INTERNATIONAL STANDARD

ISO 18639-5

First edition
2018-11

PPE ensembles for firefighters undertaking specific rescue activities —

Part 5: Helmet

Équipements de protection personnelle pour pompiers entreprenant des activités de sauvetage particulières —

Partie 5: Casque

Reference number
ISO 18639-5:2018(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

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 of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 94, *Personal safety — Personal protective equipment*, Subcommittee SC 14, *Firefighters' personal equipment*.

A list of all the parts in the ISO 18639 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

ISO 18639 is a series of standards for personal protective equipment (PPE) for firefighters when engaged in specific rescue activities. It is not possible to provide a standard for PPE to cover all of the diverse range of rescue scenarios that firefighters are likely to encounter so it is important that risk assessments be undertaken to determine if the PPE covered by the ISO 18639 series is suitable for its intended use and the expected exposure to hazards. For complete protection against exposures, the risk assessment should include protection of the whole body including the torso, arms and legs, head, face, hands and feet.

For certain rescue activities, safety ropes and harnesses may be required. For certain rescue situations, special PPE for use in and on water may be required. In some cases, appropriate respiratory protection may also be identified as being necessary.

The performance requirements in this document take account of accidental exposure to heat and flame, but do not cover PPE for firefighting. While this document takes account of accidental exposure to some common chemicals, it is not intended that PPE conforming to this document should be considered as providing chemical protection as a primary function. It does not cover PPE to protect against biological, electrical or radiation hazards. The risk assessment should determine whether PPE complying with this document or to the requirements of any other relevant standard is more suitable.

Firefighters should be trained in the use, care and maintenance of the PPE covered by this document, including an understanding of its limitations.

PPE ensembles for firefighters undertaking specific rescue activities —

Part 5:
Helmet

1 Scope

This document provides the principles that govern the development of incident type and/or hazard specific test methods and minimum performance requirements for helmets for firefighters while engaged in specific rescue activities.

Helmets related to specific rescue activities, such as road traffic crash (RTC) and urban search and rescue (USAR), are documented in individual subclauses of this document.

NOTE Further guidance can be found in ISO 18639-1.

The purpose of this document is to ensure that minimum performance requirements for incident type and/or hazard specific helmets are designated.

This document covers general helmet design, the minimum performance level of the materials used and the methods of test for determining this performance level.

It does not cover special helmets for use in other high risk situations such as firefighting.

This document does not cover protection for the torso, arms, legs and feet or protection of the hands against other hazards, e.g. chemical, biological, radiation and electrical hazards, except for limited, accidental exposure to fire ground chemicals and contaminated blood or body fluids.

Selection of the appropriate system of personal protective equipment, (PPE), including helmets, is dependent on carrying out an effective risk assessment which identifies the hazard to be faced, evaluates the likelihood of those hazards and provides the means of reducing or eliminating these hazards.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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

EN 960, *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, *Protective helmets — Test methods — Part 2: Shock absorption*

EN 13087-3, *Protective helmets — Test methods — Part 3: Resistance to penetration*

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

EN 13087-7, *Protective helmets — Test methods — Part 7: Flame resistance*

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

EN 16473:2014, *Firefighters helmet — Helmets for technical rescue*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
helmet for technical rescue
hardware, including all integral components supplied by the manufacturer, intended primarily to protect the upper part of a wearer's head against hazards which may occur during technical rescue activities

Note 1 to entry: Hereafter, helmets for technical rescue are referred to as helmets.

3.2
helmet shell
component in hard material with a smooth finish, which gives the helmet its general shape

3.3
retention system
those parts which are responsible for securing the helmet in position on the head, including items which enable adjustment or improved comfort

3.4
chin strap
part of a retention system, including a strap which passes under or on the wearer's chin and which helps to ensure that the helmet is correctly maintained in place

3.5
headform
shape that replaces the head and is used for testing certain characteristics

Note 1 to entry: The design of the headform complies with EN 960:2006, 3.7.

3.6
accessories
additional device(s) supplied or recommended by the manufacturer which may be attached to the helmet but which provide no protective function to the wearer

EXAMPLE Lamp brackets, cable clips, badges and trims.

