plane as the subject's eyes and parallel to the vertical plane of the protractor plate.

Annex E
(normative)

Flame resistance test for visor

E.1 Conditioning for the specimen

Condition the specimen for at least 24 h in an atmosphere having a temperature of (20 ± 2) °C and a relative humidity of 65 ± 5 %.

E.2 Test method

E.2.1 The test shall be carried out in accordance with ISO 15025:2000, procedure A.

E.2.2 The specimen shall be placed horizontally and the flame applied to the specimen for a period of 2 s.

Annex F
(normative)

Arrangement of retroreflective/fluorescent materials

The minimum arrangement of retroreflective/fluorescent materials shall be as shown in Figure F.1 using strips of a minimum width of 50 mm.

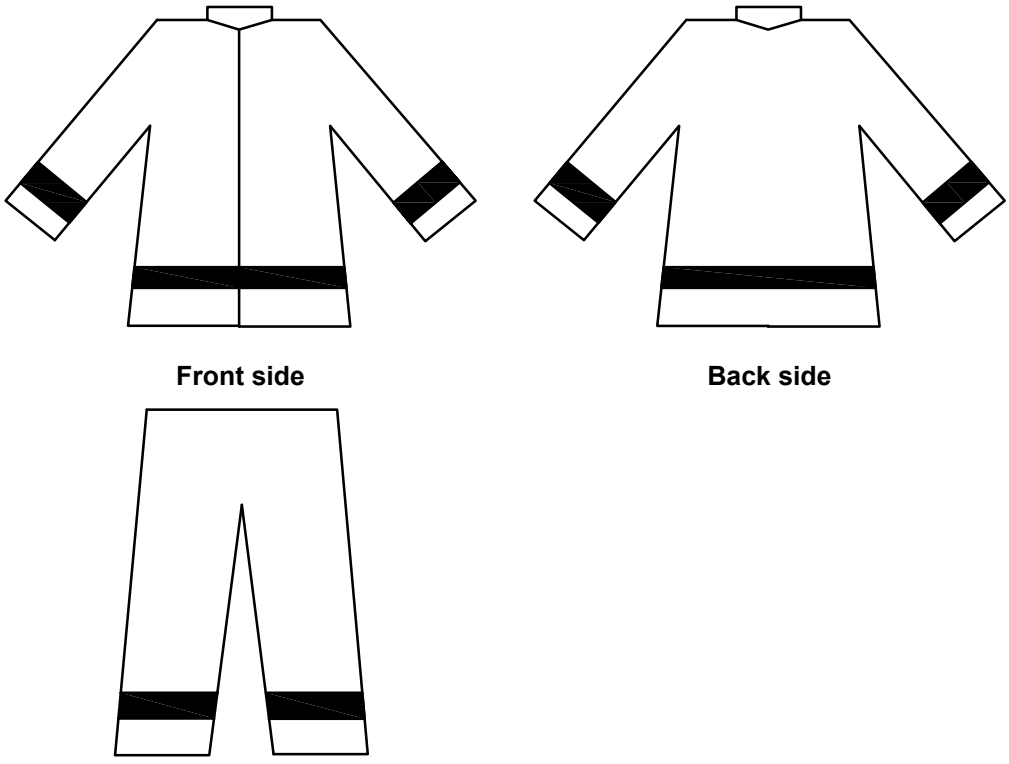


Figure F.1 — Retroreflective/fluorescent material arrangement

Annex G
(normative)

Assessment of footwear

In the course of testing in accordance with Clause 5, any of the following conditions shall constitute a failure of the test:

a) beginning of pronounced and deep cracking affecting half of the upper material thickness (see Figure G.1);

b) strong abrasion of the upper material, especially if the toe-cap is revealed (see Figure G.2);

c) the upper shows areas with deformations, burns, fusions or bubbles, or split seams in the leg (see Figure G.3);

d) the outsole shows cracks higher than 10 mm long and 3 mm deep (see Figure G.4);

e) upper/sole separation of more than 10 mm to 15 mm long and 5 mm wide (deep);

f) cleat height in the flexing area lower than 1,5 mm (see Figure G.5);

g) original insock (if any) shows pronounced deformation and crushing (see Figure G.6);

h) fastening system not in good working order (zipper, laces, eyelets, touch and close system, etc.).

NOTE Some of these criteria could vary according to the type of footwear and materials used.

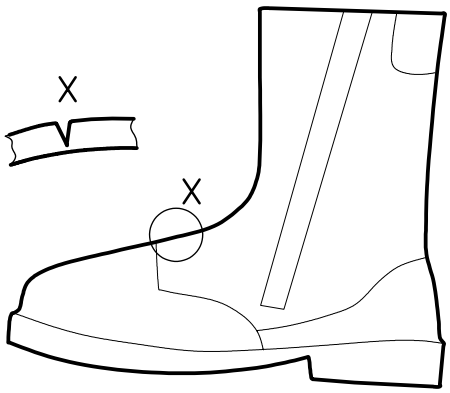


Figure G.1

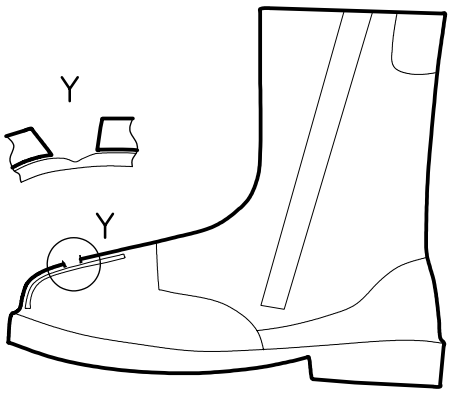


Figure G.2

Dimensions in millimetres

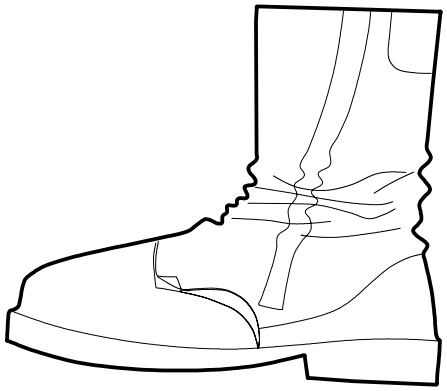


Figure G.3

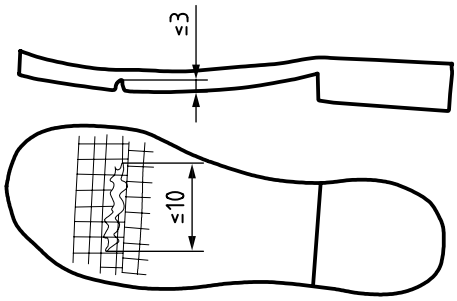


Figure G.4

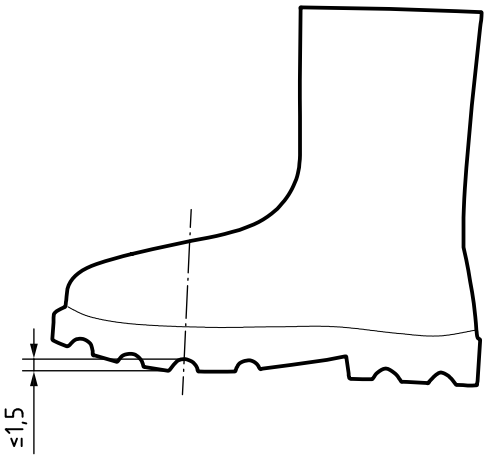


Figure G.5

Figure G.6

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