BS ISO 11999-6:2016

BSI Standards Publication

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

Part 6: Footwear

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National foreword

This British Standard is the UK implementation of ISO 11999-6:2016.

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

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

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

Part 6: **Footwear**

Équipement de protection personnelle pour pompiers — Méthodes d'essai et exigences pour les équipements de protection personnelle utilisés par les pompiers qui sont à risque d'une exposition à des niveaux élevés de chaleur et/ou de flamme quand la lutte contre les incendies survient dans les structures —

Partie 6: Chaussures

Reference number
ISO 11999-6:2016(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 14, *Firefighters' personal equipment*.

ISO 11999 consists of the following parts, under the general title *PPE for firefighters — Test methods and requirements for PPE used by firefighters who are at risk of exposure to high levels of heat and/or flame while fighting fires occurring in structures*:

— *Part 1: General*

— *Part 2: Compatibility* [Technical Specification]

— *Part 3: Clothing*

— *Part 4: Gloves*

— *Part 5: Helmets*

— *Part 6: Footwear*

— *Part 9: Fire hoods*

INTERNATIONAL STANDARD ISO 11999-6:2016(E)

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

Part 6: **Footwear**

1 Scope

This part of ISO 11999 specifies the minimum design and performance requirements for footwear as part of personal protective equipment [PPE] to be used by firefighters, primarily but not solely to protect against flame and high thermal loads while fighting fires occurring in structures.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 868, *Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness)*

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

ISO 20344:2011, *Personal protective equipment — Test methods for footwear*

ISO 20345:2011, *Personal protective equipment — Safety footwear*

EN 13832-1, *Footwear protecting against chemicals — Part 1: Terminology and test methods*

EN 13832-3, *Footwear protecting against chemicals — Part 3: Requirements for footwear highly resistant to chemicals under laboratory conditions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 20344, ISO 11999-1 and EN 13832-1 apply.

4 Classification, design and performance level

4.1 Classification

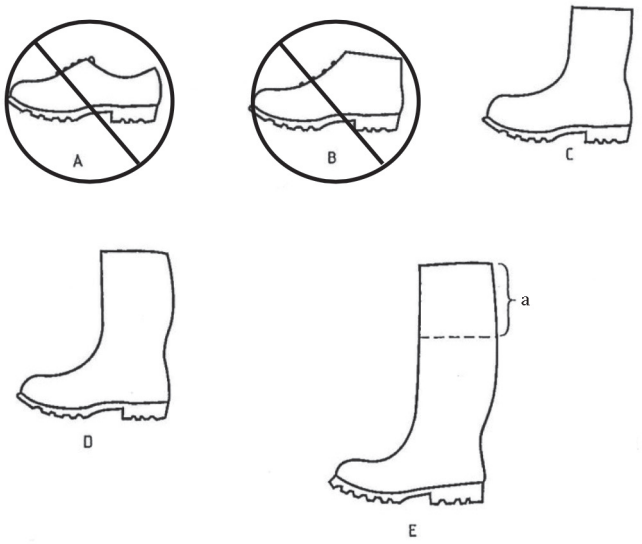
Footwear shall be classified in accordance with Table 1.

Table 1 — Classification of footwear

Classification	Description
Class I	Footwear made from leather and other materials, excluding all-rubber or all-polymeric footwear
Class II	All-rubber (i.e. entirely vulcanized) or all-polymeric (i.e. entirely moulded) footwear

4.2 Design

Footwear shall conform to one of the designs C to E given in Figure 1.



Key

A low shoe

B ankle boot

C half-knee boot

D knee-height boot

E thigh boot

a Variable extension which can be adapted to the wearer.

NOTE Design E can be 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 1 — Design of footwear

4.3 Performance Level

This part of ISO 11999 contains two performance levels, A1 and A2. While many requirements are common to both performance levels, there are differences. Thermal requirements for each level are different.

NOTE Other parts of the ISO 11999 series dealing with other items of PPE have been developed with two levels of thermal protection, A1 and A2. It is important to select items of PPE from this part of ISO 11999 from the same thermal performance level when they are to be worn together.

5 Sampling and conditioning

5.1 Sampling

The minimum number of samples shall be that specified in ISO 20344:2011, Clause 6, together with the minimum number of test pieces taken from each sample, as given in Table 2.

Wherever possible, test pieces shall be taken from the whole footwear unless otherwise stated in this part of ISO 11999 or in ISO 20344.

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 can be used instead and this shall 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.

5.2 Conditioning

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 which shall elapse 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.

The uncertainty of measurement for each test method described in the present standard can be assessed. One of the two following approaches should be used:

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

— a mathematical method, e.g. that given in Reference ENV 13005.

Table 2 — Minimum number of samples and test pieces

Property to be determined[a]	Reference	Number of samples	Number of test pieces from each sample	Test only on the final footwear
Radiant heat	6.2.2	one pair	See 7.2	Yes
Flame	6.2.3	one pair	See 7.3	Yes
Zipper puller attachment strength	6.7.2	three zippers		No
Zipper lateral strength	6.7.3	three zippers		No
[a] ISO 20344:2011, Table 1 applies.				

6 Requirements

6.1 General requirement

Footwear for firefighters shall conform to the requirements specified in Table 3.

Table 3 — General requirement

Requirement			Reference		Classification and performance level				Marking symbol
			ISO 20345: 2011	This part of ISO 11999	Class I		Class II		
					A1	A2	A1	A2	
General	Footwear construction	Type and classification		4.1	a		a		
		Height of upper	5.2.1		a		a		
		Specific ergonomic feature	5.3.4		a		a		
		Leakproofness	5.3.3		N/A		a		
		Water resistance		6.5	a		N/A		WR
	Seat region	Design C and D	5.2.2		a		a		
		Design E	5.2.2		N/A		a		
Whole footwear	Sole performance	Construction	5.3.1.1		a		N/A		
		Upper/outsole bond strength	5.3.1.2		a		N/A		
		Insulation against heat		6.2.1	A1	A2	A1	A2	A1 or A2
					d	d	d	d	
		Slip resistance	5.3.5		a		a		SRA SRB SRC
		Energy absorption of	6.2.4		a		a		
		seat region							
		Flame resistance		6.2.3	a		a		
		Penetration resistance	6.2.1		a		a		P
	Toe protection	General	5.3.2.1		a		a		
		Internal length of toe caps	5.3.2.2		a		a		
		Impact resistance	5.3.2.3		a		a		
		Compression resistance	5.3.2.4		a		a		
		Corrosion resistance of metal toe caps	5.3.2.5.1		a		a		
		Non metallic toe caps	5.3.2.5.2		a		a		
	Electrical property	Electrically insulating footwear[d]		6.4.2	d		d		See EN 50321 5.3
		Antistatic footwear[d]		6.4.3					A
	Resistance to inimical environment	Cold insulation of sole complex	6.2.3.2		c		c		CI
		Resistance to chemicals		6.3	N/A		c	c	CH
	Accessories	Zipper		6.7	b		b		
		Metatarsal protection	6.2.6		c		c		M
		Ankle protection	6.2.7		c		c		AN

