BS ISO 11999-5:2015

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 5: Helmets

National foreword

This British Standard is the UK implementation of ISO 11999-5:2015.

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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 5: Helmets

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 5: Casques

Reference number
ISO 11999-5:2015(E)

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO 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).

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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, *Fire-fighters' 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*

The following parts are under preparation:

— *Part 6: Footwear*

— *Part 9: Fire hoods*

INTERNATIONAL STANDARD **ISO 11999-5:2015(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 5: Helmets

1 Scope

This part of ISO 11999 specifies the minimum design and performance requirements for helmets as part of personal protective equipment (PPE) to be used by firefighters, primarily but not solely to protect against exposure to flame and high thermal loads.

NOTE A Type 1 helmet is similar to helmets for fighting fires in structures according to EN 443:2008. A Type 2 helmet is similar to helmets used for fighting fires in structures according to NFPA 1971:2013. However, following ISO 11999-1, all parts of heat and flame resistance requirements are consistent with each other, therefore heat and flame tests consistent with requirements for clothing given in ISO 11999-3.

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 9185:2007, *Protective clothing — Assessment of resistance of materials to molten metal splash*

ISO 11612:2008, *Protective clothing — Clothing to protect against heat and flame*

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

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

ISO 16073:2011, *Wildland firefighting personal protective equipment — Requirements and test methods*

ISO 17493:2000, *Clothing and equipment for protection against heat — Test method for convective heat resistance using a hot air circulating oven*

EN 136:1998, *Respiratory protective devices — Full face masks. Requirements, testing, marking*

EN 137:2006, *Respiratory protective devices — Self-contained open-circuit compressed air breathing apparatus with full face mask. Requirements, testing, marking*

EN 166:2001, *Personal eye protection — Specifications*

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

EN 443:2008, *Helmets for fire fighting in buildings and other structures*

EN 960:2006, *Headforms for use in the testing of protective helmets*

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

EN 13087-2:2012, *Protective helmets — Test methods — Part 2: Shock absorption*

EN 13087-4:2012, *Protective helmets — Test methods — Part 4: Retention system effectiveness*

EN 13087-5:2012, *Protective helmets — Test methods — Part 5: Retention system strength*

EN 13087-6:2012, *Protective helmets — Test methods — Part 6: Field of vision*

EN 13087-8:2000, *Protective helmets — Test methods — Part 8: Electrical properties*

EN 13087-10:2012, *Protective helmet — Test methods — Part 10: Resistance to radiant heat*

NFPA 1971:2013, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*

3 Terms and definitions

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

4 Helmet requirements

4.1 General

Helmets shall consist of at least the following assembled components:

a) Shell (area 1a according to EN 443:2008).

b) Energy absorbing system.

— Retention system. The retention system shall include a chinstrap having a minimum width of 19 mm.

c) Neck protector (Optional for Type 1 helmets, area 3a according to EN 443:2008).

d) Ear covers (Optional for Type 1 helmets, area 1b according to EN 443:2008).

e) Faceshield or goggles or both (Optional for Type 1 helmets, area 3b or area 2 according to EN 443:2008).

— Where a faceshield is selected, the faceshield shall be attached to and tested with the helmet.

— Where goggles are selected, the goggles shall be permitted to be unattached, not assembled, to the helmet. Where they are attached to the helmet, they shall be tested with the helmet. Where they are not attached, they shall be removed from the helmet before it is tested.

4.1.1 Fit

The fit of the helmet shall be adjustable laterally, in order to improve the wearing comfort and the helmet efficiency. This adjustment shall be easily feasible by the wearer without the use of tools. It should be possible for the wearer to remove the helmet by releasing the chinstraps, using one hand wearing a structural firefighting glove.

When this adjustment covers several size of head circumference, the relevant instructions shall be given in the information supplied by the manufacturer.

4.1.2 Protrusions and sharp edges

There shall be no sharp edges, roughness or projection on any part of the helmet. Projections intruding more than 5 mm from the shell interior surface and above the test line, shall not be acceptable unless covered by protective padding. Projections above the test line shall be impacted directly over the

position of the internal projection in accordance with 4.4.7, and the laboratory shall assess that the projection did not make contact with the headform.

Rigid internal projections below the test line and above the reference plane shall not be able to touch the head of the wearer when the helmet is normally affixed to the head.

The profile at the front of the helmet shall not prevent the wearing of spectacles or goggles as specified by the helmet manufacturer.

4.1.3 Reinforcement

The shell construction shall be uniformly reinforced. This does not exclude a gradual increase of the shell's thickness or of the grooves or fixation devices of the harness or of the accessories, but it does exclude every other localized reinforcement.

4.1.4 Replacement components and accessories

The fitting and/or replacement of any interchangeable parts or accessories shall not impair the function and/or safety of the helmet. All accessories and their respective replacement procedures shall be given in the information supplied by the manufacturer. No openings shall penetrate the helmet shell other than those provided by the manufacturer for mounting energy absorbing systems, retention systems or accessories.

Faceshields shall not be considered as accessories and along with neck protectors (where fitted) shall be considered as fixed sub-components of the helmet assembly.

4.1.5 Neck protector and ear covers

Type 2 helmets shall cover the wearer's neck and ears, or shall have neck protector and ear covers that cover the wearer's neck and ears. The helmet or the helmet with neck protectors and ear covers shall provide at least the following coverage.

The helmet, or the helmet with neck protector and ear covers, shall be donned in the proper wearing position as specified by the manufacturer on an EN 960:2006 headform 575 according to its positioning index. The helmet positioning index shall be the vertical distance, as specified by the manufacturer, from the lowest point of the brow at the lateral midpoint of the helmet to the basic plane of the EN 960:2006 headform 575 with the helmet firmly positioned on the headform. In this position, the neck coverage shall be measured downward from the reference plane to the lower edge of the neck coverage.

a) 95 mm measured 50 mm forward of the coronal plane;

b) 120 mm measured 25 mm forward of the coronal plane;

c) 130 mm measured at the coronal plane;

d) 130 mm measured at the midsagittal plane at the rear of the headform.

4.1.6 Shikoro

Where Shikoro is fitted, it is made of fire resistance fabric that surrounds entire wear's head, neck part below helmet brim level except eye portion covered by the face shield. Its purpose is to prevent direct flame contact to wear's head, face or neck and also to reduce heat stress. The helmet fitted with Shikoro shall continue to meet the relevant requirements of 4.4.2 to 4.4.6.

4.1.7 Optional components

Type 1 helmets shall have the facility for the fitting of any optional neck, ear and eye and face protection, unless these form integral parts of the helmet. Helmets incorporating these optional components shall continue to meet the relevant requirements of 4.4.

Neck protectors intended for use and supplied with Type 1 helmets shall conform to the requirements for neck protectors as indicated in Table 3.