3.7
non-integral additional protective devices
additional protective device(s) supplied or recommended by the manufacturer which may be attached to the helmet and intended to be removable by the user

EXAMPLE Mesh visors, ear defenders, neck-guard and safety goggles.

3.8
failure modes and effects analysis
FMEA
method used to derive design features that are difficult to test in a laboratory, and not allowed to be tested on humans, such as skin irritations

4 Physical requirements

4.1 Material and construction

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.

This shall be addressed by the FMEA conducted by the manufacturer.

NOTE A typical FMEA process is given for information in Annex B.

4.2 Projections

There shall be no sharp edges, roughness, or projections on any part of the helmet which, when worn, are in contact or potential contact with the wearer and which may cause injury to the wearer.

4.3 Retention system

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

4.4 Accessories and non-integral additional protective devices

When the helmet manufacturer states any accessories and/or non-integral additional protective devices, as defined in 3.6 and 3.7, being used with the helmet, the helmet fitted with such items shall continue to meet the requirement of this document.

4.5 Inspection

The inspection shall be made prior to laboratory or practical performance tests or as specified in the standard. This may entail a certain amount of assembly, dismantling or adjustment of the helmet. The inspection shall include a report of the findings and assessments.

Inspection shall include, where applicable, an assessment of;

a) visible damage, deformation, and corrosion;

b) operation of connections, including with the use of gloves (if required);

c) the need for special tools;

d) compatibilities with other PPE or equipment;

e) marking;

f) information provided by the helmet manufacturer;

g) documentation, e.g. safety data sheets or declarations relevant to the materials used, a written declaration with relevant parts of the FMEA.

5 Sampling and pre-treatment

5.1 Sampling and helmet adjustment

5.1.1 Samples

Helmets shall be submitted for testing in the condition in which they are offered for sale, including any requisite holes or other means of attachment, for any item(s) as defined in the manufacturer's instructions.

If several sizes of the helmet are available, then the size representing the most unfavourable helmet regarding headform size shall be used.

5.1.2 Helmet adjustment

Before any testing to the relevant headform, the helmet shall be adjusted in accordance with the manufacturer's instructions

When putting helmets on headform which has a number of head sizes, ensure the most unfavourable combination is used.

5.2 Pre-conditioning

5.2.1 General

Before any testing is performed, the helmet shall be preconditioned in accordance with the preconditioning sequences specified in Annex A and the relevant specifications defined in 5.2.2 to 5.2.4.

5.2.2 'Thermal plus' conditioning

The helmet shall be preconditioned in accordance with EN 13087-1:2000, 4.4. The temperature shall be (50 ± 2) °C for between 4 h to 24 h.

5.2.3 'Thermal minus' conditioning

The helmet shall be preconditioned in accordance with EN 13087-1:2000, 4.5.

5.2.4 Wet conditioning

The helmet shall be preconditioned by totally immersing it in water at (20 ± 2) °C for between 4 h to 24 h.

5.2.5 Normal temperature

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 ± 3) °C and a relative humidity of (60 ± 30) % prior to testing.

6 Performance requirements

6.1 General

Helmets shall be classified as RTC or USAR by meeting the performance requirements in Table 1.

Table 1 — Summary of requirements and classification

Requirements	Road traffic crash (RTC)	Urban search and rescue (USAR)
Shock absorption (Crown impact), see 6.4	< 5 kN	< 5 kN
Shock absorption (Lateral impacts), see 6.4	< 5 kN	< 5 kN
Penetration resistance, see 6.5	No contact between striker and test block	No contact between striker and test block
Retention system strength, see 6.6	Chin strap width > 15 mm and elongation < 25 mm at 250 N load	Chin strap width > 15 mm and elongation < 25 mm at 250 N load
Flame resistance, see 6.7	not burn > 5 s	not burn > 5 s
Accessories and non-integral additional protective devices, see 6.7.2	not burn > 5 s	not burn > 5 s
Lateral crushing, see 6.8	< 40 mm, < 15 mm	< 40 mm, < 15 mm
Thermal resistance, see 6.9	No contact with headform, no ignition, separation, melting or dipping	No contact with headform, no ignition, separation, melting or dipping
Electrical properties, see 6.10	< 1,2 mA	< 1,2 mA
Practical performance, see 6.11	Meet requirements	Meet requirements
Protection against high speed particles (optional), see 6.12	—	No penetration

6.2 Road traffic crash (RTC)

RTC helmets shall meet the mechanical strength requirements specified in 6.4, 6.5, 6.6 and 6.8.

