International Standard

ISO 3873

Industrial protective helmets

Casques de protection pour l'industrie

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Foreword

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

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

This second edition cancels and replaces the first edition (ISO 3873:1977), which has been technically revised.

The main changes are as follows:

— Introduction of a Type II helmet that is intended to protect the front, side and rear of the wearer's head. Reflecting this change is the introduction of impact energy attenuation requirements, dynamic strength of the retention system and dynamic stability tests.

— Elimination of mandatory harness dimensions and clearances for Type I helmets. A Type I helmet could be constructed using a conventional harness system, but it could also be constructed using an impact energy attenuation liner.

— Introduction of resistance to ignition tests to replace the flame resistance requirements.

Future considerations:

— Impacts to the head that result in head angular motion (referred to as angled, tangential or oblique impacts) are one of the causes of brain injury. The revisions to the standard have not addressed directly the performance of systems intended to manage head angular motion. The introduction of a Type II helmet will offer some improvements in managing head angular motion with regards to the first edition of ISO 3873 because of the additional impact energy attenuation tests. At the time that second edition of ISO 3873 was developed, no test method was available that could be readily incorporated into this standard. In the future, when a suitable oblique impact test method and risk analysis are available, the ambition of this committee is to revise this document and include requirements for such a test.

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

The International Organization for Standardization (ISO) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent.

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Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights other than those in the patent database. ISO shall not be held responsible for identifying any or all such patent rights.

Industrial protective helmets

1 Scope

This document specifies physical and performance requirements, test methods and marking requirements for industrial protective helmets. This document describes the requirements for two helmet types.

Type I — intended to protect the upper part of wearer's head against impacts that may occur in an industrial setting, such as a falling object.

Type II — intended to protect the head against impacts that may occur in an industrial setting, such as a falling object or a fall.

NOTE The Type II helmet is intended to offer protection from falls from standing or a low height, e.g. standing height elevated by up to one metre. The Type II helmet is not intended to offer protection to the head in all falls and is unlikely to prevent serious head injury or death in uncontrolled falls from one level to another or from a position elevated on a ladder or scaffolding. The selection of a Type II helmet should be considered as one part of an overall safe system of work in the context of working at heights and managing the risks of falls from greater than two metres.

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.

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

J211/1, *SAE Instrumentation for Impact Test Part 1 - Electronic Instrumentation*

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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/

3.1
protective helmet
helmet intended to protect at a minimum the upper part of the wearer's head against an impact

3.2
shell
hard, smoothly finished material that provides the general external form of the helmet

3.2.1
crown
the area on the upper, outer surface of a headform, centred on the mid coronal plane (see EN 960)

3.3
peak
horizontal extension of the *shell* (3.2) above the eyes

3.4
brim
rim surrounding the *shell* (3.2)

3.5
chin strap
strap that is intended to pass under the wearer's chin with two points of attachment to the helmet used with Type I helmets

Note 1 to entry: A chin strap is an accessory.

3.6
helmet accessories
any optional parts for special purposes such as chin strap, neck protector, drawlace and attachment devices for lamp and cable

3.7
helmet attachment
accessory which is not an integral part of the helmet and secured to helmet

3.8
helmet positioning index
HPI
vertical distance, measured in the vertical longitudinal plane, between the reference plane of the reference headform and the lowest point of the helmet in the forehead region

Note 1 to entry: HPI is provided by the helmet supplier and indicates the intended position of the helmet when worn.

3.9
liner
protective component of the helmet, positioned between *shell* (3.2) and head, that primarily provides impact energy attenuation