4.1.8 Material selection

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

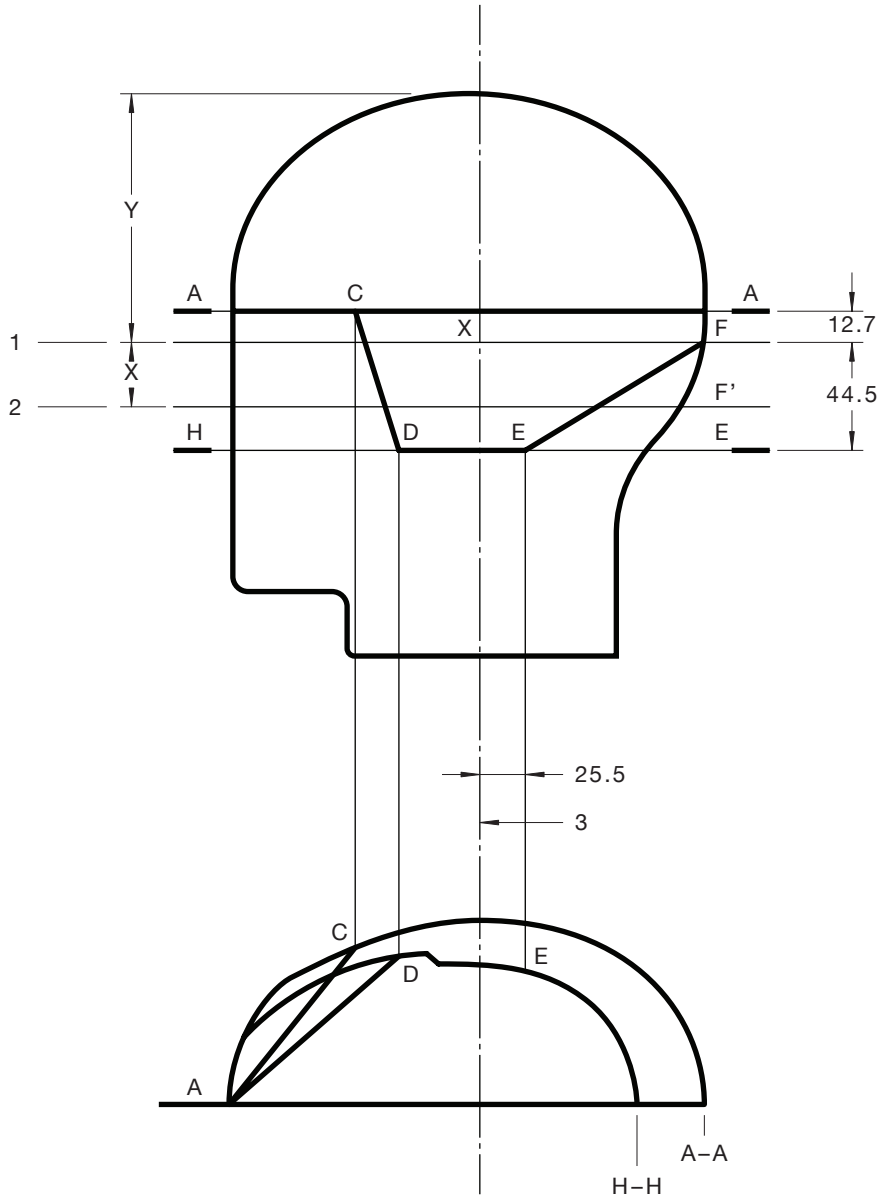
4.1.9 Resistance to cleaning agent

All materials shall be unimpaired after cleaning and disinfection by the agents and procedures specified in the information provided by the manufacturer. Such agents shall not be known to be likely to cause irritation or any other adverse effect to the health of the wearer.

4.1.10 Protected area

When adjusted on the headform as in 4.2.2, the helmet shall at least cover all the area 12,7 mm above the reference plane (see line AA in Figure 1).

NOTE This is area 1a according to EN 443:2008.



Key

1 reference plane
2 basic plane
3 central vertical axis

Figure 1 — Protected areas

4.1.11 Field of vision

4.1.11.1 When a Type 1 helmet is tested in accordance with EN 13087-6:2012, with any attached faceshield or goggle in both the stowed and deployed positions, the wearer's field of vision shall correspond to the following angles:

a) A dihedral angle of at least 105 degrees measured horizontally between L and K on each side of the sagittal plane which passes through the point L (see Figure 2 and Figure 3). Remove the neck protector or Shikoro if necessary.

b) An upper dihedral angle greater than 7 degrees above the reference plane and which is defined by the straight line passing through L1, L2 (see Figure 2 and Figure 3);

c) A lower dihedral angle greater than 45 degrees under the basic plane and which is defined by the straight line passing through K1 K2 situated on the surface of the headform as 31 mm on each side of the point K (see Figure 2 and Figure 3).

4.1.11.2 When a Type 2 helmet is tested in accordance with NFPA 1971:2013, Section 6.4.5, with faceshield or faceshield/goggle component deployed, the wearer's field of vision shall correspond to the following angles:

a) A dihedral angle of at least 85 degrees measured horizontally between L and K on each side of the sagittal plane which passes through the point L (refer to Figure 2 and Figure 3).

b) An upper dihedral angel greater than 10 degrees above the reference plane and which is defined by the straight line passing through L1 L2 (refer to Figure 2 and Figure 3).

c) A lower dihedral angle greater than 40 degrees under the basic plane and which is defined by the straight line passing through K1 K2 situated on the surface of the headform as 31 mm on each side of the point K (refer to Figure 2 and Figure 3).

d) With faceshield or faceshield/goggle component in the stowed position, the helmet shall provide peripheral vision clearance of at least 94 degrees to each side.

NOTE "Stowed position" means to be placed in "out of use" position, when it is not providing the designed protection. "Deployed position" means to be placed "in use" position, when it is providing the designed protection.

4.1.12 Helmet mass

If helmet mass, excluding non-permanently fitted accessory parts, exceed 1 500 g it shall then be marked on the helmet visible to users.

4.2 Samples and helmet adjustment

Helmet samples shall be submitted for testing in the condition in which they are offered for sale, including any means of attachment for energy absorbing systems, retention systems or accessories specified by the manufacturer.