Table 3 *(continued)*

Requirement			Reference		Classification and performance level				Marking symbol
			ISO 20345: 2011	This part of ISO 11999	Class I		Class II		
					A1	A2	A1	A2	
Upper		Thickness	5.4.2		N/A		a		
		Tear strength	5.4.3		a		N/A		
		Tensile properties	5.4.4		a		a		
		Flexing resistance	5.4.5		N/A		a		
		Water vapour permeability &coefficient	5.4.6		a		N/A		
		pH value	5.4.7		a		N/A		
		Hydrolysis	5.4.8		N/A		a		
		Chromium VI content	5.4.9		a		N/A		
		Water penetration	6.3.1		a		N/A		
		water absorption							
		Radiant heat		6.2.2	a		a		
		Flame resistance		6.2.3	a		a		
		Cut resistance	6.2.8		c		c		CR
Lining	Vamp	Tear strength	5.5.1		a		N/A		
		Abrasion resistance	5.5.2		a		N/A		
		Water vapour permeability &coefficient	5.5.3		a		N/A		
		pH value	5.5.4		a		N/A		
		Chromium VI content	5.5.5		a		N/A		
	Quarter	Tear strength	5.5.1		b		N/A		
		Abrasion resistance	5.5.2		b		N/A		
		Water vapour permeability &coefficient	5.5.3		b		N/A		
		pH value	5.5.4		b		N/A		
		Chromium VI content	5.5.5		b		N/A		
Tongue		Tear strength	5.6.1		b		N/A		
		pH value	5.6.2		b		N/A		
		Chromium VI content	5.6.3		b		N/A		
Insole/insocks				See Table 4	a		b		
Outsole		Tear strength	5.8.2		a		a		
		Abrasion resistance	5.8.3		a		a		
		Flexing resistance	5.8.4		a		a		
		Hydrolysis	5.8.5		a		a		
		Interlayer bond strength	5.8.6		b		b		
		Resistance to fuel oil	6.4.2		a		a		
		Cleated area	5.8.1.2		a		a		
		Thickness	5.8.1.1		a		a		
		Cleat design		6.6.1	a		a		
		Cleat height		6.6.2	a		a		

Table 3 *(continued)*

Requirement			Reference		Classification and performance level				Marking symbol
			ISO 20345: 2011	This part of ISO 11999	Class I		Class II		
					A1	A2	A1	A2	
		Cleat height in the waist area		6.6.3	a		a		
		Heel breast		6.6.4	a		a		
		Resistance to hot contacts	6.4.1		a		a		

The applicability of requirement to a particular classification is indicated in this table by the following:

a Means that the requirement has to be met. In some cases, the requirement relates 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.

b Means that if the component parts exists, the requirement shall be met.

c Means that if the property is claimed, the requirement given in the appropriate clause shall be met.

d Means that one of the two requirements shall be chosen.

N/A means the requirement is not applicable.

Table 4 — Basic requirements for insoles and/or insocks

Options			Component to be assessed	Requirements to fulfill in ISO 20345					
				Thickness	pH	Water absorption desorption	Abrasion		Chromium VI
							Insole	Insock	
1	No insole or if present not fulfilling the requirements	Non-removable insock	Insock	a	a	a	N/A	a	a
2	Insole present	No insock	Insole	a	a	a	a	N/A	a
		Seat sock present							
3		Full insock, non-removable	Insock and insole	a	N/A	a	N/A	N/A	N/A
			Insock	N/A	a	N/A	N/A	a	a
4		Full insock, removable and water permeable	Insole	a	a	a	a	N/A	a
			Insock	N/A	a	N/A	N/A	a	a
5		Full insock, removable not water permeable	Insole	a	a	a	a	N/A	a
			Insock	N/A	a	a	N/A	a	a

NOTE 1 For removable insocks, see 9.3.

a Means that the requirement shall be met.

N/A means the requirement is not applicable.

6.2 Thermal behaviour

6.2.1 Insulation against heat

When tested in accordance with the method described in 7.1, the footwear shall meet the respective requirements for A1 or A2 performance level in Table 5 and Table 6.

Table 5 — Insulation against heat: requirements for the temperature inside the footwear

Level of performance for each requirements	Performance level A1	Performance level A2
Sand bath temperature (°C)	250	
Inside temperature of the footwear (°C)	<42 after 10 min	

Table 6 — Insulation against heat: requirements for footwear degradation

Level of performance for each requirements	Performance level A1	Performance level A2
Sand bath temperature (°C)	250	
Total duration of the test	20 min	40 min
Assessment	After testing, the footwear shall conform to A.2.1.	

6.2.2 Radiant heat

When tested in accordance with the method described in 7.2, the temperature increase for each material combination shall be equal or less than 24 °C. After testing, the footwear shall conform to A.2.2.

6.2.3 Flame resistance

When tested in accordance with the method described in 7.3, the footwear shall neither flame for more than 2 s (after-flame time) nor glow more than 2 s (after-glow time). After testing, the footwear shall conform to A.2.3.

6.3 Resistance to chemicals

6.3.1 Degradation resistance

When tested in accordance with EN 13832-3:2006, 6.2.2, footwear with resistance to chemicals shall meet the degradation requirement with at least three chemicals from Table 7. Other chemicals can be used additionally according to the intended use.

The sole and upper shall both be tested with the same chemicals. After degradation, the test pieces shall be tested according to Table 8.

Samples that are too strongly affected by the degradation test do not need to be tested and shall be considered to fail the test. For example, when the test pieces

— have holes,

— are swollen and distorted, or

— become brittle.