In addition to 6.10 and 6.11, the thermal requirements specified in 6.7 and 6.9 shall be met.

6.3 Urban search and rescue (USAR)

USAR helmets shall meet the mechanical strength requirements specified in 6.4, 6.5, 6.6, 6.8 and 6.12.

In addition to 6.10 and 6.11, the thermal requirements specified in 6.7 and 6.9 shall be met.

6.4 Shock absorption

6.4.1 General

All four impacts (1 crown and 3 lateral) shall be performed on the same helmet following different environmental preconditioning as per Annex A.

6.4.2 Crown impact

6.4.2.1 General

When a helmet is tested by the method described in 6.4.2.2, the force transmitted to the headform shall not exceed 5 kN, for an impact energy of (50 ± 2) J.

6.4.2.2 Test method

The helmet shall be tested in accordance with EN 13087-2 falling mass method, using the hemispherical striker.

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 impact point 1 as shown in Figure 1.

6.4.3 Lateral impacts (front, rear, side)

6.4.3.1 General

When a helmet is tested by the method described in 6.4.3.2, the force transmitted to the headform shall not exceed 5 kN, for an impact energy of (25 ± 1) J.

6.4.3.2 Test method

The helmet shall be tested in accordance with EN 13087-2, falling mass method, using the flat striker and impact points 2, 3, 4 as shown in Figure 1. Testing shall ensure that both left and right lateral positions are tested across the three samples 1 to 3 (see Annex A).

6.5 Penetration resistance

6.5.1 General

When a helmet is tested by the method described in 6.5.2 following different environmental preconditioning as per Annex A, there shall be no contact between the striker and the test block, for an impact energy of (30 ± 1) J.

6.5.2 Test method

The helmet shall be tested in accordance with EN 13087-3 using the conical striker. The helmet shall be tested on two points of impact, separated from each other by a distance of at least 50 mm, within a circle having a radius of 50 mm, centred on point 1 shown in Figure 1.

6.6 Retention system strength

6.6.1 General

When a helmet is tested by the method described in 6.6.2, the following shall apply:

a) maximum dynamic elongation shall not exceed 25 mm under the intermediate load condition;

b) minimum width of the chin strap under intermediate load condition shall be not less than 15 mm;

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

6.6.2 Test method

The helmet shall be tested in accordance with EN 13087-5:2012, 5.2, Method b.

The helmet shell shall be fixed relative to the headform to prevent shell movement during retention system strength testing.

The initial tensile force shall be 30 N and the intermediate force shall be 250 N.

The chinstrap width shall be measured 1 min after initial application of the intermediate force.

6.7 Flame resistance

6.7.1 Helmet shell

When a helmet is tested by the method given in 6.7.2.2, any of the externally exposed materials of the helmet shell, not within 5 mm of an edge, shall not burn with the emission of flame or drip molten material after a period of 5 s has elapsed from the removal of the flame.

6.7.2 Accessories and non-integral additional protective devices

6.7.2.1 General

Any items as defined in 3.6 and 3.7 stated as being for use with the helmet by the helmet manufacturer for technical rescue and associated operations and on the outside of the helmet shell, shall be tested by the method given in 6.7.2.2 in their in-use position. The flame shall not be applied within 5 mm of any edge of the item and the item shall not burn with the emission of flame or drip molten material after a period of 5 s has elapsed from the removal of the flame.

6.7.2.2 Helmet shell and items test method

The helmet shell and items, as defined in 3.6 and 3.7, shall be tested in accordance with EN 13087-7, using a flame application time of 15 s.