4.2.1 Samples

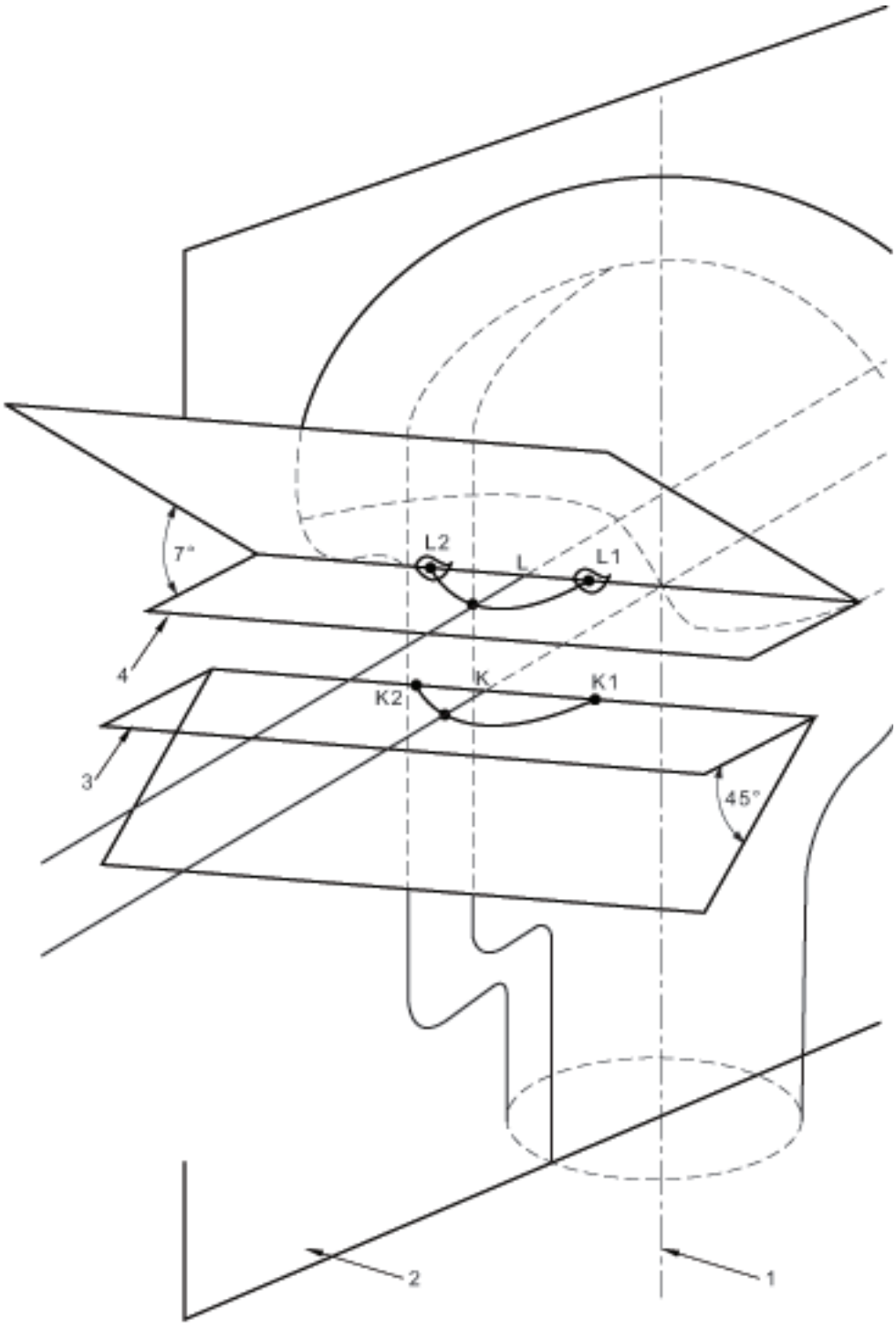
Unless otherwise specified in the test methods, the number of specimens needed for pre-conditioning and testing shall be in accordance with Table 1 or Table 2 as appropriate.

4.2.2 Helmet adjustment

Before any testing on a headform, the helmet shall be adjusted in accordance with the manufacturer's instructions. If the wearing adjustment covers several sizes of headform then the size of headform representing the most unfavourable case shall be used.

Type 1 helmets shall be tested on headforms, where required, that conform to EN 960:2006 sizes 495, 535, 605, and 625 or EN 168:2001 medium size, as appropriate to the test performed.

Type 2 helmets shall be tested on headforms, where required, that conform to NFPA 1971:2013, Figure 8.15.4.1 (a), (b), and (c). (Acceleration and penetration tests are done on ISO size J headform, and only force impact is on an aluminium ISEA size 7 headform).

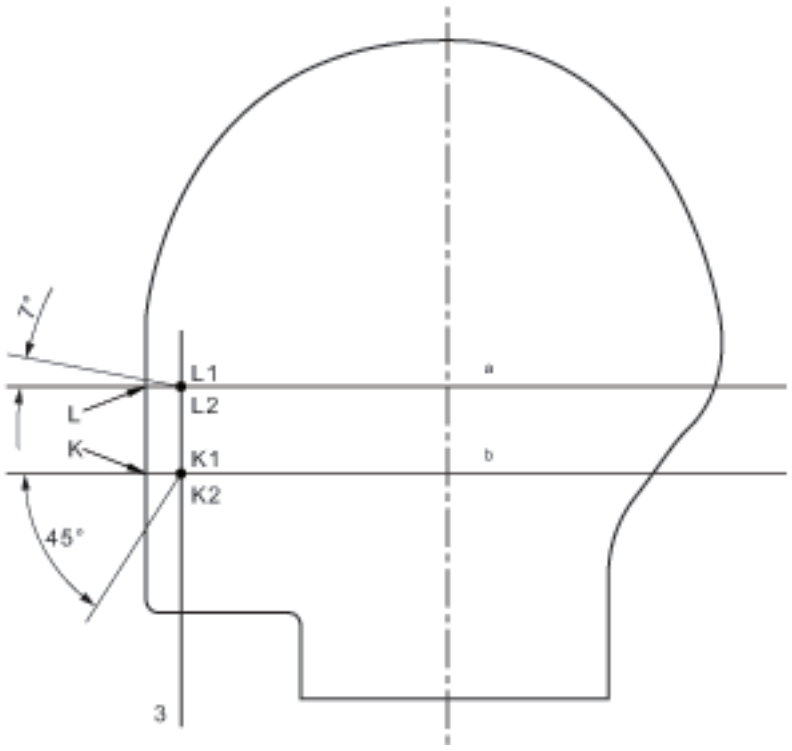


Key

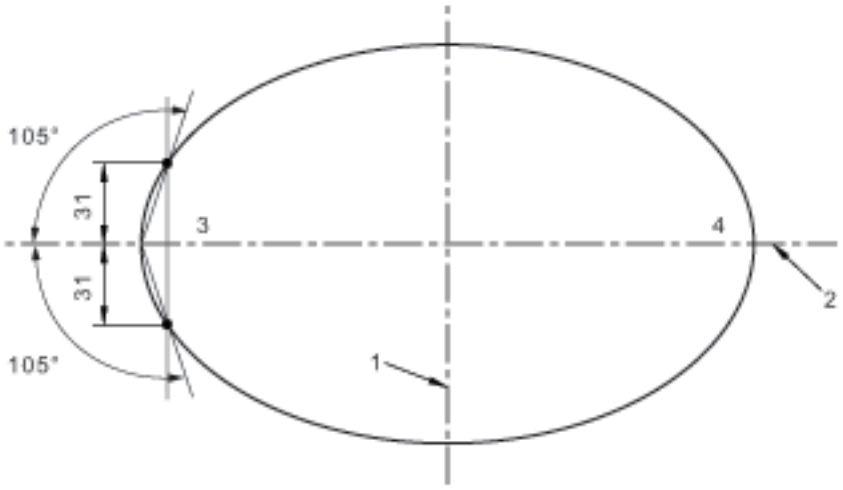
1 central vertical
2 longitudinal vertical median plane
3 basic plane
4 reference plane

