



International
Standard

ISO 11999-5

**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 individuelle pour pompiers —
Méthodes d'essai et exigences pour les équipements de protection
individuelle utilisés par les pompiers qui risquent d'être exposés
à des niveaux élevés de chaleur et/ou de flamme lorsqu'ils
combattent des incendies dans des structures —*

Partie 5: Casques

**Second edition
2024-08**

STANDARDSISO.COM : Click to view the full PDF of ISO 11999-5:2024



COPYRIGHT PROTECTED DOCUMENT

© ISO 2024

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

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

Published in Switzerland

Contents

Page

Foreword.....	v
Introduction.....	vi
1 Scope.....	1
2 Normative references.....	1
3 Terms and definitions.....	2
4 Helmet requirements.....	2
4.1 General.....	2
4.1.1 Fit.....	3
4.1.2 Protrusions and sharp edges.....	3
4.1.3 Reinforcement.....	3
4.1.4 Protected area.....	3
4.1.5 Field of vision.....	4
4.1.6 Material innocuousness.....	4
4.1.7 Resistance to cleaning and disinfecting agents.....	5
4.1.8 Replacement components and accessories.....	5
4.1.9 Helmet mass.....	5
4.1.10 Shell conspicuity.....	5
4.1.11 Retro-reflective material.....	5
4.1.12 Neck protector and ear covers.....	5
4.1.13 Shikoro.....	6
4.2 Samples, helmet adjustment and pre-conditioning.....	6
4.2.1 Samples.....	6
4.2.2 Helmet adjustment.....	6
4.3 Pre-conditioning.....	6
4.3.1 Thermal shock.....	6
4.3.2 Water soak.....	7
4.3.3 “Thermal plus”.....	7
4.3.4 “Thermal minus”.....	7
4.3.5 Pre-treatment and pre-conditioning for fabrics.....	7
4.4 Performance requirements.....	12
4.4.1 Requirement table.....	12
4.4.2 Mechanical performances.....	13
4.4.3 Thermal performances.....	14
4.4.4 Others.....	16
4.5 Test methods.....	17
4.5.1 Force impact resistance.....	17
4.5.2 Impact energy attenuation (optional).....	17
4.5.3 Penetration resistance.....	18
4.5.4 Lateral crushing.....	18
4.5.5 Retention system strength.....	18
4.5.6 Retention system effectiveness.....	19
4.5.7 Flame resistance.....	19
4.5.8 Flame engulfment (optional).....	22
4.5.9 Radiant heat resistance.....	22
4.5.10 Convective heat resistance.....	22
4.5.11 Thermal protective performance for neck protector and/or ear covers or Shikoro.....	23
4.5.12 Protection against molten metals.....	23
4.5.13 Tests for electrical insulation.....	23
4.5.14 Test for resistance to liquid chemical.....	24
4.5.15 Hardware corrosion resistance.....	24
4.5.16 Optical properties measurements for oculars.....	24
4.5.17 Scratch resistance test to oculars.....	24
4.5.18 Resistance to fogging test to oculars.....	25
4.5.19 High speed particle impact resistance test to oculars.....	25

5 Marking.....25

STANDARDSISO.COM : Click to view the full PDF of ISO 11999-5:2024

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 document 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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 — Protective clothing and equipment*, Subcommittee SC 14, *Fire-fighters' personal equipment*.

This second edition cancels and replaces the first edition (ISO 11999-5:2015), which has been technically revised.

The main changes are as follows:

- the content has been revised with a focus on single performance requirements.

A list of all parts in the ISO 11999 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

Figures are reproduced from AS/NZS 4067:2012 and AS/NZS 2512.1:2009, with permission from Standards Australia. ISO has no responsibility and context in which are extracts are reproduced, nor is ISO in anyway responsible for the other content or accuracy therein.

STANDARDSISO.COM : Click to view the full PDF of ISO 11999-5:2024

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 document 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 impact and exposure to flame and high thermal loads.

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 3146, *Plastics — Determination of melting behaviour (melting temperature or melting range) of semi-crystalline polymers by capillary tube and polarizing-microscope methods*

ISO 6330:2021, *Textiles — Domestic washing and drying procedures for textile testing*

ISO 6942:2022, *Protective clothing — Protection against heat and fire — Method of test: Evaluation of materials and material assemblies when exposed to a source of radiant heat*

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

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

ISO 11612:2015, *Protective clothing — Clothing to protect against heat and flame — Minimum performance requirements*

ISO 11999-3, *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 3: Clothing*

ISO 11999-9, *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 9: Firehoods*

ISO 13688:2013 + ISO 13688:2013/Amd.1:2021, *Protective clothing — General requirements*

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

ISO 17492, *Clothing for protection against heat and flame — Determination of heat transmission on exposure to both flame and radiant heat*

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

ISO/TR 19591, *Personal protective equipment for firefighters — Standard terms and definitions*

EN 136:1998, *Respiratory protective devices - Full face masks*

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

EN 167:2001, *Personal eye protection — Optical test methods*

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

EN 172:1994 + A1:2000, *Personal eye protection — Sunglare filters for industrial use*

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

EN 13087-1:2012, *Protective helmets — Test methods — Part 1: Conditions and conditioning*

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

EN 13087-4, *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, *Protective helmets — Test methods — Part 6: Field of vision*

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

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

NFPA 1971:2018, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*

CIE 54.2, *Retroreflection – Definition and measurement*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TR 19591 and the following apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

4 Helmet requirements

4.1 General

Helmets shall consist of at least the following assembled components:

- a) Shell (at the minimum area above the A-A' line as per [Figure 1](#)).
- b) Energy absorbing system.
- c) Retention system. The retention system shall include a chinstrap having a minimum width of 19 mm, quick release buckle, and size adjustment mechanism.
- d) Neck protector and/or ear covers, or Shikoro.
- e) Face shield or goggles or both —
 - where a face shield is selected, the face shield shall be attached to and tested with the helmet;
 - where goggles are selected, the goggles shall be permitted to be removed from the helmet before it is tested. This only applies to those which are removable. Where they are attached to the helmet, they shall be tested with the helmet.

f) Retro-reflective material.