6.8 Lateral crushing

6.8.1 General

When the helmet is tested by the method given in 6.8.2, the maximum transverse deformation of the helmet shall not exceed 40 mm. The residual deformation shall not exceed 15 mm.

6.8.2 Test method

6.8.2.1 Principle

The helmet is subjected to transverse compressive force. The maximum and the residual deformations are measured. See Figure 2.

6.8.2.2 Procedure

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

b) Position the lower edges of the plates at the level of the AA' plane as specified in EN 960.

c) 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.

d) Increase the forces by 100 N/min up to 430 N and hold for 30 s. Measure the distance between the plates and calculate the maximum deformation.

e) 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.

f) Carry out measurements to the nearest millimetre.

6.9 Thermal resistance

6.9.1 General

When the helmet fitted with any items, as defined in 3.6 and 3.7 and stated by the helmet manufacturer, is tested by the method given in 6.9.2, the following requirements shall be met:

a) no part of the helmet or any item as defined in 3.6 and 3.7 that is not in contact with the headform before the test shall come into contact with the headform as a result of the test;

b) there shall be no separation, melting or dripping of any part of the helmet or any item as defined in 3.6 and 3.7;

c) any moveable elements of the helmet or any item as defined in 3.6 and 3.7, e.g. chin strap closure and release device(s), visors, hearing defenders, etc. shall remain functional;

d) there shall be no ignition of any part of the helmet or any item as defined in 3.6 and 3.7; and

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

6.9.2 Test method

The helmet shall be tested in accordance with ISO 17493 with a temperature of (90 ± 5) °C for 20 min. Any items, as defined in 3.6 and 3.7, shall be tested in the 'in-use' position.

The results of the test are assessed by visual inspection.

6.10 Conductive headform

6.10.1 General

When the helmet is tested by the method given in 6.10.2, there shall be no visible evidence of breakdown and the leakage current shall not exceed 1,2 mA.

6.10.2 Test method

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

6.11 Practical performance

A practical performance test shall be undertaken in accordance with EN 16473:2014, 6.16.

6.12 Protection against high speed particles (optional)

6.12.1 General

When the helmet is tested by the method given in 6.12.2, the following requirements shall be met:

a) projectile shall be prevented from passing completely through the helmet;

b) there shall be no release of material from the inner surface of the helmet;

c) where protection is provided by non-rigid material, there shall be no additional contact with the headform such that a mark appears on the white paper on the opposite side to that struck by the ball.

6.12.2 Test method

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

a) The test in EN 166:2001, 7.1.4.2.2 shall not be performed.

b) The steel ball shall be projected at a speed of 120^{+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.

7 Marking

Any helmet claimed to comply with the requirements of this document shall be marked by means of punching, moulding or legible and durable label with the following information:

a) name or identification mark of manufacturer;

b) month of manufacture;

c) manufacturer's designation for the helmet model;

d) size or size range (in cm); and

e) reference number of this document, i.e. ISO 18369-5.

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

8 User information

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

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

b) This helmet is made to absorb the energy of a blow, by partial destruction or damage to the shell and the harness. Any helmet subjected to severe impact should be replaced.

c) Helmets shall not be adapted for the purpose of fitting attachments in any way not recommended by the helmet manufacturer.

d) Do not apply paint, solvents, adhesives or self-adhesive labels, except in accordance with instructions from the helmet manufacturer.

e) Name and address of the manufacturer.

f) Reference number of this document, i.e. ISO 18369-5.

g) Instructions or recommendations regarding adjustment, fitting, use, servicing and storage, use and maintenance, including size or size range. Substances recommended for cleaning, maintenance or disinfection shall have no adverse effect on the helmet and shall not be known to be likely to have any adverse effect upon the wearer, when applied in accordance with the manufacturer's instructions.

h) Specific instructions for cleaning and disinfection.

i) Details of intended field of use, protection capabilities and performance characteristics.