Figure 2 — Vertical field of vision

Dimensions in millimetres



a) Section of headform at longitudinal vertical median plane

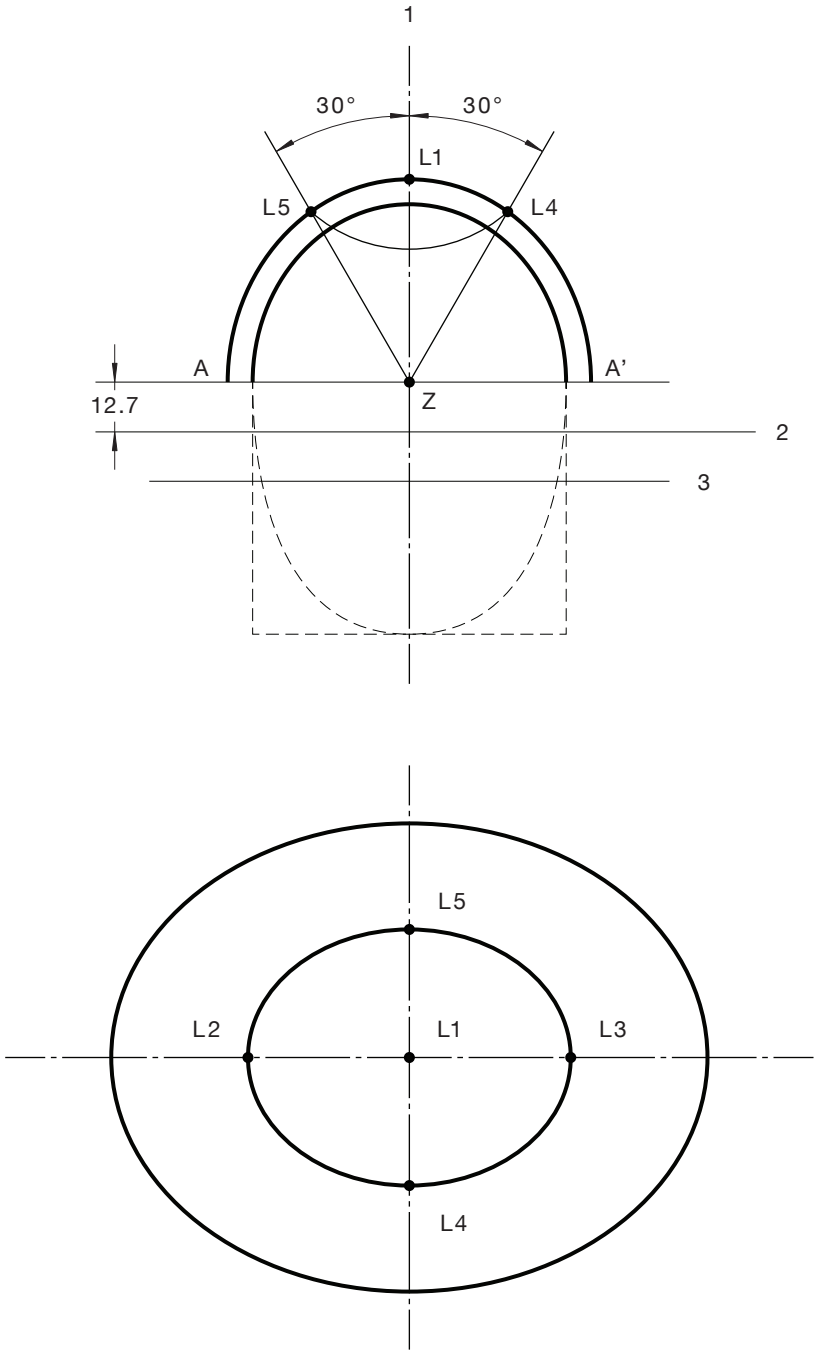


b) Section of headform at the reference plane

Key

1 central transverse vertical plane
2 longitudinal vertical median plane
3 front
4 back

Figure 3 — Section of headform, longitudinal, vertical, medial and reference planes



Key

1 central vertical axis
2 reference plane
3 basic plane

Figure 4 — Impact points on the helmet

4.3 Pre-conditioning

4.3.1 Pre-conditioning for Type 1 helmets

Unless otherwise specified in the specific test methods, all specimens (complete with any attached accessories, which shall be in the stowed position, where appropriate) shall be conditioned for a minimum of 24 h by exposure to a temperature of 20 °C ± 3 °C and a relative humidity of 60 % ± 30 % prior to testing.

Testing shall be carried out within 5 min of removing the samples from the pre-conditioning.

Before any testing, Type 1 helmets shall be conditioned in accordance with the conditioning sequence defined in Table 1.

4.3.1.1 Thermal shock

Expose the helmet successively to the following conditions:

a) 1 h at a temperature of: (choose a condition and mark accordingly) –10 °C ± 2 °C; –20 °C ± 2 °C; –30 °C ± 2 °C or –40 °C ± 2 °C.

b) 1 h at a temperature of 60 °C ± 2 °C;

c) 15 min totally immersed in fresh tap water at a temperature of 10 °C ± 2 °C;

d) 1 h at a temperature of 60 °C ± 2 °C;

e) 20 h to 24 h at standard temperature 20 °C ± 2 °C and standard relative humidity 60 % ± 30 %.

The time interval between sequences a) to b), b) to c) and c) to d) shall be within 5 s.

During sequences d) and e), the helmet shall be in a position that allows it to drain.

4.3.1.2 Water soak

The helmet shall be pre-conditioned according to EN 13087-1:2012, 4.6, method 1.

4.3.1.3 “Thermal plus”

The helmet shall be pre-conditioned according to EN 13087-1:2000, 4.4 at the temperature of 50 °C ± 2 °C.

4.3.1.4 “Thermal minus”

The helmet shall be pre-conditioned according to EN 13087-1:2000, 4.5 at the temperature chosen in 4.3.1.1 a).

Table 1 — Pre-conditioning and testing sequence for Type 1 helmets

Sequence	1	2	3	4	5
Helmet specimen number	**Thermal shock 4.3.1.1**	**Thermal plus 4.3.1.3**	**Thermal minus 4.3.1.4**	**Water soak 4.3.1.2**	**Specific test**
1					4.1.10 Protected area
2					4.1.11 Field of vision
3	X				4.4.2 Radiant heat
4	X				4.4.3 Molten metal (optional)
5	X				4.4.4.1 Heat resistance
6	X				
7	X	X			4.4.6 Flame engulfment (optional)
8	X	X			4.4.8.1 Force impact resistance
9	X		X		
10	X			X	
11	X	X			4.4.9 Ballistic resistance (optional)
12	X		X		
13	X			X	
14	X	X			4.4.11.1 Penetration
15	X		X		
16	X				4.4.12 Lateral crushing
17	X				4.4.13 Retention system effectiveness (optional)
18	X				4.4.14.1 Retention system strength
19	X				4.4.17.1.1 Electrical properties (4.4.17.1.2 and 3 optional)
20	X				
21	X				

4.3.2 Pre-conditioning for Type 2 helmets

Unless otherwise specified in the specific test methods, all specimens (complete with any attached accessories, which shall be in the stowed position, where appropriate) shall be conditioned for a minimum of 24 h by exposure to a temperature of 20 °C ± 3 °C and a relative humidity of 60 % ± 30 % prior to testing.

Testing shall be carried out within 2 min of removing the samples from the pre-conditioning.

Before any testing, helmets shall be conditioned in accordance with the conditioning sequence defined in Table 2. A total of 14 helmets are needed for all the pre-conditioning.