Table 7 — List of chemicals

	Letter code	Chemical	CAS-NR	Class
1	B	Acetone	78-93-3	Ketone
2	D	Dichloromethane	75-09-2	Chlorinated hydrocarbon
3	F	Toluene	108-88-3	Aromatic hydrocarbon
4	G	Diethylamine	109-89-7	Amine
5	H	Tetrahydrofurane	109-99-9	Heterocyclic ether
6	I	Ethyl acetate	141-78-6	Ester
7	J	n-Heptane	142-85-5	Saturated hydrocarbon
8	K	Sodium hydroxide solution 30 % d = 1,33	1310-73-2	Alkali solution
9	L	Sulphuric acid 95 % d = 1,84	7664-93-9	Inorganic acid
10	M	Nitric acid (65 ± 3) %	7697-37-2	Inorganic acid
11	N	Acetic acid (99 ± 1) %	64-19^7	Organic acid
12	O	Ammonia solution (25 ± 1) %	1336-21-6	Alkali solution
13	P	Hydrogen peroxide (30 ± 1) % v/v	124-43-6	peroxide
14	Q	Isopropanol	67-63-0	Aliphatic alcohol
15	R	Sodium hypochlorite (13 ± 1) % (of active chloride)	7681-52-9	hypochlorite

NOTE 1 CAS-NR chemical abstract services = reference number of chemical.

NOTE 2 Letters B to L are identical to those given in EN 374-1:2003, Annex A.

Table 8 — Tests for basic properties of the sole and the upper after degradation

	Sole		Upper	
Test	**Tear resistance**	**Hardness**	**Tear resistance**	**Elongation at break**
Test method	ISO 20344:2011, 8.2	ISO 868	ISO 20344:2011, 8.2	ISO 20344:2011, 6.4
Requirement	Greater or equal to 6,4 kN/m	Minimum : 30 shore A Maximum : (value before degradation +10) shore A	Greater or equal to 6,4 kN/m	Minimum: 80 % of value before degradation

6.3.2 Permeation resistance

When tested in accordance with EN 13832-3:2006, 6.2.3, footwear uppers shall achieve a permeation resistance at or above 121 mins with at least three of the chemicals from Table 7. The same chemicals as used in 6.3.1 shall be used.

6.4 Electrical Properties

6.4.1 General

Electrical properties shall conform to either 6.4.2 or 6.4.3.

6.4.2 Electrically insulating footwear

Electrically insulating footwear shall fulfill the requirements given in ISO 20345:2011, 6.2.2.3.

The test voltages shall be 5 kVrms for the proof test and shall be 10 kVrms for withstand test. (This relates to Class 0 electrical resistance.)

6.4.3 Antistatic footwear

Footwear shall conform to all the requirements given in ISO 20345:2011, 6.2.2.2.

6.5 Water resistance

When tested in accordance with ISO 20344:2011, 5.15.2, the total wetted area inside the footwear shall not be greater than 3 cm^2.

6.6 Outsole

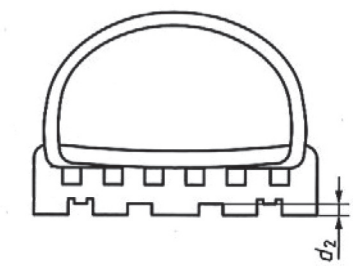
6.6.1 Cleat design

The cleat design (excluding waist area) shall be such that there are no continuous linear transverse valleys across the sole.

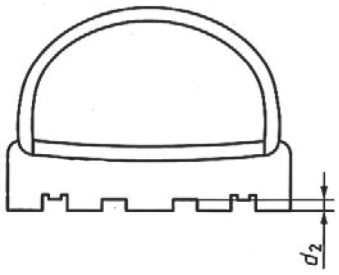
6.6.2 Cleat height

When tested in accordance with ISO 20344:2011, 8.1, the cleat height d_2 shall be not less than 3 mm.

NOTE For the measurement site of d_2, it is described in Figure 2.



a) Cemented construction (cleated)



b) Direct vulcanised or injected (cleated)

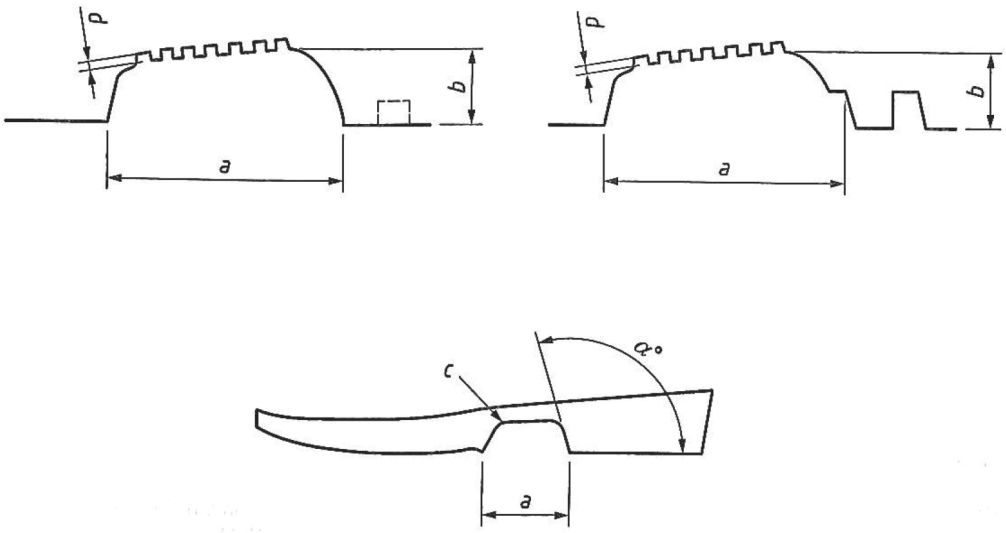
Figure 2 — Cleat height of direct injected, vulcanised and cemented outsole

6.6.3 Cleat height in the waist area

The outsole shall have transverse cleat with a height of at least 1,5 mm in the waist area (see Figure 3).

6.6.4 Heel breast

The outsole shall have an inclined-breast heel. Distance “a” (the waist area) shall be at least 35 mm, angle α shall be between 90°and 120° and dimension “b” shall be at least 10 mm (see Figure 3).



Key

a Waist area.

b Heel breast.

c Cleat profile.

d Cleat height in the waist area.

NOTE Design is an example, only the dimensions are requirements.

Figure 3 — Outsole dimensions

6.7 Zipper (slide fastener)

6.7.1 Zipper construction

The zipper shall have an interlocking mechanism.

6.7.2 Zipper puller attachment strength

When tested in accordance with the methods described in 7.4.1, each recorded value of the attachment strength of puller shall be greater than 250 N.

6.7.3 Zipper lateral strength

When tested in accordance with the methods described in 7.4.2, each recorded value of the lateral strength shall be greater than 500 N.

7 Test methods

7.1 Insulation against heat

The test shall be conducted according to the procedure described in ISO 20344:2011, 5.12.

7.2 Radiant heat

Two test pieces shall be tested from all different material combinations including seams, label and any closing mechanism. Take the samples from the upper of at least one pair of footwear.