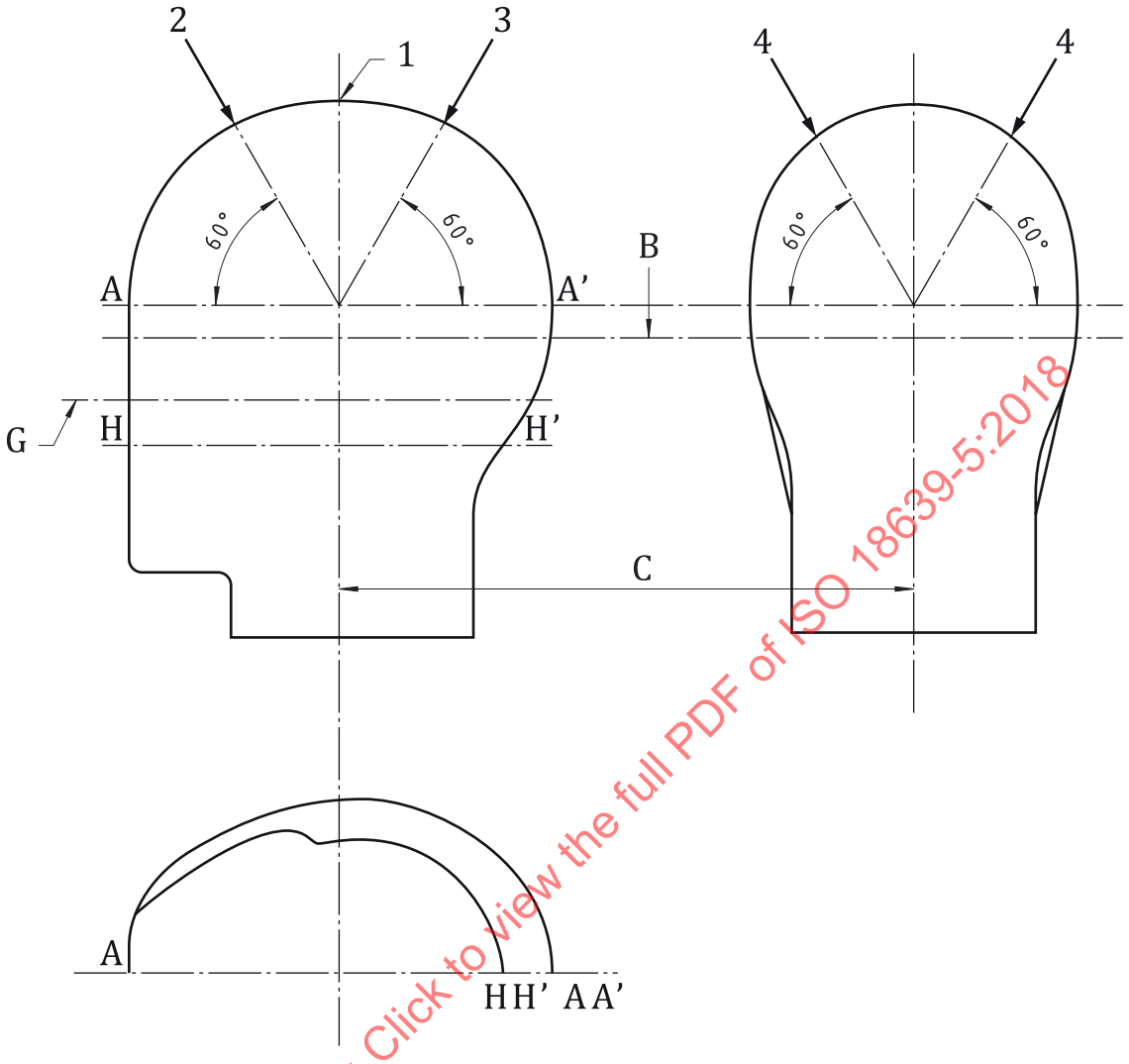
j) Details of accessories and non-integral protective devices associated with the helmet.

k) Obsolescence deadline or period of obsolescence, if applicable.

l) Type of packaging suitable for transport, if applicable.

m) The significance of the optional requirements, if any.

n) Disposal in relation to local regulatory guidance.