4.3.2.1 Room temperature

The helmet shall be pre-conditioned according to NFPA 1971:2013, Section 8.1.3.

4.3.2.2 Low temperature

The helmet shall be pre-conditioned according to NFPA 1971:2013, Section 8.1.4.

4.3.2.3 Convective heat

The helmet shall be pre-conditioned according to NFPA 1971:2013, Section 8.1.5.

4.3.2.4 Radiant heat

The helmet shall be pre-conditioned according to NFPA 1971:2013, Section 8.1.6.

4.3.2.5 Wet

The helmet shall be pre-conditioned according to NFPA 1971:2013, Section 8.1.7.

4.3.2.6 Washing/drying

Fabric portions of helmets, such as chin straps, neck protectors and ear covers, shall be pre-conditioned according to NFPA 1971:2013, Section 8.1.2.

Table 2 — Pre-conditioning and testing sequence for Type 2 helmets

Test	Room temperature 4.3.2.1	Low temperature 4.3.2.2	Convective heat 4.3.2.3	Radiant heat 4.3.2.4	Wet 4.3.2.5	Washing/ drying 4.3.2.6
4.4.4.2 Heat: Helmet, Faceshield/goggle	1					
4.4.4.2 Heat: Neck Protector Chin Strap	X					X
4.4.4.2 Heat: Thread	X					
4.4.5.2 Flame: Helmet, Faceshield/goggle	2					
4.4.5.2 Flame: Ear Cover, Chin Strap	X					X
4.4.7 TPP; Ear Covers	X					
4.4.8.2 Force Impact Resistance	3	4	9	7	11	
4.4.10 Impact Energy Attenuation	5	6	10	8		
4.4.11.2 Penetration	3	4	9	14	12	
4.4.14.2 Retention System Strength	1					
4.4.15 Suspension Retention	1					
4.4.16 Shell Retention	13					
4.4.17.2 Electrical properties	4					
4.4.18 Hardware corrosion	3					

"X" means a helmet is not needed for the pre-conditioning, only the component.

NOTE 14 helmet specimens required for testing. The number above indicates the helmet to be used for the specific test and condition.

4.4 Performance requirements

4.4.1 Requirement table for Type 1 and Type 2 helmets

No helmet sample that has been subjected to testing shall be offered for sale.

Helmets shall be tested according to the performance requirements for Type 1 or Type 2 in accordance with Table 3, as appropriate.

Helmets shall be tested with manufacturer's accessories in place. The required state of deployment of these accessories during testing is described in 4.4.2 to 4.4.18.

Table 3 — Overview of helmet performance requirements

Performance property	**Applies to**	**Type 1**		**Type 2**
Thermal		**Method A**	**Method B**	
Radiant heat	Helmet	4.4.2.1	4.4.2.2	
Molten metal (optional)	Helmet	4.4.3		
Heat resistance	Helmet	4.4.4.1		4.4.4.2 a) 4.4.4.2 b) 4.4.4.2 c) 4.4.4.2 d) 4.4.4.2 e) 4.4.4.2 f)
	Label			4.4.4.2 g)
	Faceshield/Goggles	4.4.4.1		4.4.4.2 h) 4.4.4.2 i)
	Ear covers / Neck protector	4.4.4.1 g)		4.4.4.2 d)
	Thread			4.4.4.2 f)
Flame resistance	Helmet	4.4.5.1 a) 4.4.5.1 b) 4.4.5.1 d)		4.4.5.2
	Ear covers / Neck protector			4.4.5.2
	Chin strap			4.4.5.2
	Faceshield/Goggles	4.4.5.1 c)		4.4.5.2
	Fabric			4.4.5.2
	Attachment hardware			4.4.5.2
Flame engulfment (optional)	Helmet (complete)	4.4.6		
Thermal Protective Performance	Ear covers / Neck protector			4.4.7
Force impact resistance	Helmet	4.4.8.1		4.4.8.2
Ballistic resistance (optional)	Helmet (complete)	4.4.9		
Impact energy attenuation	Helmet			4.4.10
Penetration resistance	Helmet	4.4.11.1		4.4.11.2
Lateral crushing	Helmet	4.4.12		
Retention system effectiveness (optional)	Retention system	4.4.13		
Retention system strength	Retention system	4.4.14.1		4.4.14.2
Suspension system retention	Suspension system			4.4.15
Shell Retention	Suspension system			4.4.16
Others				
Electrical, Conductive headform	Helmet	4.4.17.1.1		4.4.17.2
Electrical, Wet helmet insulation (optional)	Helmet	4.4.17.1.2		
Electrical, Surface insulation (optional)	Helmet	4.4.17.1.3		
Corrosion resistance	Hardware			4.4.18

4.4.2 Radiant heat requirements for Type 1 helmets

4.4.2.1 Radiant heat resistance (method A)

The helmet, with any visor/goggle in the stowed position, shall be tested according to 4.5.1.1, and shall meet the following requirements.

a) No part of the helmet shall ignite or melt to such a degree as to cause softening or dripping of material such that there is contact of the material with the headform.

b) The temperature measured at the surface of the artificial head shall not rise more than 25 °C above the standard laboratory temperature, 20 °C ± 3 °C.

4.4.2.2 Radiant heat resistance (method B)

The helmet shall be tested according to 4.5.1.2, and shall meet the following requirements;

a) The temperature measured at the surface of the artificial head shall not rise more than 24 °C within 180 s after start of the test.

b) No part of the shell material shall melt or drip.

c) No part of the shell material around test point shall show dilatation, deformation, crack or hole to such a degree as to impair its function.

4.4.3 Protection against molten metals for Type 1 helmets (optional)

When tested according to 4.5.2, Type 1 helmets and ear covers:

a) shall not be penetrated by the molten metal;

b) shall not show any deformation greater than 10 mm when measured at right angles to the base plane of the helmet;

c) shall not burn with the emission of a flame after a period of 5 s has elapsed after the pouring of the molten metal has ceased.

Neck protectors shall meet the requirements of ISO 11612:2008, 7.5 Performance level E2.

4.4.4 Heat resistance

4.4.4.1 Heat resistance for Type 1 helmets

When tested according to 4.5.3.1, Type 1 helmets with any attached faceshields or goggles in the deployed position shall meet the following requirements.

a) No part of the helmet assembly that is not in contact with the headform before the test shall come into contact with the headform as a result of the test. Evaluate by visual inspection.

b) There shall be no separation, melting or dripping of any part of the helmet assembly.

c) Any moveable elements of the helmet, (e.g. chin strap closure and release device(s) or faceshield mechanism) shall remain functional.

d) There shall be no ignition of any part of the helmet assembly.

e) There shall be no ignition, melting or loss of legibility of any part of the product labels.

f) No part of the faceshield that was not below the brim line prior to the test shall be below the brim line after the test.

g) No part of the neck protector shall ignite or melt or shrink more than 5 % in two perpendicular directions.