If it is not possible to obtain a large enough test piece from the footwear, then a sample of the material or material combination from which the component has been manufactured can be used instead and this should be noted in the report. This test piece shall include the same arrangement of layers, e.g. padding and lining, as found in footwear.

Test the test pieces according to ISO 6942, method B at a heat flux density of 20 kW/m2 exposing the outer surface to radiant heat for 40 s. The result shall be expressed as temperature increase of the highest single result of ΔT rounded to 0,1 °C.

7.3 Flame resistance test

7.3.1 Conditioning and sampling

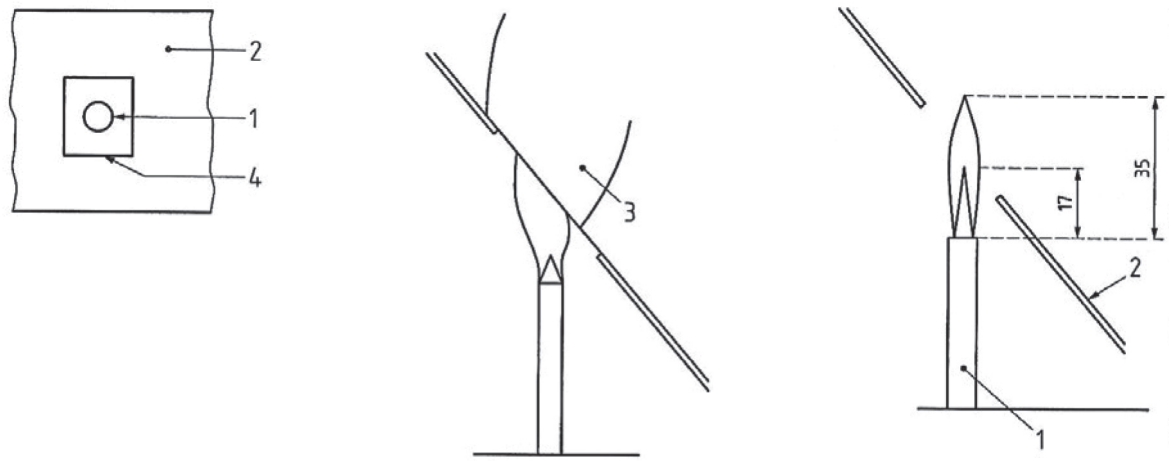
All different external materials, including external seams, labels and closing mechanisms, as provided, as a complete sample of footwear shall be tested in accordance with ISO 15025 as modified in 7.3.2.

7.3.2 Procedure

7.3.2.1 Place the burner (see Figure 4) on a flat, horizontal surface with the burner and flame in a vertical position.

7.3.2.2 Clamp the part of the footwear to be tested so that the minimum distance from the top of the burner to the footwear surface is (17 ± 1) mm and the angle between the sample area to be tested and the horizontal plane is (45 ± 5)° (see Figure 4). The sample carrier has a square flame application aperture size of [(50 × 50) ± 1] mm.

NOTE A simple clamp commonly used for holding test tubes on a metal stand or a sample carrier can be used to hold the footwear.



a) Plan view **b) During the test** **c) Before the test**

Key

1 burner
2 sample carrier
3 footwear being tested
4 flame application aperture

Figure 4 — Equipment for flame resistance tests

7.3.2.3 Move the burner away from the sample and ignite the burner and preheat it for 2 min and adjust the flame height in accordance with ISO 15025.

7.3.2.4 Reposition the burner as in 7.3.2.2 and apply the flame for (10 ± 1) s to the designated area.

7.3.2.5 Remove the flame and measure any after-flame and/or after-glow as defined in ISO 15025.

7.3.2.6 Repeat procedures 7.3.2.2, 7.3.2.3 and 7.3.2.4 for at least one test piece of each different external material used in the construction of the footwear, external seams and closing mechanism.

7.4 Zipper

7.4.1 Puller attachment strength

7.4.1.1 Principle

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

7.4.1.2 Apparatus

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

7.4.1.3 Procedure

Mount the slider in the lower jaw of the tensile machine with the puller passed through the masking plate. Clearing the end of the puller in the upper jaw of tester so that tension is applied perpendicular to the slider, set the testing machine in use until failure occurs. Record the maximum force to cause failure. Three test pieces shall be tested and the results recorded.

7.4.2 Lateral strength

7.4.2.1 Principle

The zipper is subject to a lateral force to measure the resistance of the closed zip to opening. The force required to cause failure of the zipper is measured.

7.4.2.2 Apparatus

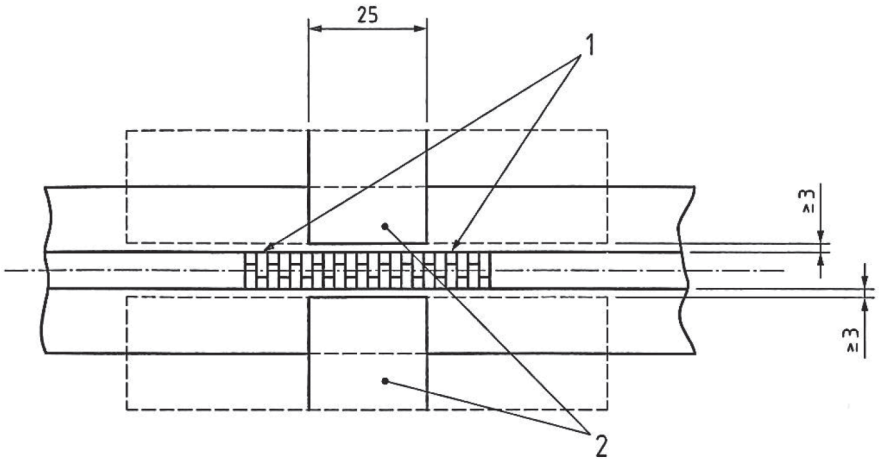
Tensile machine with a jaw separation rate of (100 ± 20) mm/min having a facility to record the force throughout the test and gripping jaws of 25 mm wide, constructed and finished so as not to damage the tape of the zipper.

7.4.2.3 Test pieces

Three test pieces with a minimum length of closed chain for each test of 75 mm. No more than one test piece shall be taken from a single zipper.

7.4.2.4 Procedure

Clamp the test piece in the jaws of the testing machine so that there is at least 25 mm of closed chain either side of the jaw. The jaw shall be positioned 3 mm from the chain. Figure 5 shows the arrangement. Set the machine in the operation and measure the force to induce failure. Three test pieces shall be tested and the results recorded.