4.1.1 Fit

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

When this adjustment covers several sizes 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 or impact liner. Projections above the test line shall be impacted directly over the position of the said projection in accordance with [4.4.2.1](#), and the testing laboratory shall assess that the projection did not make contact with the head form.

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.

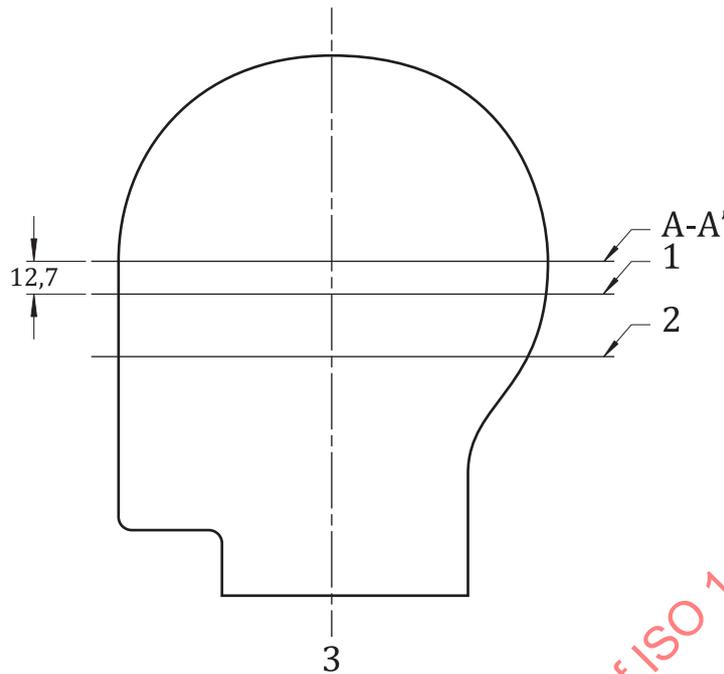
The profile at the front of the helmet shall not prevent the wearing of spectacles or goggles as specified by the helmet manufacturer.

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 Protected area

When adjusted on the head form as in [4.2.2](#), the helmet shall at the minimum cover the entire area 12,7 mm above the reference plane (see line A -A' in [Figure 1](#)).

**Key**

- 1 reference plane
- 2 basic plane
- 3 central vertical axis

Figure 1 — Protected area (Image taken from AS/NZS 2512.1:2009)

4.1.5 Field of vision

When the helmet is tested in accordance with EN 13087-6, with any attached face shield 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° measured horizontally between L and K on each side of the sagittal plane which passes through the point L (see [Figure 2](#)). Remove the neck protector or Shikoro, if necessary.
- b) An upper dihedral angle greater than 7° above the reference plane and which is defined by the straight line passing through L1, L2 (see [Figure 2](#)).
- c) A lower dihedral angle greater than 45° under the basic plane and which is defined by the straight line passing through K1, K2 situated on the surface of the head form as 31 mm on each side of the point K (see [Figure 2](#)).
- d) With face shield or goggles in the stowed position, the helmet shall provide peripheral vision clearance of at least 94° to each side.

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

4.1.6 Material innocuousness

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. They shall meet the requirements as detailed in ISO 13688:2013, 4.2.

4.1.7 Resistance to cleaning and disinfecting agents

All helmet 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.

4.1.8 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.

Face shields shall not be considered as accessories and along with neck protectors shall be considered as fixed components of the helmet assembly.

4.1.9 Helmet mass

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

4.1.10 Shell conspicuity

The helmet shell shall have retro-reflective markings in accordance with [4.1.11](#) adhered to the shell exterior. A minimum of 26 cm² of the markings shall be visible when the helmet is viewed from any angle at the reference plane (see Key 2 on [Figure 1](#)). A material which combines both fluorescent and retro-reflective properties may be used. Care should be exercised when selecting marking materials to ensure they will not degrade the helmet shell.

4.1.11 Retro-reflective material

The material shall have a coefficient of luminous intensity per square meter (CIL/m²) of not less than 100 cd·lux⁻¹·m⁻² when measured in accordance with CIE 54.2 with an observation angle of 0,2° and entrance angle of -4°.

4.1.12 Neck protector and ear covers

Neck protector and/or ear covers shall cover the wearer's neck and ears and shall provide at least the following area of coverage as described below.

The helmet with neck protector and ear cover shall be donned in the proper wearing position as specified by the manufacturer on an EN 960 head form 575 according to its helmet 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 head form 575 with the helmet firmly positioned on the head form. See [Figure 4](#).

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 head form.

4.1.13 Shikoro

Where Shikoro is fitted, it shall be made of fire resistant fabric that surrounds the entire wearer's head, neck part below the helmet brim level except eye portion covered by the face shield. Its purpose is to prevent direct flame contact to wearer's head, face, or neck and also to reduce heat stress. The helmet fitted with Shikoro shall continue to meet the relevant requirements of [4.4.3.1](#) to [4.4.3.5](#).

4.2 Samples, helmet adjustment and pre-conditioning

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, neck protector and ear covers or Shikoro, as well as face shield or goggles as specified in the test methods.

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 2](#).