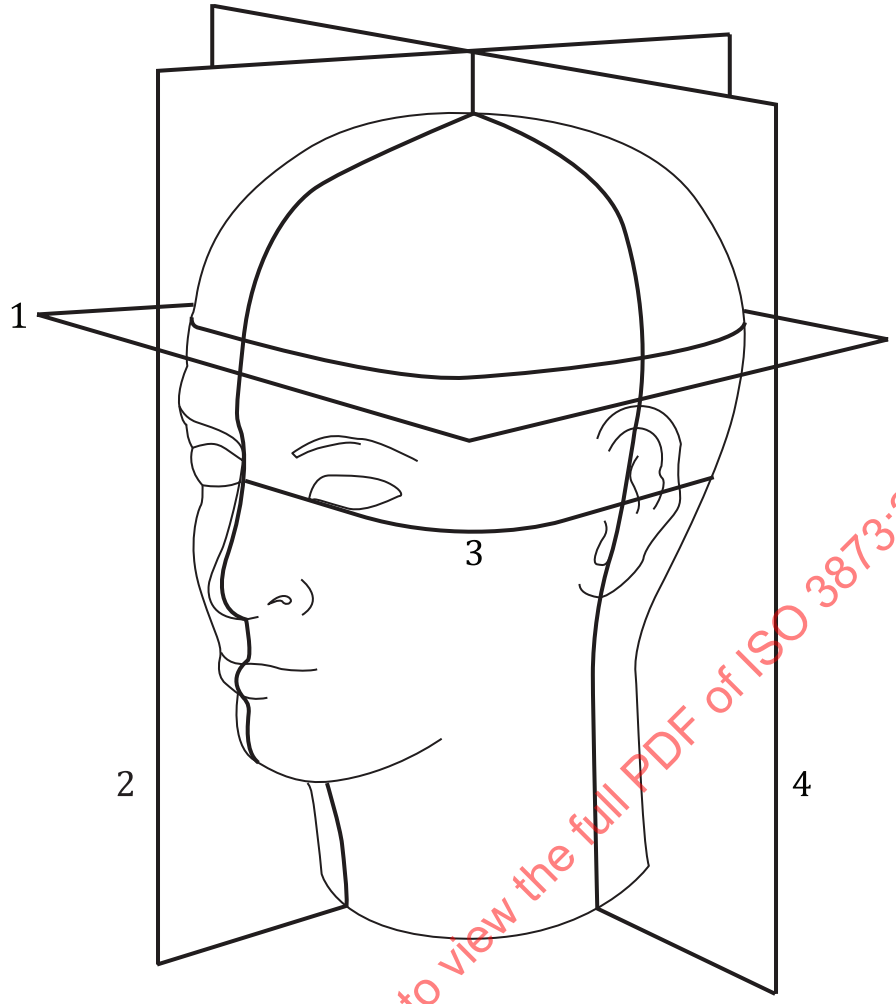
3.10
planes

3.10.1
basic plane
Frankfurt plane
plane intersecting the inferior borders of the orbits and external auditory meatuses

3.10.2
mid-sagittal plane
median plane
plane equivalent to the vertical longitudinal plane

3.10.3
mid-coronal plane
frontal plane
plane equivalent to the vertical transverse plane

Note 1 to entry: See Figure 1.



Key

1 horizontal plane (also known as transverse plane)
2 mid-sagittal plane
3 basic plane
4 mid-coronal plane

Figure 1 — Orientation planes

3.11
impact energy attenuation
ability of the helmet to manage the kinetic energy during an impact

3.12
harness
assembly comprising a cradle, headband, comfort padding and nape strap which maintains the helmet in position on the head and provides *impact energy attenuation* (3.11)

Note 1 to entry: A harness assembly has been the method used on occupational protective helmets meeting ISO 3873:1977 to maintain the helmet in position on the head and provide impact energy attenuation.

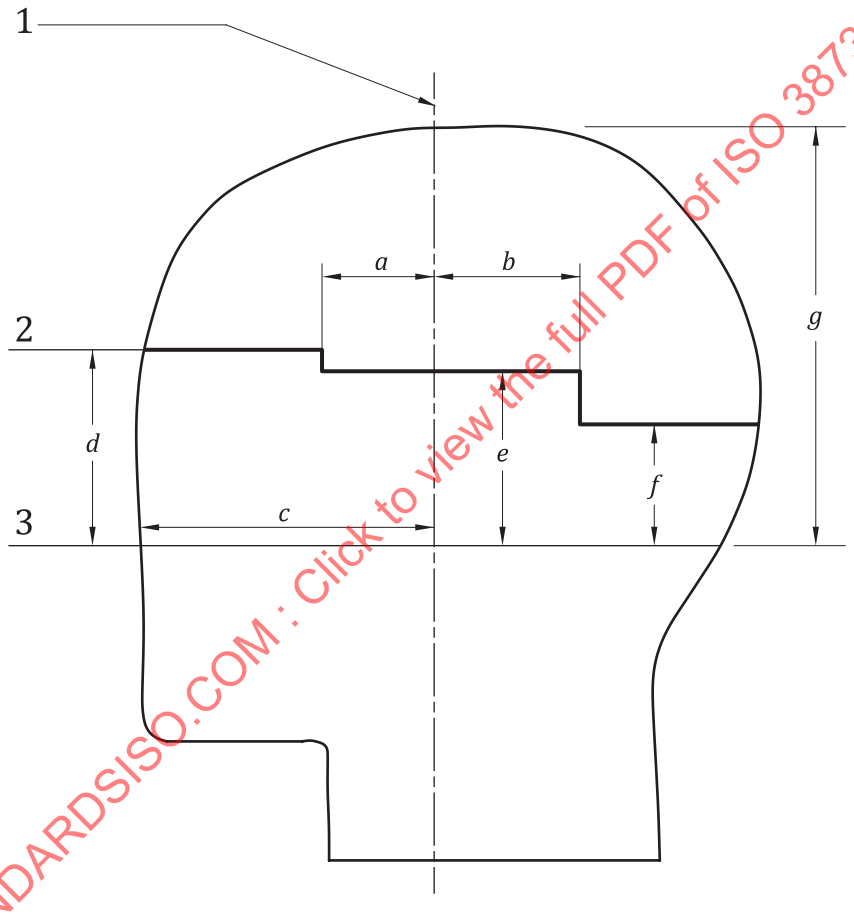
3.13
retention system
assembly that maintains the position of the helmet on the head during use; consisting of components for adjustment and improved comfort; a chin strap is not a retention system