Key

1 at least 25 mm of closed chain either side of the jaws

2 clamps

Figure 5 — Zipper test

8 Marking

Each item of footwear for firefighters shall be clearly and permanently marked, for example, by embossing or branding, with the following:

a) size;

b) manufacturer's identification mark;

c) manufacturer's type designation;

d) year and, at least the quarter of manufacture;

e) number and year of this part of ISO 11999;

f) marking symbol(s) from Table 3 appropriate to the protection provided which is not covered by the symbol(s) of the pictogram (see Figure 6);

g) pictogram shown in Figure 6, at a size of at least 30 mm × 30 mm, attached in a visible position on the outside of the footwear, one of the marking symbols given in Table 9 shall be marked in the bottom left hand corner of the pictogram.

NOTE Other letter markings relating to other standards could be present in the bottom right hand corner of the pictogram.

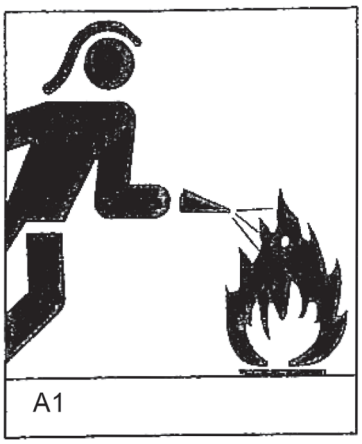


Figure 6 — Pictogram indicating types and protection of footwear for firefighters

Table 9 — Marking symbols

Symbol	Properties signified[a]
A1	All normative requirements for performance level A1 of Table 3.
A2	All normative requirements for performance level A2 of Table 3.
[a] The normative requirements of Table 3 are those signified by "(a)".	

Footwear protecting against chemicals shall be supplied to the customer with additional necessary information. The following information shall be given in the marking.

a) The use of the "operating instructions" symbol is mandatory and shall be as in Figure 7.

b) The use of the "protection against chemicals" symbol is mandatory and shall be as in Figure 8. The letter codes of the tested chemicals shall be listed directly under the symbol.

NOTE If the footwear fulfils all the requirements of ISO 20345, this part of ISO 11999 can be marked additionally on the product.

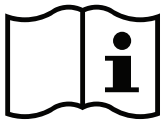


Figure 7 — Symbol 1641 of ISO 7000:2004 7000:2004 "operating instructions"

Figure 8 — Symbol 2414 of ISO "protection against chemicals"

9 Information to be supplied

9.1 General

Footwear for firefighters shall be supplied to the customer with information written at least in the official language(s) of the state/country of destination. All information shall be unambiguous. The following information shall be given:

a) name and full address of the manufacturer and/or the manufacturer's authorized representative;

b) number of the International Standard;

c) explanation of any pictogram, markings and levels of performance. A basic explanation of the test that have been applied to the footwear, if applicable;

d) instruction for use

   1) checks to be carried out by the wearer before use, if required;

   2) fitting, how to put on and take off the footwear, if relevant;

   3) application, basic information on possible uses and, where detailed information is available, the source;

   4) limitations of use (e.g. temperature range, etc.);

   5) instructions for storage and maintenance, with maximum periods between maintenance checks (if important, drying procedures to be stated);

   6) instructions for cleaning and/or decontamination; obsolescence deadline or period of obsolescence;

   7) if appropriate, warnings against problems likely to be encountered (modifications can invalidate the type approval, e.g. orthopaedic footwear);

   8) if helpful, additional illustrations, part numbers, etc.;

e) reference to accessories and spare parts, if relevant;

f) the type of packaging suitable for transport, if relevant;

g) information on electrical properties in accordance with 9.2 or 9.3;

h) information on insocks in accordance with 9.4;

i) information on chemical resistance of footwear in accordance with this part of ISO 11999, if applicable;

j) information on assessment of the state of footwear for the wearer;

   NOTE See Annex B for an example.

k) information on penetration resistant inserts in accordance with 9.5.

9.2 Antistatic footwear

Each pair of antistatic footwear shall be supplied with a leaflet containing the following wording:

"Antistatic footwear should be used if it is necessary to minimize electrostatic build-up by dissipating electrostatic charge, thus avoiding the risk of spark ignition of, for example, flammable substances and eliminated. **It should be noted, however, that antistatic footwear cannot guarantee an adequate protection against electric shock as it introduces only a resistance between foot and floor.** If the risk of electric shock has not been completely eliminated, additional measures to avoid this risk are

essential. Such measures, as well as the additional tests mentioned below, should be a routine part of the accident prevention programme at the workplace.

Experience has shown that, for antistatic purposes, the discharge path through a product should normally have an electrical resistance of less than 1 000 MΩ at any time throughout its useful life. A value of 100 kΩ is specified as the lowest limit of resistance of a product when new, in order to ensure some limited protection against dangerous electric shock or ignition in the event of any electrical apparatus becoming defective when operating at voltages of up to 250 V. However, under certain conditions, users should be aware that the footwear might give inadequate protection and additional provisions to protect the wearer should be taken at all times.

The electrical resistance of this type of footwear can be changed significantly by flexing, contamination, or moisture. This footwear will not perform its intended function if worn in such conditions. It is therefore necessary to ensure that the product is capable of fulfilling its designed function of dissipating electrostatic charges and also of giving some protection during the whole of its life. The user is recommended to establish an in-house test for electrical resistance and test it at regular intervals.

Classification I footwear can absorb moisture if worn for prolonged periods and in moist and wet conditions can become conductive.

If the footwear is worn in conditions where the soling material becomes contaminated, wearers should always check the electrical properties of the footwear before entering a hazard area.

Where antistatic footwear is in use, the resistance of the flooring should be such that it does not invalidate the protection provided by the footwear.

In use, no insulating elements should be introduced between the inner sole of the footwear and the foot of the wearer. If any insert is put between the inner sole and the foot, the combination footwear/insert should be checked for its electrical properties."

9.3 Electrically insulating footwear

Footwear with insulating properties provides limited protection against the inadvertent contact with damaged electrical apparatus and therefore each pair shall be supplied with a leaflet containing the following wording.

a) Electrically insulating footwear shall be worn if there is a danger of electric shock, for example, from damaged live electrical apparatus.

b) Electrically insulating footwear cannot guarantee 100 % protection from electric shock and additional measures to avoid this risk are essential. Such measures, as well as the additional tests mentioned below, should be part of a routine risk assessment program.

c) The electrical resistance of footwear should meet the requirements of EN 50321:1999, 6.3 at any time throughout the life of the footwear.

d) This level of protection can be affected during service by the footwear becoming damaged by nicks, cuts, abrasions, or chemical contamination. Regular inspections are necessary and worn or damaged footwear should not be used.

e) If footwear is worn in conditions where the soling material becomes contaminated, for example, by chemicals, caution should be taken when entering hazardous areas, as this can well affect the electrical properties of the footwear.

f) It is recommended that the users establish an appropriate means of having the electrical insulating properties of footwear inspected and tested whilst in service.