4.2.2 Helmet adjustment

The helmet shall be adjusted in accordance with the Head Positioning Index (HPI) provided by the manufacturer before testing is performed. Following alignment with the selected head form, the helmet is firmly seated on the head form with the aid of a $(5,0 \pm 0,5)$ kg ballast mass. If the wearing adjustment covers several sizes of head form, then the size of head form representing the most unfavourable case shall be used.

Helmets shall be tested on head forms that conform to EN 960 and to sizes as appropriate to the test performed.

4.3 Pre-conditioning

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 pre-conditioned for a minimum of 24 h by exposure to a temperature of (20 ± 2) °C and a relative humidity of (65 ± 15) % prior to testing.

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

Where specified in the test methods, helmets shall be conditioned in accordance with the conditioning sequence defined in [Table 2](#) and testing shall be carried out within 5 min of removing from the conditioning chamber.

4.3.1 Thermal shock

Expose the helmet successively to the following conditions:

- a) 1 h at the temperature of: (choose a condition mark accordingly) $-10 \text{ °C} \pm 2 \text{ °C}$; $-20 \text{ °C} \pm 2 \text{ °C}$; $-30 \text{ °C} \pm 2 \text{ °C}$ or $-40 \text{ °C} \pm 2 \text{ °C}$,
- b) 1 h at a temperature of $60 \text{ °C} \pm 2 \text{ °C}$;
- c) 15 min totally immersed in fresh tap water at a temperature of $10 \text{ °C} \pm 2 \text{ °C}$;
- d) 1 h at a temperature of $60 \text{ °C} \pm 2 \text{ °C}$;
- e) 20 h to 24 h at standard temperature $20 \text{ °C} \pm 2 \text{ °C}$ and standard relative humidity $65 \% \pm 5 \%$.

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.

4.3.2 Water soak

The helmet shall be conditioned according to EN 13087-1:2012, 4.6, with tap water temperature not greater than 27 °C, for between 4 h and 24 h.

4.3.3 “Thermal plus”

The helmet shall be conditioned according to EN 13087-1:2012, 4.4 at the temperature of 50 °C ± 2 °C for between 4 h and 24 h.

4.3.4 “Thermal minus”

The helmet shall be conditioned according to EN 13087-1:2012, 4.5 at the temperature chosen in [4.3.1 a\)](#) for between 4 h and 24 h.

4.3.5 Pre-treatment and pre-conditioning for fabrics

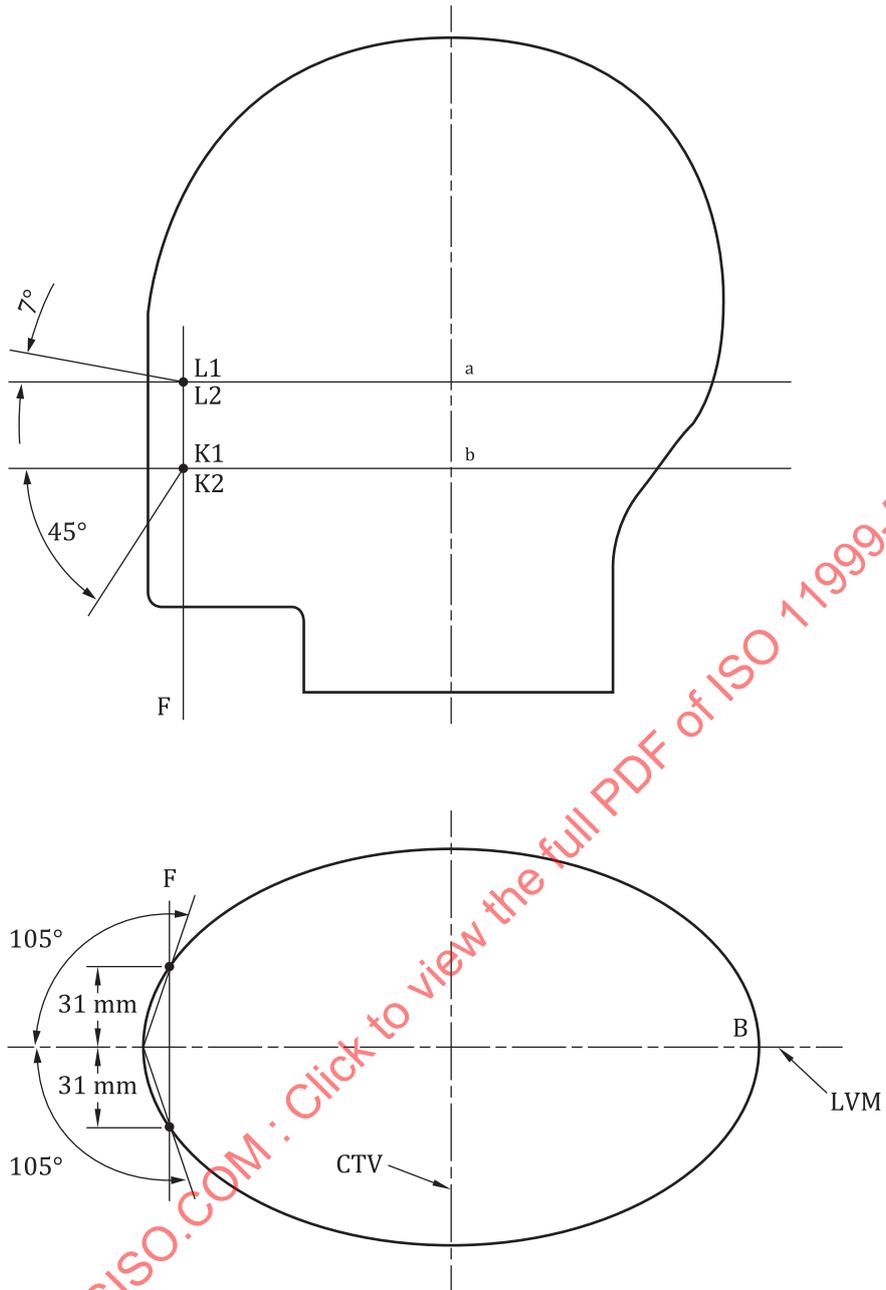
The neck protector and/or ear cover or Shikoro shall be laundered in line with the manufacturer’s instructions on the basic standardized processes for five cleaning cycles. If the cleaning method is not specified, the specimens shall be subjected to five cleaning cycles in accordance with the procedure defined in [Table 1](#).