Key

1 to 4	impact points
B	reference plane
C	central vertical axis
G	basic plane
AA', HH	see EN 960

Figure 1 — Impact points on helmet

Dimensions in millimetres

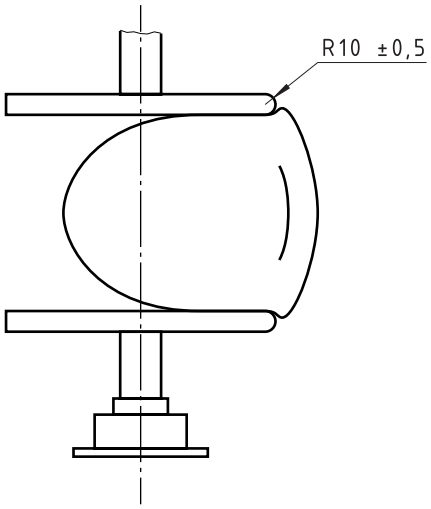


Figure 2 — Lateral crushing

Annex A
(normative)

Conditioning and testing schedule

Table A.1 — Conditioning and testing schedule

	Sequence	1	2	3	4		
Sample	**Helmet/headform combination**	**Normal temperature**	**Thermal plus**	**Thermal minus**	**Wet**	**Test 1**	**Test 2**
1	Largest helmet and largest appropriate headform		X			Crown impact	Lateral impacts
2	Largest helmet and largest appropriate headform			X		Crown impact	Lateral impacts
3	Largest helmet and largest appropriate headform				X	Crown impact	Lateral impacts
4	Smallest helmet fitting penetration test block		X			Penetration resistance	Retention system strength Note: Normal temperature
5	Smallest helmet fitting penetration test block			X		Penetration resistance	N/A
6	Any helmet and appropriate headform		X			Flame resistance	N/A
7	Any helmet	X				Lateral crushing	N/A
8	Any helmet and appropriate headform	X				Thermal resistance	N/A
9	Any helmet and appropriate headform	X				Conductive headform	N/A
10	Any helmet and appropriate headform	X				Practical performance	Protection from high speed particle
N/A = Not applicable.							

Annex B
(informative)

Example of failure modes and effect analysis (FMEA)

B.1 General

The FMEA is an important tool for the prediction of the reliability of the product that conforms to intended standards and consistently performs according to its design specifications. The manufacturer has the greatest knowledge and experience of the product to perform a FMEA. Helmet manufacturers may follow any FMEA process. However, at a minimum the FMEA process shall include the following:

a) the probability that the occurrence of a potential failure cause will occur;

b) the severity of the potential failure effect;

c) the ability to detect the occurrence of the potential failure cause or failure; and

d) specific instructions including cautions, limitations, and restrictions of use to ensure product reliability.

This annex has been prepared based on References [1] to [3] and using examples of FMEA from manufacturers. Information is provided for general guidance to helmet manufacturers in performing an FMEA. The following guidelines and examples are provided for illustrative purposes only. There are many FMEA templates available in reliability literature that could be referenced. The scale used in the following examples was simply 1 to 10 to illustrate the process. However, any scale could be used that serves the purpose of identifying and differentiating the levels associated with the likelihood, potential severity, and the ability to detect the failure.

B.2 Procedure guidelines

A process flow diagram should be developed to indicate system functional interdependencies.

An intended use statement should be written, which defines how the product is expected to perform as well as its intended life expectancy. Intended use also aids in establishing what is actually considered a failure.

A technical team (FMEA team) with solid knowledge of the technology, regulations, processes and use, should be formed to ensure an objective and more thorough evaluation of the product.

The team should establish and implement a procedure to ensure that all applicable technical and legal requirements are identified and taken into consideration.

In completing the FMEA matrix (see Table B.1) place the part number, ID or reference number in the 1st column. List the part name in the 2nd column. The 3rd column is for a brief description of the part function. In most cases, the failures are the opposite of the function. The team should use brainstorming techniques to develop a comprehensive list of potential failures for the product. Potential failure modes are in the 4th column of the FMEA process matrix. Potential failure modes which are less likely to occur or those that will not create a problem for the end-user if they do occur will get a lower priority for corrective action.

For each potential failure mode, list the effects that the failure may have on the system functionality and list those in the 5th column of the matrix next to the failure mode.