Note 1 to entry: A retention system may consist of webbing, webbing adjustment components used to lengthen and shorten webbing pieces and a buckle

3.14
test line
line denoting the extent of protection of a helmet

Note 1 to entry: Defined by the dimensions presented in Table 1 corresponding to Figure 2.

Note 2 to entry: The extent of coverage may exceed the test line. Helmets may have components below the test line which may be contacted during testing. Such contact does not invalidate the test.



Key
1 central and vertical axis
2 test line
3 basic plane

Figure 2 — Extent of protection and test line for helmets

Table 1 — Test line dimensions for headforms

Headform size Code letter (EN 960 size)	Dimensions(see Figure 2) mm						
	a	b	c	d	e	f	g
A (495)	23	65	88	59	34,5	26,5	113,5
E (535)	29,5	65	94,5	64	39	33	121,5
J (575)	36	65	101	66	41	36	130
M (605)	41	65	106	67	41,5	37	136
O (625)	43,5	65	108,5	68	42	38	140

4 Physical requirements

4.1 Materials

Recommendations for general consideration of materials are given in Annex A.

4.2 General construction

Recommendations for general consideration of construction of helmets are given in Annex A.

A Type I helmet shall typically be constructed from a shell and liner; shell, liner and harness; or, shell and harness.

NOTE If a helmet is constructed from a shell and liner, it requires a system for retaining the helmet on the wearer's head. The headband and nape strap in a harness typically offer an adjustable system for retaining the helmet on the wearer's head.

A Type II helmet shall be constructed from a shell, liner, harness and retention system; or, shell, liner and retention system. The retention system shall have at least three points of permanent attachment to the shell.

NOTE One point of attachment can be shared, e.g. at the rear of the helmet.

4.3 Accessories and attachments

An helmet accessory, an helmet attachment or a combination of accessories and attachments shall not decrease the protective performance of the helmet.

NOTE The test lab should consider testing the helmet with the accessory or attachment on the helmet as per manufacturer's instructions against relevant performance requirements in Clause 5.

5 Performance requirements

5.1 Type I Mandatory requirements

5.1.1 Striker drop test

When tested by the method given in 6.5.1 at low and high temperatures and in wet conditions, the force transmitted to the headform shall not exceed 5,0 kN. The striker shall be allowed to fall on the centre of the crown of the helmet shell with an impact energy of 49 J attained by the striker impacting at $4,43\,\mathrm{m/s}\,^{0,05}_{0}\,\mathrm{m/s}$ measured over the last 40 mm of fall. 4,43 m/s equates to a nominal striker drop height of 1 000 mm.

5.1.2 Resistance to penetration

When the helmet is tested by the method given in 6.6, the point of the striker shall not contact the surface of the headform.

5.1.3 Resistance to ignition

When tested in accordance with 6.9, no part of the helmet shell shall ignite upon application of the heated rod nor continue to glow after removal of the heated rod.

5.2 Type II Mandatory requirements

5.2.1 Impact energy attenuation

5.2.1.1 Crown impacts

When tested at the prescribed crown impact location by the method given in 6.5.1 at low and high temperatures and in wet conditions, the force transmitted to the headform shall not exceed 10,0 kN. The striker shall be allowed to fall on the centre of the crown of the helmet shell with an impact energy of 98 J attained by the striker impacting at $6{,}26 \pm {}^{0{,}06}_{0}$ m / s measured over the last 40 mm of fall. 6,26 m/s equates to a nominal striker drop height of 2 000 mm.