Table 1 — Laundering procedure

Wash procedure	Dry procedure
ISO 6330, 6N (front load, normal, 60 °C, 1 g/L ECE detergent in soft water)	ISO 6330:2021, Annex F, (machine Type A1) exhaust temperature normal

Following pre-treatment, specimens shall be pre-conditioned in accordance with [4.3](#).

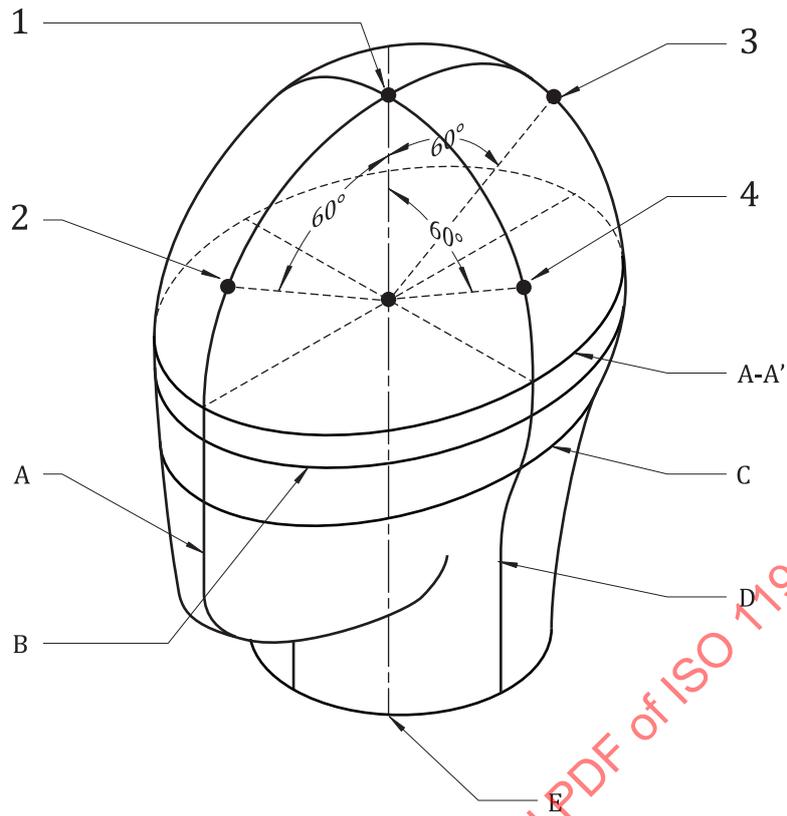
STANDARDSISO.COM : Click to view the full PDF of ISO 11999-5:2024



Key

- CTV central transverse vertical plane
- LVM longitudinal vertical median plane
- F front
- B back
- a Reference plane.
- b Basic plane.

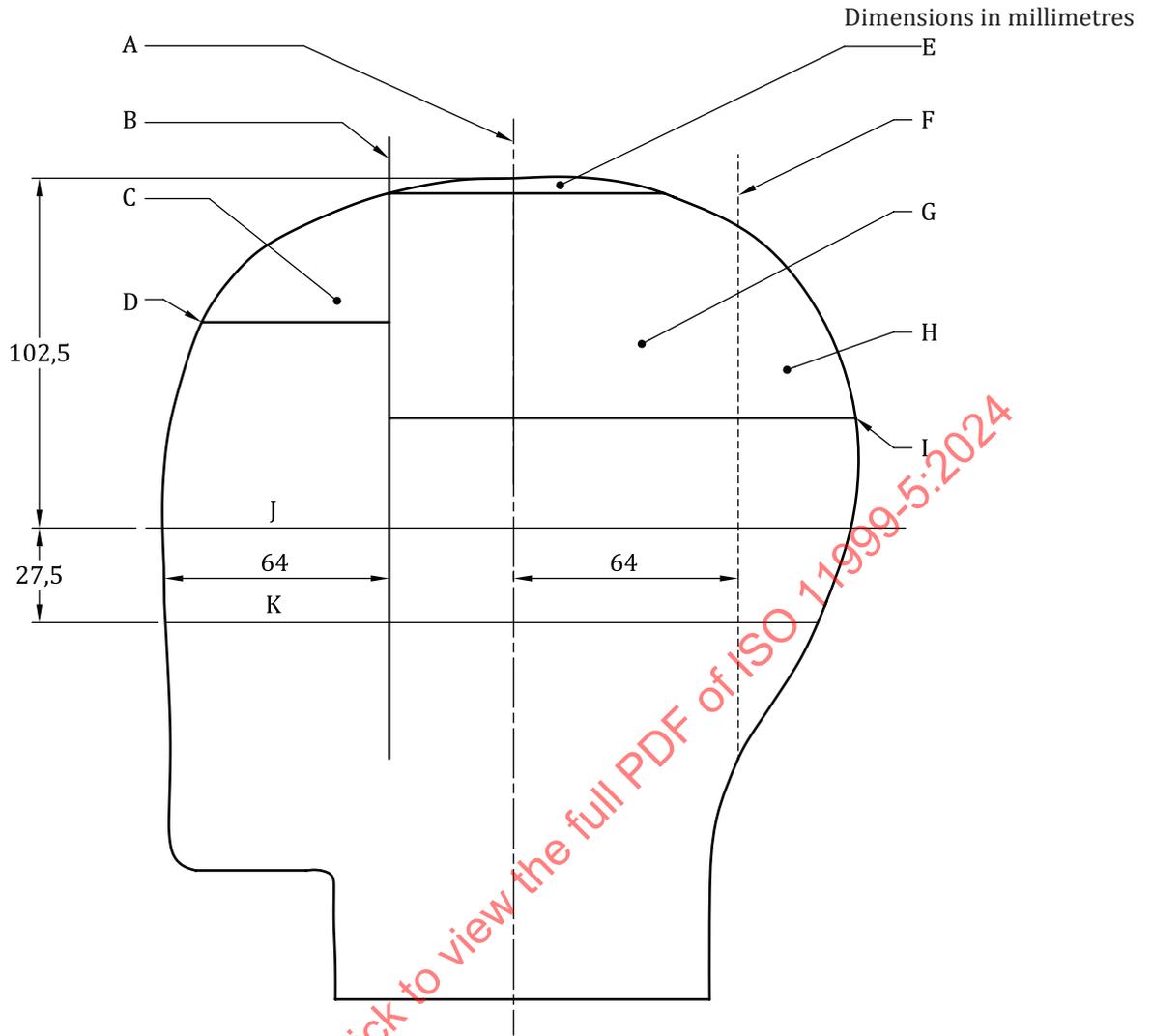
Figure 2 — Section of head form, longitudinal, vertical, medial, reference and basic planes (Image taken from of AS/NZS 4067)