9.4 Insocks

If the footwear is supplied with a removable insock it should be made clear in the leaflet that testing was carried out with the insock in place. A warning shall be given that the footwear shall only be used

with the insock in place and that the insock shall only be replaced by a comparable insock supplied by the original footwear manufacturer.

If the footwear is supplied without an insock, it should be made clear in the leaflet that testing was carried out with no insock present. A warning shall be given that fitting an insock can affect the protective properties of the footwear.

9.5 Information regarding penetration resistant insert

Each pair of penetration resistant footwear shall be supplied with a leaflet containing the following wording.

"The penetration resistance of this footwear has been measured in the laboratory using a truncated nail of diameter 4,5 mm and a force of 1 100 N. Higher forces or nails of smaller diameter will increase the risk of penetration occurring. In such circumstances, alternative preventative measures should be considered. Two generic types of penetration resistant insert are currently available in PPE footwear. These are metal types and those from non-metal materials. Both types meet the minimum requirements for penetration resistance of the standard marked on this footwear, but each has different additional advantages or disadvantages including the following:

— metal is less affected by the shape of the sharp object/hazard (i.e. diameter, geometry, sharpness) but, due to shoemaking limitations, does not cover the entire lower area of the shoe;

— non-metal may be lighter, more flexible and provide greater coverage area when compared with metal, but the penetration resistance may vary more depending on the shape of the sharp object/hazard (i.e. diameter, geometry, sharpness)

For more information about the type of penetration resistant insert provided in your footwear, contact the manufacturer or supplier detailed on these instructions."

Annex A
(normative)

Assessment of the footwear by the laboratory during testing for resistance to heat and flame

A.1 General

The following list and drawings are provided to assess the performance of footwear for firefighters tested for resistance to heat and flame in accordance with 7.1, 7.2 and 7.3.

A.2 Criteria for the assessment of the state of footwear

A.2.1 Insulation against heat

Footwear for firefighters shall be failed when tested in accordance with 7.1, if any of the signs of deterioration identified below are found:

— the outsole shows cracks greater than 10 mm long and 3 mm deep [Figure C.1 d)];

— upper/outsole separation of more than 15 mm long and 5 mm wide (deep);

— pronounced deformation of the outsole still present when the footwear is at ambient temperature again.

To assess any pronounced deformations, the ergonomic requirements of ISO 20345:2011, 5.3.4 shall be satisfied.

A.2.2 Radiant heat

Footwear for firefighters shall be failed when tested in accordance with 7.2, if any signs of wear identified below are found:

— beginning of pronounced and deep cracking affecting half of the sample material thickness [Figure C.1 a)];

— ignition and melting of the upper affecting more than half of the sample thickness (exception: melting of reflective material, label);

— the sample shows split seams [separation of components; Figure C.1 c)]

— the complete closing mechanism is no longer closed or cannot be opened easily (the footwear shall remain in place and the wearer shall be able to take off the footwear easily).

A.2.3 Flame resistance

Footwear for firefighters shall be failed when tested in accordance with 7.3, if any of the following signs of deterioration identified below are found:

— beginning of pronounced and deep cracking affecting half of the upper material thickness [Figure C.1 a)];

— ignition and melting of the upper affecting to more than half of the upper thickness;

— the upper shows split seams [separation of components; Figure C.1 c)];

— the outsole shows cracks of more than 10 mm long and 3 mm deep [Figure C.1 d)];

— upper/outsole separation of more than 15 mm long and 5 mm wide (deep);

— the closing mechanism is no longer closed or cannot be opened easily.

Annex B
(informative)

Assessment of the footwear by the wearer

B.1 General

The following list and drawing can be provided to assist in assessing the performance of firefighting footwear.

B.2 Criteria for the assessment of the state of footwear

Footwear for firefighters should be assessed at regular intervals by inspection and should be replaced when any of the signs of wear identified below are found. Some of these criteria can vary according to the type of footwear and materials used:

— beginning of pronounced and deep cracking affecting half of the upper material thickness [Figure C.1 a)];

— strong abrasion of the upper material, especially if the toecap is revealed [Figure C.1 b)];

— the upper shows areas with deformations, burns, fusions, bubbles, or split seams in the leg [Figure C.1 c)];

— the outsole shows cracks greater than 10 mm long and 3 mm deep [Figure C.1 d)]; upper/sole separation of more than 10 mm long and 5 mm wide (deep);

— cleat height in the flexing area lower than 1,5 mm [Figure C.1 e)];

— original insock (if any) showing pronounced deformation and crushing.

— it is convenient to check manually the inside of the footwear from time to time, aiming at detecting destruction of the lining or sharp borders of the toe protection which could cause wounds [Figure C.1 f)];

— the closing mechanism is in working order (zip, laces, eyelets, touch and close system);

— the obsolescence deadline should not be exceeded;

— the footwear durability depends on the level of use and remarks made above.

NOTE Replacement of footwear for firefighters in this context means also replacement of damaged parts, which are attached to the footwear, e.g. insocks, zippers, tongues, laces.

Annex C
(informative)

Assessment of the performance of the footwear

The following drawing can be provided to assist in assessing the performance of firefighting footwear.