4.4.4.2 Heat resistance for Type 2 helmets

When tested according to 4.5.3.2, the helmets, with ear covers deployed and attached faceshields/goggles, shall meet the following requirements.

a) No part of the helmet not in contact with the headform before the test shall be in contact with the headform as a result of the test.

b) No shell distortion in the back of the helmet extending more than 40 mm below the original position.

c) No distortion of the front and sides of the helmet extending more than 30 mm below the original position.

d) No separation, melting or dripping of the retention system, energy absorption system or ear covers.

e) Chin strap closure device shall remain functional.

f) No ignition of any part of the helmet assembly.

g) No ignition or melting of the product labels.

h) No part of the faceshield/goggle component that was not below the brim line before the test, shall be below the brim line after the test.

i) No dripping of the faceshield/goggle component.

4.4.5 Flame resistance

4.4.5.1 Flame resistance for Type 1 helmets

The helmets shall be tested according to 4.5.4.1, and shall meet the following requirements.

a) Shell material shall not show any visible afterflame or glow 2 s after removal from the test flame.

b) Paint material over the shell surface shall not show any visible after flame or glow 5 s after removal from the test flame.

c) If face shield is fitted, it shall not show any visible flame or glow 2 s after removal from the test flame.

d) No part of the shell material and faceshield around test point shall show separation or dripping.

4.4.5.2 Flame resistance for Type 2 helmets

When tested according to 4.5.4.2, the helmets shall not show any visible afterflame or glow 5 s after removal from the test flame in each case.

4.4.6 Flame engulfment for Type 1 helmets (optional)

When tested according to 4.5.5, the helmets shall not drip or show any visible flame or glow 5 s after removal of the flame.

4.4.7 Thermal protective performance (TPP) for Type 2 helmets

When tested according to 4.5.6, helmet ear covers shall have an average TPP of at least 20.

4.4.8 Force impact resistance

4.4.8.1 Force impact resistance for Type 1 helmets

The helmets shall be tested according to 4.5.7.1 and the force transmitted to the headform shall not exceed 15 kN.

4.4.8.2 Force impact resistance for Type 2 helmets

When tested according to 4.5.7.2, helmet assemblies, with all attached accessory items in the deployed position, shall have no sample transmit a force of more than 3 780 N.

4.4.9 Ballistic resistance for Type 1 helmets (optional)

The helmets shall be tested according to 4.5.8 and there shall be no release of material from the inner surface of the helmet and the projectile shall be prevented from passing completely through the shell of the helmet. Any attached faceshields or goggles shall be in the deployed position, and shall not be impacted.

4.4.10 Impact energy attenuation for Type 2 helmets

When tested according to 4.5.9, helmet assemblies, with all attached accessory items in the deployed position, shall have no specimen exceed the maximum acceleration specified as follows:

— top, 1 471,5 m/s^2 (150 G);

— front, 2 943,0 m/s^2 (300 G);

— sides, 2 943,0 m/s^2 (300 G); and

— back, 2 943,0 m/s^2 (300 G).

Any acceleration above 1 962 m/s^2 (200 G) shall not exceed a duration of 3 ms, and an acceleration above 1 471,5 m/s^2 (150 G) shall not exceed a duration of 6 ms.

4.4.11 Penetration resistance

4.4.11.1 Penetration resistance for Type 1 helmets

The helmets shall be tested according to 4.5.10.1 and there shall be no contact between the striker and the test block.

4.4.11.2 Penetration resistance for Type 2 helmets

When tested according to 4.5.10.2, helmet assemblies, with all manufactured accessories in the deployed position shall exhibit no electrical or physical contact between the penetration test striker and the headform.

4.4.12 Lateral crushing for Type 1 helmets

When testing according to 4.5.11, the maximum transverse and longitudinal deformations of the helmet shall not exceed 40 mm, and the residual deformations shall not exceed 15 mm.

4.4.13 Retention system effectiveness for Type 1 helmet (optional)

When tested according to 4.5.12, the helmets shall not come off the headform.

4.4.14 Retention system strength

4.4.14.1 Retention system strength for Type 1 helmets

When tested according to 4.5.13.1:

a) the maximum elongation of the whole system shall not exceed 20 mm for a load of 250 N;

b) the minimum width of the chin strap shall not be less than 15 mm for a load of 250 N;

c) the release point of the retention system shall be between 500 N and 1 000 N. (optional).

NOTE Users are reminded of the following possible consequences when making a decision to implement 4.4.14.1:

1) Option to not adopt – there is a risk of strangulation due to the wearer being hung by the chinstrap if the chinstrap does not release below 1 000 N.

2) Option to adopt – there is a risk of losing head protection by having the helmet retention system break prematurely (i.e. below 500 N) due to deterioration of retention system over time.

4.4.14.2 Retention system strength for Type 2 helmets

When testing the helmet retention system according to 4.5.13.2, the test should occur without any break and without any resulting slip or stretch of more than 20 mm.

4.4.15 Suspension system retention for Type 2 helmets

When tested according to 4.5.14, helmet suspension systems shall not have the helmet separate from the helmet suspension system or helmet retention system.

4.4.16 Shell retention for Type 2 helmets

When tested according to 4.5.15, the helmets shall not have the helmet separate from the helmet suspension system or helmet retention system.

4.4.17 Electrical properties

4.4.17.1 Electrical properties of Type 1 helmets

4.4.17.1.1 Conductive headform test

When tested according to 4.5.16.1.1, the helmet assembly shall show no visible evidence of breakdown and the leakage current shall not exceed 1,2 mA.

4.4.17.1.2 Wet helmet insulation test (optional)

When tested according to 4.5.16.1.2, the helmet assembly shall show no visible evidence of breakdown and the leakage current shall not exceed 1,2 mA.

4.4.17.1.3 Surface insulation test (optional)

When tested according to 4.5.16.1.3, the helmet assembly shall show no visible evidence of breakdown and the leakage current shall not exceed 1,2 mA.

NOTE These requirements are intended to provide protection to the wearer against short-term accidental contact with live electrical conductors at voltages up to 440 V AC.

4.4.17.2 Electrical properties of Type 2 helmets

When tested according to 4.5.16.2, helmet assemblies, with all attached accessory items in the deployed position, shall not have leakage current exceed 3,0 mA in either procedure.

4.4.18 Hardware corrosion resistance for Type 2 helmets

When tested according to 4.5.17, all metal hardware and specimens of all hardware that include metal parts shall have metals that are inherently resistant to corrosion, including but not limited to, stainless steel, brass, copper, aluminium, and zinc show no more than light surface-type corrosion or oxidation, shall have ferrous metals show no corrosion of the base metal, and shall have all hardware remain functional.

4.5 Test methods

4.5.1 Radiant heat

4.5.1.1 Radiant heat resistance for Type 1 helmets (method A)

The helmets shall be tested in accordance with EN 13087-10:2012, except that the exposure time shall be 480 s ± 5 s. The heat flux density shall be 14 kW/m^2.

4.5.1.2 Radiant heat resistance for Type 1 helmets (method B)

The helmets shall be mounted onto test headform with any attached faceshield/goggles in the deployed position. The helmet is kept upside down so that the contactable surface of the test point angle is 45° to the vertical, and 40 kW/m^2 of heat flux is applied to the test point for 180 s.

4.5.2 Protection against molten metals for Type 1 helmets (optional)

Helmets and ear covers (where fitted) shall be tested in accordance with ISO 9185:2007, using a mass of 150 g ± 10 g.