Key

- A mid-sagittal plane
- B reference plane
- C basic plane
- D coronal plane
- E central vertical axis
- 1 crown
- 2 front
- 3 rear
- 4 left or right

Figure 3 — Impact points for force impact



Key

- A central and vertical axis
- B front vertical transverse plane
- C front test area
- D front test line (85 mm above basic plane)
- E top test area
- F rear vertical transverse plane
- G two side test area (left and right)
- H rear test area
- I rear test line (60 mm above test line)
- J reference plane
- K basic plane

Figure 4 — Impact sites for impact energy attenuation (Image taken from AS/NZ 4067)

Table 2 — Pre-conditioning and testing sequence

Sequence	0	1	2	3	4	5
Helmet specimen number	Pre-conditioning	Thermal shock 4.3.1	Thermal plus 4.3.3	Thermal minus 4.3.4	Water soak 4.3.2	Specific test
1	X					4.1.4 Protected area
1	X					4.1.5 Field of vision
1		X	X			4.5.1 Force impact resistance
2		X		X		
3		X			X	4.5.2 Impact energy attenuation (optional)
4		X	X			
5		X		X		4.5.3 Penetration
6		X			X	
7		X	X			4.5.4 Lateral crushing
8		X		X		
2		X				4.5.5 Retention system strength
3		X				4.5.6 Retention system effectiveness
7		X				4.5.7.2 Flame resistance tests on helmets, Method 1 4.5.7.2 Flame resistance tests on helmets, Method 2
9		X	X			
	X					4.5.7.3 Flame resistance on face shield/goggles
	X					4.5.7.4 Flame resistance on neck protector and/or ear cover of Shikoro and chin strap material
13 (optional)	X					4.5.8 Flame engulfment (optional)
10		X				4.5.9.1 (method A) Radiant heat resistance: Helmet
	X					4.5.9.2 (method B) Radiant heat resistance: Face shield/goggle
Fabric assembly	X					4.5.9.3 Radiant heat transfer: Neck protector and ear cover/Shikoro
11		X				4.5.10 Convective heat: Helmet
	X					4.5.10 Convective heat: Neck protector and ear cover/Shikoro, thread
	X					4.5.10 Convective heat: Face shield/goggles
Fabric assembly	X					4.5.11 TPP: neck protector and ear cover or Shikoro HTI: Shikoro only
14	X					4.5.12 Protection against molten metal
3	X					4.5.13.1 Electrical: Conductive head form (On helmet and face shield)
6	X					4.5.13.2 Electrical: Wet helmet insulation
3	X					4.5.13.3 Electrical: Surface insulation
12	X					4.5.14 Contact with liquid chemicals (On helmet and face shield/goggles)
	X					4.5.15 Hardware corrosion resistance
	X					4.5.16 Optical properties: Face shield/goggles
	X					4.5.17 Resistance to scratch: Face shield/goggle
	X					4.5.18 Resistance to fogging: Face shield/goggles
	X					4.5.19 High speed particle impact: Face shield

4.4 Performance requirements

4.4.1 Requirement table

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

Helmets shall be tested according to the performance requirements in accordance with [Table 3](#), as appropriate with manufacturer's accessories in place as appropriate. The required state of deployment of these accessories during testing are described in [4.4.2](#) to [4.4.4](#).