Dimensions in millimetres

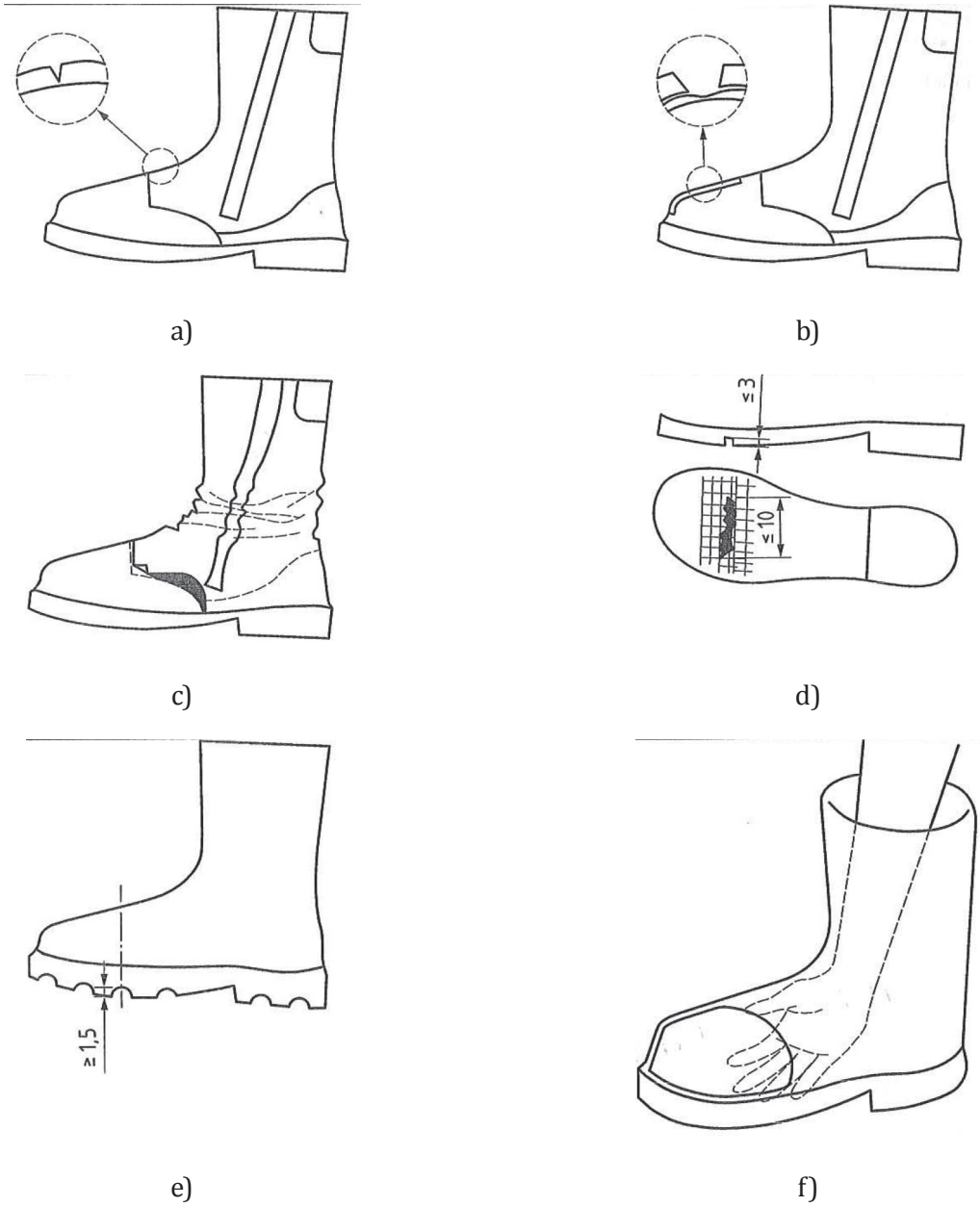


Figure C.1 — Criteria for the assessment of the state of footwear for firefighters

Annex D
(informative)

Summary of testing methodology used in 6.3

D.1 General

Footwear meeting the optional requirement for 6.3 has been tested according to the requirements of EN 13832-3.

EN 13832-3 details a list of 15 hazardous chemicals from which a minimum of three chemicals have been selected to be tested against.

The footwear outsole and upper are both tested for their resistance to degradation from each of the selected chemicals. The footwear uppers are also tested for their resistance to permeation of the selected chemicals through the material. The same chemicals must be used for all tests.

Each chemical in Table 7 is represented by a letter code. These letter codes are to be marked on the footwear to signify which chemicals the footwear has been tested against. This information is also found in the manufacturer's user instructions supplied with each product.

A minimum of three chemicals are selected for testing to meet the requirements of the standard. More than three chemicals can be tested.

D.2 Resistance to degradation

Resistance to degradation is evaluated in accordance with EN 13832-1. In the evaluation of resistance to degradation, the basic physical properties of the footwear upper and sole are checked before and after contact with the chosen chemicals. A summary of the testing protocol is as follows.

a) 120 mm disc samples are taken from footwear upper and footwear sole.

b) Weight and thickness is measured for each specimen.

c) For upper rubber materials, elongation and break are determined in accordance with ISO 20344 prior to degradation.

d) For sole and upper materials, tear resistance is determined in accordance with ISO 20344 prior to degradation.

e) For sole materials, hardness is determined in accordance with ISO 868 prior to degradation.

f) The specimens are then placed in a test apparatus and the outer surface is exposed to the selected chemical for a period of 22 h to 24 h.

g) Following the chemical exposure, the specimens are washed and are evaluated per a) through e). Additionally, the specimens are visually assessed for damage, such as holes, swelling or distortion, and brittleness.

D.3 Resistance to permeation

Resistance to permeation is evaluated in accordance with EN 13832-1. In the evaluation of resistance to permeation, the amount a chemical moves through the footwear material on a molecular level is

measured. This measurement is reported as "breakthrough time" and occurs when the permeation rate reaches 1 $\mu g \cdot cm^{-2} \cdot min^{-1}$. A summary of the testing protocol is as follows:

a) Disc samples are taken from the footwear in the size necessary to match the test cells.

b) Thickness is measured for each specimen.

c) Specimens are placed in the test cell such that the outer surface of the footwear material is in contact with the test chemical, and the inner surface is in contact with the collection medium.

d) The outer surface is then exposed to the test chemical and the collection medium flows across the inner surface and is analysed for the presence of the test chemical.

e) The test continues until the breakthrough time of the chemical is determined.

f) Following the chemical exposure, the specimens are visually examined for changes in appearance.

D.4 Precision of the method against chemicals

The test in 6.3 has been developed during a research program founded by the European community (CONTRACT No: G 6RD-CT-2000-00262, PROJECT No: GRD1-1999-20011): "Definition" of a standard for footwear protecting against chemicals and micro-organisms. The descriptor was "CHEM SAFE FOOTWEAR".

The standard deviation was studied and the results are given in Tables D.1 and D.2 for the degradation test and in Table D.3 for the permeation test.