The method shall be modified by the introduction of an appropriate headform and by substituting the helmet under test for the material sample and PVC skin stimulant. The metal shall be iron as specified in ISO 9185:2007, Annex A. Place the helmet on the headform in such a way that the point of impact of the liquid metal is within a circle of radius 50 mm centred on the crown. Any attached faceshields or goggles shall be in the stowed position.

4.5.3 Heat resistance

4.5.3.1 Heat resistance for Type 1 helmets

The helmet assembly with any attached faceshields or goggles in the deployed position, shall be tested in accordance with ISO 17493:2000 at a temperature of 180 °C ± 5° C for 5 min.

4.5.3.2 Heat resistance for Type 2 helmets

The helmets with ear covers deployed and attached faceshields/goggles in the stowed position, shall be tested in accordance with NFPA 1971:2013, Section 8.6 at a temperature of 260 °C +5/−0 °C for 5 min +15/−0 s.

All materials used in the construction of the helmet ear covers and chin straps shall be individually tested in accordance with NFPA 1971:2013, Section 8.6 at a temperature of 260 °C +5/−0 °C for 5 min +15/−0 s, and shall not shrink more than 10 % in any direction, and shall not melt, separate or ignite. The chin strap material shall meet the thermal shrinkage requirement for the length direction only.

All sewing thread used in the construction of helmets shall be tested for melting resistance in accordance with NFPA 1971:2013, Section 8.11 and shall not melt below 260 °C.

4.5.4 Flame resistance

4.5.4.1 Flame resistance for Type 1 helmets

The helmet is exposed to a specified flame and the state of combustion is observed.

a) A Bunsen burner with a 10 mm diameter bore suitable for propane gas and capable of adjusting a rate of gas flow and air vent shall be used.

b) The gas used shall be propane having a minimum purity of 95 %, gas pressure of 3,5 kPa.

c) The flame shall be adjusted so that the blue cone is clearly defined, although turbulent, and the blue flame is approximately 15 mm long.

d) With helmet upside down, the shell is kept so that the contactable surface of the test point (to which the end of the flame is applied) within a range of 50 mm to 100 mm apart from the crown of the shell is kept horizontally and, with the burner angle 45° to the vertical, the end of the flame is applied to the test point for period of 10 s.

4.5.4.2 Flame resistance for Type 2 helmets

The helmet shall be tested for flame resistance in accordance with NFPA 1971:2013, Section 8.3 Procedures A and C.

All materials used in the construction of helmet ear covers and chin straps shall be individually tested for flame resistance in accordance with NFPA 1971:2013, Section 8.2, and shall not have a char length greater than 100 mm and shall not show any visible afterflame 2 s after removal from the test flame and shall not drip or melt.

Faceshield/goggle components shall be tested for flame resistance in accordance with NFPA 1971:2013, Section 8.3, Procedure B and shall not show any visible afterflame 5 s after removal of the test flame.

All fabrics used in the construction of faceshield/goggle components shall be individually tested for flame resistance in accordance with NFPA 1971:2013, Section 8.2, and shall not have a char length greater than 100 mm and shall not show any visible afterflame 5 s after removal from the test flame and shall not drip or melt.

Where provided, the faceshield/goggle component attachment hardware shall be individually tested for flame resistance in accordance with NFPA 1971:2013, Section 8.3, Procedure D, and shall not show any visible afterflame 5 s after removal from the test flame.

4.5.5 Flame engulfment for Type 1 helmets (optional)

The helmet shall be tested in accordance with EN 137:2006, 7.4.1.3 with the following modifications.

a) The test manikin shall be fitted with the helmet to be tested, together with a firefighters jacket according to ISO/TS 11999-2, a fire hood according to ISO/TS 11999-2 and a full facemask according to EN 136:1998, Class 3. The jacket, hood and facemask shall be selected with the agreement of the manufacturer of the helmet and the models used shall be reported by the test house. Any helmet accessories, or non-integral additional protective functional components, fitted during the test shall also be reported. It is not necessary to fit breathing apparatus according to EN 137:2006.

b) One helmet shall be tested.

c) A breathing machine shall not be used for testing, and the measurement of breathing resistance is not required.

d) The burner strips shall not be set as per EN 137:2006, Figure 3 but instead shall be raised so that the highest burner strip is positioned on the level of point L 1 (see EN 137:2006, Figure 7 and 8) of the helmet on the test manikin's head.

e) Faceshields, where attached to the helmet, shall be in the stowed position, unless they can be in the deployed position when a full RPD (respiratory protective device) facemask is fitted to the manikin head. Attached goggles shall be in the stowed position.

f) The drop test shall not be performed.

4.5.6 Thermal protective performance for Type 2 helmets ear covers

The helmet ear covers shall be tested for thermal insulation in accordance with NFPA 1971:2013, Section 8.10.

4.5.7 Force impact resistance

4.5.7.1 Force impact resistance for Type 1 helmets

The helmet assemblies, with any attached faceshields or goggles in the stowed position, shall be tested in accordance with EN 13087-2:2012, 5.2, falling mass method, using the hemispherical striker with the following modifications.

a) The radius of the hemispherical striker shall be 50 mm ± 2 mm.

b) The impact energy shall be 123 J ± 3 J.

c) The headform shall be rotated so that the impact point lies along the axis through the striker and transducer. Allow the striker to fall on to each of the 5 impact points shown in Figure 4.

d) The first impact shall be performed within 1 min of removal from the pre-conditioning and subsequent impacts within 5 min. If further impacts are required, the samples shall be returned immediately to the pre-conditioning chamber for at least 1 h before further impacts.

4.5.7.2 Force impact resistance for Type 2 helmets

The helmet assemblies, with all attached accessory items in the deployed position, shall be tested for impact resistance in accordance with NFPA 1971:2013, Section 8.15.

4.5.8 Ballistic resistance for Type 1 helmets (optional)

The helmets shall be tested in accordance with EN 166:2001, 7.2.2, with the following modifications.

a) The test in EN 166:2002, 7.1.4.2.2 shall not be performed.

b) The steel ball shall be projected at a speed of 120 m/s +3/−0 m/s.

c) The helmets shall be individually impacted. The impact point of the ball shall be at any point of at least 5 mm inside the edge of these areas.

d) A sheet of carbon paper, on top of a sheet of white paper, shall be attached to the headform at the impact points.

e) Impacts shall be conducted additionally on any area of visually different construction.

f) Multiple impacts may be performed on the same sample, but there shall be a minimum separation of 15 mm between impact sites. In the case of samples initially pre-conditioned, the first impact shall be performed within 1 min of removal from the pre-conditioning and subsequent impacts within 5 min. If further impacts are required, the samples shall be returned immediately to the pre-conditioning chamber for at least 1 h before further impacts.

g) During testing, the headform shall only be rotated about the vertical axis.

4.5.9 Impact energy attenuation for Type 2 helmets

The helmet assemblies, with all attached accessory items in the deployed position, shall be tested for impact resistance in accordance with NFPA 1971:2013, Section 8.16.