Table 3 — Overview of helmet performance requirements

Performance property	Applies to	Clause
Mechanical		
Resistance to force impact	Helmet	4.4.2.1
Impact energy attenuation (optional)	Helmet	4.4.2.2
Resistance to penetration	Helmet	4.4.2.3
Lateral crushing	Helmet	4.4.2.4
Retention system strength	Retention system	4.4.2.5
Retention system effectiveness	Retention system	4.4.2.6
Thermal		
Flame resistance	Helmet	4.4.3.1
	Neck protector and/or ear cover or Shikoro	
	Chin strap	
	Face shield/goggles	
Flame engulfment (optional)	Helmet and accessories	4.4.3.2
Radiant heat resistance	Helmet	4.4.3.3
	Face shield/goggles	
	Neck protector and/or ear cover or Shikoro	
Convective heat resistance	Helmet	4.4.3.4
	Face shield/goggles	
	Neck protector and/or ear cover or Shikoro	
	Thread	
	Label (for traditional style helmet)	
Thermal protective performance	Neck protector and/or ear cover or Shikoro	4.4.3.5
Molten metal	Helmet	4.4.3.6
	Neck protector and/or ear cover or Shikoro	
Others		
Electrical, conductive headform	Helmet	4.4.4.1.1
	Face shield	
Electrical, wet helmet insulation	Helmet	4.4.4.1.2
Electrical, surface insulation	Helmet	4.4.4.1.3
Contact with liquid chemical	Helmet	4.4.4.2
	Face shield	
Corrosion resistance	Hardware	4.4.4.3
Optical properties	Face shield/goggles	4.4.4.4
Resistance to scratch	Face shield/goggles	4.4.4.5
Resistance to fogging	Face shield/goggles	4.4.4.6
High speed particle impact	Face shield/goggles	4.4.4.7

4.4.2 Mechanical performances

4.4.2.1 Force impact resistance

The helmet shall be tested according to [4.5.1](#), with face shield/goggles attached (excluding neck protector and/or ear cover or Shikoro), and the force transmitted to the head form shall not exceed 15 kN with an impact energy of (123 ± 1) J on the crown and (25 ± 1) J on the off-crowns.

4.4.2.2 Impact energy attenuation (optional)

The helmet, with face shield/goggles in the deployed position (excluding neck protector and ear cover/Shikoro), shall be tested according to [4.5.2](#), and shall not exceed the maximum acceleration as specified follows:

- top: 1 471,5 m/s² (150g);
- front: 2 943,0 m/s² (300g);
- sides: 2 943,0 m/s² (300g);
- back: 2 943,0 m/s² (300g).

Any acceleration above 1 962 m/s² (200g) shall not exceed a duration of 3 ms, and an acceleration above 1 471,5 m/s² (150g) shall not exceed a duration of 6 ms.

4.4.2.3 Penetration resistance

The helmet shall be tested according to [4.5.3](#) with the face shield/goggles in deployed position (excluding neck protector and ear cover/Shikoro), and shall have no contact between the striker and the test block.

4.4.2.4 Lateral crushing

The helmet shall be tested according to [4.5.4](#) with the maximum transverse and longitudinal deformations not exceeding 40 mm, and the residual deformations not exceeding 15 mm.

4.4.2.5 Retention system strength

The helmet shall be tested according to [4.5.5](#):

- 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.

NOTE Users are reminded of the following possible consequences when making a decision with regards to c):

- 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.
- 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.

4.4.2.6 Retention system effectiveness

Tested according to [4.5.6](#), the helmets shall not come off the head form.

4.4.3 Thermal performances

4.4.3.1 Flame resistance

The helmet, together with face shield/goggles, neck protector and/or ear cover or Shikoro and chin strap material shall be tested according to the respective subclauses of [4.5.7](#) and shall meet the following requirements.

- a) Helmet material, including edging shall not show any visible after flame or glow 5 s after removal from the test flame.
- b) Face shield/goggles shall not show any visible flame or glow 5 s after removal from the test flame.
- c) No part of the helmet and face shield/goggles around test point shall show separation, melting or dripping.
- d) Individual materials in the fabric assembly of neck protector and/or ear cover or Shikoro and chin strap webbing shall demonstrate the following performances:

Table 4 — Limited flame spread performance following Surface ignition

Properties	Requirements
Flame spread	No specimen shall permit any part of the lowest boundary of any flame to reach the upper or either vertical edge.
Flaming debris	No specimen shall give flaming or molten debris.
Hole formation	No specimen shall give hole formation of 5 mm or greater in any direction, except for an inner layer that is used for specific protection other than flame or heat protection.
Afterglow	Afterglow time shall be ≤ 2 s. A glowing inside the charred area is defined in ISO 15025 as afterglow without combustion and for the purpose of this clause is not regarded as afterglow.
After flame	After flame time shall be ≤ 2 s.

Table 5 — Limited flame spread performance following Bottom-edge ignition

Properties	Requirements
Flame spread	No specimen shall permit any part of the lowest boundary of any flame to reach the upper or either vertical edge.
Flaming debris	No specimen shall give flaming or molten debris.
After flame	After flame time shall be ≤ 2 s.
Afterglow	Afterglow time shall be ≤ 2 s. A glowing inside the charred area is defined in ISO 15025 as afterglow without combustion and for the purpose of this clause is not regarded as afterglow.
Char length	Char length shall be < 100 mm in accordance with ISO 15025:2016, Annex C.

4.4.3.2 Flame engulfment (optional)

When tested in accordance with [4.5.8](#), the helmet together with face shield/goggles, neck protector and/or ear cover or Shikoro, shall not show any visible afterflame or glow 5 s after removal from the test flame.

4.4.3.3 Radiant heat resistance

The helmet, with face shield/goggle attached in the stowed position, shall be tested in accordance with [4.5.9.1](#) (method A) for helmet, [4.5.9.2](#) (method B) for face shield/goggles and [4.5.9.3](#) for neck protector and/or ear cover or Shikoro, and shall meet the following requirements.

- a) No part of the helmet, face shield/goggles 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 head form.

- b) The temperature measured at the surface of the artificial head shall not rise more than 20 °C above the standard laboratory temperature of 20 °C ± 3 °C.
- c) Neck protector and/or ear cover or Shikoro shall achieve the radiant heat transfer performances in [Table 6](#) and results rounded to the nearest whole second (s).