Table D.1 — Comparison of the standard deviation of results on uppers with and without degradation procedure

Tear resistance of upper				Tensile strength at break of upper (MPa)			
Without degradation		With degradation		Without degradation		With degradation	
Hypalon	30 %	Hypalon/acetone	22 %	Hypalon	13 %	Hypalon/acetone	14 %
PVC	18 %	PVC/acetic acid 99%	15 %	PVC	25 %	PVC/acetic acid 99%	31 %
Neoprene	29 %	Neoprene/acetone	23 %	Neoprene	16 %	Neoprene/acetone	32 %
Nitrile	20 %	Nitrile/n-heptane	10 %	Nitrile	30 %	Nitrile/n-heptane	16 %
Polyurethane	32 %	Polyurethane/toluene	45 %	Polyurethane	33 %	Polyurethane/toluene	17 %
Leather	20 %	Leather/toluene	26 %	Leather	24 %	Leather/toluene	21 %
Average	25 %	Average	24 %	Average	24 %	Average	22 %

Table D.2 — Comparison of the standard deviation of results on soles with and without degradation procedure

Tear resistance of sole				Abrasion resistance of sole			
Without degradation		With degradation		Without degradation		With degradation	
Neoprene	23 %	Neoprene/acetone	9 %	Hypalon	40 %	Hypalon/acetone	21 %
Nitrile	23 %	Nitrile/n-heptane	16 %	PVC	41 %	PVC/acetic acid 99 %	7 %
				Nitrile	36 %	Nitrile/n-heptane	43 %
Average	23 %	Average	12 %	Average	41 %	Average	24 %

Table D3 — Results of the round robin test in terms of level of protection (permeation time in minutes)

Material	Chemical	Lab 1	Lab 2	Lab 3	Lab 4	Lab 5	Lab 6	AV	SD	CV %
PU	Toluene	204	252	143	89	260	108	183	84	46 %
Hypalon	n-heptane	380	366	300	318	440	480	381	69	18 %
Neoprene	Ethylacetate	114	107	100	151	210	112	132	42	32 %

Annex E
(informative)

Slip resistance

E.1 General

This Annex provides the reader with information on slip resistance in relation to footwear. When specifying and selecting footwear, slip resistance should be given a high priority.

In this context, slip resistance is a specific term referring to the coefficient of friction between the footwear and the floor.

Slips, trips and falls are the biggest cause of accidents in the work place. Many other types of accident, such as a fall from height, are often initiated by a slip. In addition to the personal costs of these accidents, the resultant injuries may bring about great financial costs.

The slip resistance test defined in ISO 13287 provides a benchmark to give end users a better idea of which products will work well in service. The information given here is intended to interpret and to complement the test data generated by ISO 13287 and to ultimately reduce the number of accidents and associated costs.

Footwear should not be assumed to be slip resistant unless this has been demonstrated by laboratory testing. Further valuable information may be gained from additional testing. Footwear field trials are recommended to assess suitability in the work place as suggested in relevant European Personal Protective Equipment (PPE) legislation.

Terms such as “anti-slip”, “non-slip”, “slip proof” are misleading and should not be used.

It is important that slip resistant footwear is in use at all times when there is a potential risk of slip; comfortable footwear will encourage this.

E.2 Explanation of ISO 13287 and marking codes SRA, SRB, or SRC

If the coefficient of friction value is below 0,24 then it is highly likely that a slip will occur during normal walking. A higher figure will reduce the likelihood of slipping accidents. It is generally accepted that at a value of 0,36 the pedestrian has a low risk of slip.

ISO 13287 test conditions and performance thresholds associated with marking codes SRA, SRB and SRC are considered basic requirements. Often it is found that footwear can achieve higher levels than just meeting SRA, SRB, or SRC.

— SRA Marked footwear has been tested on ceramic tile wetted with dilute soap solution. This represents a generic test for assessing performance on water based contaminants.

— SRB Marked footwear has been tested on stainless steel with glycerol. This represents a generic test to mimic performance on more viscous contaminants, such as oil. It should be noted that this test condition is particularly demanding and results in this test tend to be inherently low.

— SRC Marked footwear has been tested under both the above conditions and represents a test for footwear, where both types of contaminant may be encountered.

It is important to note that the SRC code may be considered misleading as it does not necessarily mean that the footwear has superior slip resistance to that only claiming SRA or SRB. For example, if the intended conditions of use only involve wet paved surfaces, then it is better to have excellent

SRA performance rather than lower levels of slip resistance when tested under both SRA and SRB conditions. It is always better to use protective equipment that has been shown to perform well under test conditions that are as similar as possible to the conditions of use.

It should also be noted that neither the SRA nor the SRB test conditions mimic outdoor environments when walking on heavy or lose ground. Under these conditions, small cleats or narrow tread patterns may become clogged with contamination, such as mud or gravel, thus leading to a significant reduction in slip resistance. Once again, additional testing and trials may be more informative than the standard slip resistance test results.

No footwear can ever provide complete safety under particularly demanding conditions, such as spillages of cooking or mineral oil. Under such conditions, slip-resistance footwear may only reduce the risk. Often the only solution in such circumstances is to either prevent contamination in the first place or promptly clean up the spill.

E.3 Additional testing

E.3.1 General

This part of ISO 11999 details specific combinations of floor surface and liquid contaminant (lubricant) to be used for testing. However, it is clearly impossible for any limited set of test conditions to successfully model the wide range of walking surfaces encountered in real-life. In the majority of cases, it would be useful to know the performance of footwear when tested against other surfaces and contaminants.

E.3.2 Additional surfaces

Slip resistance is highly dependent on the test conditions and the particular combination of surface and contaminant. It would therefore be prudent to test footwear, as far as is practicable, against real-life surfaces and other challenges.

Caution should be applied when testing or using footwear on profiled floors. Such combinations may give the impression of providing slip resistance through friction; in many cases, this impression could be misleading. Specific tread patterns may interlock with profiled floors. This interaction may change quickly with even a small amount of wear.

E.4 Factors influencing footwear performance

E.4.1 General

The heel and forepart cleat (tread) patterns and the material from which they are made are both important for slip resistance. A softer material and close-packed cleat pattern generally works well with fluid contaminants. A more open pattern usually works better with solid loose contaminants. Ideally, all footwear should be trialled in the end-use environment.

E.4.2 Durability of slip resistance

Slip resistance properties are generally only measured on new footwear. Slip-resistance is likely to change with wear. For example, if the cleated sole-pattern has fine detail, this may quickly be worn away with use. It may therefore be desirable to monitor the performance of footwear throughout its service-life. Monitoring may include periodic inspection of footwear, field-trials involving used footwear, and recording of slip-related incidents.

E.4.3 Other factors

Footwear performance may be impaired by the following factors:

— clogging of cleats;

— soiling;

— degradation due to exposure to certain environmental contaminants;

— wear;

— damage;

— exceeding the service life.

It is recommended that footwear is cleaned, maintained, inspected and replaced as necessary to ensure optimum performance.

Bibliography

[1] ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement*

[2] ISO 13287, *Personal protective equipment — Footwear — Test method for slip resistance*

[3] ISO 23529, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

[4] EN 15090:2012, *Footwear for firefighters*

[5] ENV 13005, *Guide to the uncertainty of measurement (GUM)*

[6] Pye P.W., & Harrison H.W BRE Building Elements Floors and Flooring, 1997

[7] Hallas K, Houlihan R, Shaw R., Thorpe S. Comparison of site-based friction measurement and slip potential. In: Contemporary Ergonomics. (Bust P.D. ed.). 2008 p, pp. 723–7

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