4.5.10 Penetration resistance

4.5.10.1 Penetration resistance for Type 1 helmets

The helmet assemblies, with any attached faceshields or goggles in the deployed position, shall be tested in accordance with ISO 16073:2011, 7.6 with following modifications.

a) The sample shall be adjusted to its greatest possible wearing height.

b) The test shall be completed within 1 min after finishing room temperature conditioning.

4.5.10.2 Penetration resistance for Type 2 helmets

The helmet assemblies, with all attached accessory items in the deployed position, shall be tested for penetration resistance in accordance with NFPA 1971:2013, Section 8.19.

4.5.11 Lateral crushing for Type 1 helmets

The helmet is subjected to transverse compressive force, then to longitudinal compressive force. The maximum and residual deformations are measured. The following procedure shall be followed.

a) Pre-condition the helmet according to the relevant conditioning in Table 1.

b) Place the helmet between two guided rigid parallel plates of size 300 mm × 250 mm nominal, having their lower 300 mm long inner edges radiuses to 10 mm ± 0,5 mm.

c) Position the lower edges of the plates at the level of the AA plane (see Figure 1).

d) Apply an initial force of 30 N perpendicular to the plates, so that the helmet is subjected to a compressive force. After 30 s measure the distance between the plates.

e) Increase the force by 200 N/min up to 630 N and hold for 30 s. Measure the distance between the plates and calculate the maximum distortion.

f) Decrease the force to 25 N and then immediately increase to 30 N, and hold for 30 s. Measure the distance between the plates and calculate the residual deformation.

g) Make measurements to the nearest mm and note the extent of damage, if any.

4.5.12 Retention system effectiveness for Type 1 helmets (optional)

The helmet retention system shall be tested in accordance with EN 13087-4:2012, using a drop height of 175 mm ± 5 mm.

Testing shall be conducted with any attached faceshields or goggles in both the stowed and deployed positions.

4.5.13 Retention system strength

4.5.13.1 Retention system strength for Type 1 helmets

The helmet retention system shall be tested in accordance with EN 13087-5:2012, 5.2, Method b, using an initial tensile force of 30 N and an intermediate tensile force of 250 N, and the maximum elongation of the whole system shall not exceed 20 mm for a load of 250 N, the minimum width of the chin strap shall not be less than 15 mm for a load of 250 N.

The release point of the retention system shall be between 500 N and 1 000 N (optional).

4.5.13.2 Retention system strength for Type 2 helmets

The helmet retention system shall be tested in accordance with NFPA 1971:2013, Section 8.34, without any break occurring and without any resulting slip or stretch of more than 20 mm.

4.5.14 Suspension system retention for Type 2 helmets

Type 2 helmet suspension systems shall be tested in accordance with NFPA 1971:2013, Section 8.35.

4.5.15 Shell retention for Type 2 helmets

Type 2 helmets shall be tested in accordance with NFPA 1971:2013, Section 8.43.

4.5.16 Electrical properties

4.5.16.1 Electrical properties for Type 1 helmets

4.5.16.1.1 Conductive headform test

The helmet assembly shall be tested in accordance with EN 13087-8:2000, 5.2.

Testing shall be conducted with any attached faceshields or goggles in both the stowed and deployed positions, ensuring that any exposed surfaces are included in the assessment.

NOTE This test is intended to simulate closely the situation in use, that is the leakage current to the wearer via a live conductor touching the external surface of the helmet assembly.

4.5.16.1.2 Wet helmet insulation test (optional)

The helmet assembly with all fitting devices and accessories shall be tested in accordance with EN 13087-8:2000, 5.3.

Testing shall be conducted with any attached faceshields or goggles in both the stowed and deployed positions, ensuring that any exposed surfaces are included in the assessment.

NOTE This test is dependent only upon the transverse resistance of the helmet assembly and attached accessories (thickness). This effectively precludes the use of a metal shell and of holes or metal fasteners passing through the helmet assembly or accessories.

4.5.16.1.3 Surface insulation test (optional)

The helmet assembly shall be tested in accordance with EN 13087-8:2000, 5.4.

Testing shall be conducted with any attached faceshields or goggles in both the stowed and deployed.

NOTE This test is also dependent upon the surface resistance of the helmet assembly and effectively precludes the use of exposed materials which have a conductive surface (metal-electroplating). This test is intended to obviate danger to the wearer should they try to touch or remove a helmet whose shell is in contact with a live conductor.

4.5.16.2 Electrical properties for Type 2 helmets

The helmet assemblies, with all attached accessory items in the deployed position, shall be tested in accordance with NFPA 1971:2013, Section 8.30, Procedure A and Procedure B.

4.5.17 Hardware corrosion resistance for Type 2 helmets

All metal hardware and specimens of all hardware that include metal parts shall be individually tested in accordance with NFPA 1971:2013, Section 8.29.

5 Marking

5.1 Marking for Type 1 helmets

Every helmet shall carry visible, legible and unambiguous, permanent and durable marking giving the following information:

a) reference and year of this part of ISO 11999, i.e. ISO 11999-5:2015

b) name or identification mark of the manufacturer;

c) year of manufacture;

d) type of helmet, e.g. Type 1;

e) model of helmet (manufacturer's designation);

f) size or size range (in cm).

Every helmet claimed to conform to the optional requirements of this part of ISO 11999 shall carry visible, legible and unambiguous, permanent and durable marking on the shell or shall carry durable self-adhesive label, stating the optional requirements complied with, as follows:

1) protection against molten metal classification (where compliance is claimed):

M for products conforming with the requirements of 4.4.3;

2) flame engulfment classification (where compliance is claimed):

F for products conforming with the requirements of 4.4.6;

3) ballistic resistance classification (where compliance is claimed):

B for products conforming with the requirements of 4.4.9;

4) retention system effectiveness classification (where compliance is claimed):

RE for products conforming with the requirements of 4.4.13;

5) retention system strength classification (where compliance is claimed):

RS for products conforming with the requirements of 4.4.14.1 c);

6) electrical properties classification (where compliance is claimed):

i) E2 for products conforming with the requirements of 4.4.17.1.2,

ii) E3 for products conforming with the requirements of 4.4.17.1.3.

Marking shall be easily visible to the user without requiring disassembly of the helmet or removal of accessories.

5.2 Marking for Type 2 helmets

a) The following information shall be printed legibly on each product label with all letters at least 1,5 mm (1/16 in.) in height:

   1) manufacturer's name, identification, or designation;

   2) manufacturer's address;

   3) country of manufacture;

   4) manufacturer's element identification number, lot number, or serial number;

   5) month and year of manufacture, not coded;

   6) model name, number, or design;

   7) size or size range;

   8) principal material(s) of construction — For principal materials of construction of helmets, generic terminology for the shell material shall be provided;

   9) cleaning precautions.

b) The following compliance statement shall be printed legibly on the product label.

   All product label letters and figures shall be at least 2,5 mm (3/32 in.) in height.

   "THIS STRUCTURAL FIRE FIGHTING PROTECTIVE HELMET MEETS THE HELMET REQUIREMENTS OF NFPA 1971, 2013 EDITION. DO NOT REMOVE THIS LABEL."

c) For helmets only, the helmet manufacturer shall place a unique manufacturer's part number, the symbol of the certification organization, and the words "NFPA 1971, 2013 ED." permanently on each replaceable performance critical part of the goggle lens or faceshield.

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