Table 6 — Radiant heat transfer

Heat transfer index	Performance (s)
RHTI ₂₄	≥11
RHTI ₂₄ - RHTI ₁₂	≥4

4.4.3.4 Convective heat resistance

When tested according to [4.5.10](#), helmets with neck protector and ear cover/Shikoro, and face shield/goggles attached in the deployed position shall meet the following requirements.

- a) no part of the helmet assembly that is not in contact with the head form before the test shall come into contact with the head form as a result of the test. Evaluate by visual inspection.
- b) there shall be no ignition, separation, melting or dripping of any part of the helmet assembly, including threads.
- c) any moveable elements of the helmet, (e.g. chin strap closure and release device(s) or face shield mechanism) shall remain functional.
- d) there shall be no ignition, melting or loss of legibility of any part of the product labels.
- e) no part of the face shield/goggles component that was not below the brim line prior to the test shall be below the brim line after the test.
- f) there shall be no dripping of the face shield/goggle component.
- g) no part of the neck protector and ear cover and Shikoro shall ignite, melt or shrink more than 5 % (10 % for Shikoro) in two perpendicular directions.

4.4.3.5 Thermal protective performance (TPP)

When tested according to [4.5.11](#), neck protector and/or ear cover assembly or Shikoro shall have an average TPP of at least 20.

Shikoro only shall be tested in accordance with ISO 9151, after [4.3.5](#) pre-treatment with the performance of HTI₂₄ ≥ 10 s and HTI₂₄ - HTI₁₂ ≥ 3 s.

4.4.3.6 Protection against molten metals

When tested according to [4.5.12](#), helmets, neck protector and/or ear covers or Shikoro:

- 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;
- d) neck protector and ear cover/Shikoro shall meet the requirements of ISO 11612:2015, 7.5 Performance level E2.

4.4.4 Others

4.4.4.1 Electrical resistance

4.4.4.1.1 Conductive headform test

The helmet assembly shall be tested according to [4.5.13.1](#) and shall show no visible evidence of breakdown and the leakage current shall not exceed 3,0 mA.

4.4.4.1.2 Wet helmet insulation test

When tested according to [4.5.13.2](#), the helmet assembly shall show no visible evidence of breakdown and the leakage current shall not exceed 3,0 mA.

4.4.4.1.3 Surface insulation test

When tested according to [4.5.13.3](#), the helmet assembly shall show no visible evidence of breakdown and the leakage current shall not exceed 3,0 mA.

4.4.4.2 Contact with liquid chemical

When tested according to [4.5.14](#), there shall be no visible damage to the shell, fitting devices, and the optical properties of the face shield ocular shall continue to meet the requirements of [4.4.4.4](#).

4.4.4.3 Hardware corrosion resistance

Helmet shall be tested according to [4.5.15](#), whereby 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.

4.4.4.4 Optical properties for face shield/goggles

When tested according to [4.5.16](#), the optical properties of the ocular shall meet the requirements as outlined in the [Table 7](#) below:

Table 7 — List of optical properties

Property	Minimum requirement
Refractive power	Optical Class 2
Luminous transmittance	≥85 % for clear oculars, ≥ 43 % for tinted oculars
Diffusion of light	0,75 cd/m ² ·lx
Quality of surface	Free from imperfection likely to impair vision, such as bubbles, scratches, pitting, inclusions, mold marks, scouring, grains, pocking, scaling, and undulation

4.4.4.5 Resistance to scratches for face shield/goggles

When tested according to [4.5.17](#), the delta haze value of the oculars shall not exceed 25 % when measured in accordance with NFPA 1971:2018, Section 8.22.

4.4.4.6 Resistance to fogging for face shield/goggles

When tested according to [4.5.18](#), the duration for which oculars remain free from fogging shall not be less than 8 s.

4.4.4.7 High speed particle impact resistance for face shield/goggles

When tested according to [4.5.19](#), the face shield/goggles shall not exhibit the following defects:

- a) Ocular fractured whereby it cracks through its entire thickness into two or more pieces, or 5 mg of the ocular material detached from the surface, or the ball passes through the ocular;
- b) Ocular deformed, leaving a mark on the white paper on the opposite side to that struck by the ball;
- c) Ocular housing or frame failed where it separates into two or more pieces, or no longer capable of holding an ocular in position, or an unbroken ocular detaches from the frame or the ball passes through the housing or frame;
- d) A part of the face shield or goggles came into contact with any part of the head form on impact;
- e) The raising/lowering mechanism of the face shield failed to operate normally after impact.

4.5 Test methods

4.5.1 Force impact resistance

The helmet assemblies, with attached face shield/goggles in the deployed position, shall be tested in accordance with EN 13087-2:2012, 5.2, falling mass method. All four impacts shall be performed on the same helmet following the sequence of 1 (crown), 2 (front), 3 (rear) and 4 (left or right side) as shown in [Figure 3](#).

The first impact shall be performed within 1 min of removal from conditioning as per [Table 2](#) and subsequent impacts within 5 min. If further impacts are required, the samples shall be returned immediately to the conditioning chamber for at least 1 h before continuing.

4.5.1.1 Crown impact (impact point 1)

A hemispherical striker that has a mass of $(5 \pm 0,05)$ kg and a striking face of radius (50 ± 1) mm shall be used. The head form shall be rotated so that the impact point lies along the axis through the striker and transducer. Allow the striker to fall freely onto the impact point 1.

4.5.1.2 Off-crown impacts (impact points 2, 3, and 4)

A flat striker that has a mass of $(5 \pm 0,05)$ kg and a striking face of diameter (100 ± 2) mm shall be used for impact points 2, 3, and 4. Testing shall ensure impact point 4 covers both left and right sides across the three samples.

4.5.2 Impact energy attenuation (optional)

The helmet assemblies, with attached face shield/goggles in the stowed position, shall be tested in accordance with EN 13087-2:2012, 5.3, falling head form method, using the flat anvil with the following modifications.

- a) Test head form size J is to be used.
- b) The flat anvil surface shall be $125 \text{ mm} \pm 15 \text{ mm}$.
- c) The drop assembly with a helmet attached shall free fall from height that yields an impact velocity within 2 % of 6,0 m/s.
- d) Helmet shall be impacted above the test line as shown in [Figure 4](#), with it adjusted to ensure the edge of the flat anvil does not extend below the test line, in the order of top, front, left, right and rear with each targeted impact site at a distance of $63 \text{ mm} + 13 \text{ mm}/-0 \text{ mm}$ from each other.
- e) The first impact shall be performed within 1 min of removal from conditioning as per [Table 2](#) and subsequent impacts within 5 min.

4.5.3 Penetration resistance

4.5.3.1 Apparatus

Test striker is allowed to fall freely onto a helmet securely fastened to a suitable head form. The contactable surface of the head form shall be of a material that readily permits detection should contact by the striker occurred, and that can be restored after contact, if necessary.

The cone striker has the following characteristics:

- a) mass: 1,01 kg \pm 0,01 kg
- b) angle of point: 60° \pm 1°
- c) radius of point: 0,5 mm \pm 0,1 mm
- d) hardness of tip: between 45 HRC and 50 HRC

4.5.3.2 Test procedure

- a) The helmet shall be placed firmly, with any attached face shield/goggles in the deployed position, fastened securely on an appropriate head form and adjusted to its lowest possible wearing height.
- b) The helmets shall be conditioned in accordance with [Table 2](#) and tests performed within 1 min of removal from conditioning and subsequent impacts within 5 min.
- c) The striker shall be allowed to fall freely so that the velocity at impact is at 7 m/s \pm 0,1 m/s.
- d) A minimum of two penetration sites per condition, each site separated from the other at a distance of 63 mm + 13 mm/-0 mm, shall be picked from within the zone of 60° inclined from the impact point 1 as shown in [Figure 3](#).

4.5.4 Lateral crushing

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) Condition the helmet according to the relevant conditioning in [Table 2](#).
- b) Place the helmet between two guided rigid parallel plates of size 300 mm \times 250 mm nominal, having their lower 300 mm long inner edges radiused to 10 mm \pm 0,5 mm.
- c) Position the lower edges of the plates at the level of the A-A' 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.

4.5.5 Retention system strength

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.

4.5.6 Retention system effectiveness

The helmet retention system shall be tested in accordance with EN 13087-4, attach the hook over the front edge of the helmet, using a drop height of 175 mm ± 5 mm.

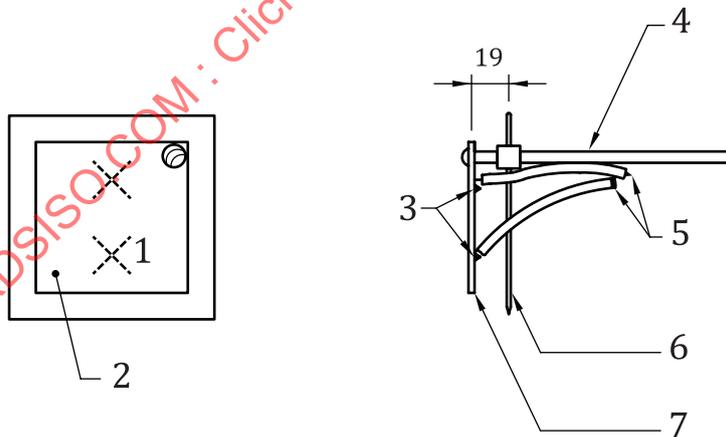
Testing shall be conducted with the attached face shield/goggles in the deployed positions.

4.5.7 Flame resistance

4.5.7.1 Apparatus

- A Bunsen burner with a 12,3 mm ± 0,5 mm diameter bore suitable for propane gas and capable of adjusting a rate of gas flow and air vent shall be used.
- The gas used shall be propane having a minimum purity of 95 % with gas pressure of 3,5 kPa.
- The flame shall be adjusted so that the blue cone is clearly defined, although turbulent, and the blue flame is 50 mm ± 1,5 mm long with an inner core of 25 mm ± 1,5 mm. Temperature at the tip of the flame inner core shall be 1 200 °C ± 100 °C.
- A radiant heat panel with an effective radiating surface of at least 150 mm x 150 mm. The special radiant emittance curve of the radiant panel shall be that of a blackbody at a temperature of 1 000 K ± 200 K.
- A radiant heat transducer constructed from sheet copper, conforming to ASTM B152, Type 110 ETC, half hard, 0,64 mm ± 0,05 mm thick and 50,8 ± 0,4 mm square. A constantan wire of 0,81 mm ± 0,05 mm in diameter, and an iron wire of the same diameter shall be silver soldered near the edges of the copper sheet on the same side (see Figure 5). The side of the copper sheet opposite that with the wires attached shall be painted flat black. The resulting transducer is a Type J thermocouple that shall be used in conjunction with appropriate instrumentation to monitor the heat exposure to which the helmet will be subjected to.

Dimensions in millimetres



Key

- thermocouples detection points
- front surface painted flat black
- braze or hard solder thermocouple connections
- ceramic or phenolic (insulating) rod cross-section area ≤1,5 mm²
- iron and constantan wires to thermocouple readout device
- phenolic or ceramic shield ~1,6 mm × 55 mm × 55 mm
- copper sheet ~0,63 mm × 45 mm × 45 mm

Figure 5 — Radiant heat transducer (Image taken from of AS/NZS 4067)