5.2.1.2 All other impact locations

When tested at any of the other three prescribed and one non-prescribed impact locations by the headform drop test method given in 6.5.2 at low and high temperatures and in wet conditions, the peak resultant linear headform acceleration shall not exceed 200 *g*. In the headform drop test, the helmeted headform shall contact the centre of the anvil with a velocity of $5{,}05 \pm {}^{0{,}05}_{0}$ m / s, measured over the last 40 mm of fall. The impact velocity equates to a nominal drop height of 1 300 mm. The test laboratory shall select the site considered most likely to achieve the worst result for the impact at the non-prescribed impact location.

5.2.2 Resistance to penetration

When the helmet is tested by the method given in 6.6 the point of the striker shall not contact the surface of the headform.

5.2.3 Dynamic strength of the retention system

When tested by the method given in 6.7 using a drop height of 150 mm, the dynamic displacement of the retention system shall not exceed 30 mm.

5.2.4 Dynamic stability

When tested by the method given in 6.8 with a drop mass of 10 kg and drop height of 100 mm, the helmet shall not rotate forward or rearward by more than 45° to the horizontal. The helmet shall be tested rear-to-front and front-to-rear.

5.2.5 Resistance to ignition

When tested in accordance with 6.9, no part of the helmet shell shall ignite upon application of the heated rod nor continue to glow after removal of the heated rod.

5.2.6 Buckle release

It shall be possible for the wearer to remove the helmet by releasing the retaining strap or buckle, using one hand.

5.3 Optional requirements

5.3.1 Low temperature tests

With the conditioning temperature lowered to -30 °C, Type I helmets tested for impact energy attenuation in accordance with 6.5 and for resistance to penetration in accordance with 6.6 shall meet the requirements of 5.1.1 and 5.1.2 respectively.

With the conditioning temperature lowered to -30 °C, Type II helmets tested for impact energy attenuation in accordance with 6.5 and for resistance to penetration in accordance with 6.6 shall meet the requirements of 5.2.1 and 5.2.2 respectively.

Helmets claimed to meet these requirements shall state this fact on the label attached to the helmet, in accordance with Clause 7.

5.3.2 Artificial ageing

The helmet shall be conditioned according to EN 13087-1.

After conditioning to EN 13087-1, Type I helmets tested for impact energy attenuation in accordance with 6.5 and for resistance to penetration in accordance with 6.6 shall meet the requirements of 5.1.1 and 5.1.2 respectively.

After conditioning to EN 13087-1, Type II helmets tested for impact energy attenuation in accordance with 6.5 and for resistance to penetration in accordance with 6.6 shall meet the requirements of 5.2.1 and 5.2.2 respectively.

Helmets claimed to meet these requirements shall state this fact on the label attached to the helmet, in accordance with Clause 7.

5.3.3 Electrical Performance

5.3.3.1 General requirements

Type I and Type II helmets shall meet the relevant performance requirements listed below to meet the optional requirements.

5.3.3.2 Low voltage

The low-voltage resistant helmet shall withstand 2 200 V (root mean square) for 1 min at 60 Hz AC, when tested in accordance with 6.10. The leakage current shall not exceed 3 mA.

Helmets claimed to meet this requirement shall state this fact on the label attached to the helmet, in accordance with Clause 7.

5.3.3.3 High voltage

The high voltage resistant helmet shall withstand 20 000 V (root mean square) for 1 min at 60 Hz AC when the test is first conducted in accordance with 6.10. The leakage current shall not exceed 10 mA.

Helmets claimed to meet this requirement shall state this fact on the label attached to the helmet, in accordance with Clause 7.

5.3.4 Enhanced resistance to penetration

After conditioning to -10 °C and +50 °C, the helmet shall be tested by the method given in 6.6 at the front, side and rear impact sites defined in 6.5.2.3. The point of the striker shall not contact the surface of the headform.

5.3.5 Chin strap

A chin strap shall have a minimum width of 10 mm.

6 Test requirements

6.1 Samples

Helmets shall be submitted for testing by model and size in the condition in which they are offered for sale, including any requisite holes in the shell, and other means of attachment of any accessories for special purposes.

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

Type I helmets: The minimum number of samples required for one set of tests per model and size is as follows:

— Mandatory tests
  — 1 helmet for striker drop test at -10 °C;
  — 1 helmet for striker drop test in wet conditions;
  — 1 helmet for striker drop test at +50 °C, then for resistance to ignition;
  — 1 helmet for resistance to penetration test.
— Optional tests
  — 1 helmet for electrical performance test;
  — 1 helmet for the test for resistance to penetration at -30 °C.
  — 1 helmet for striker drop test at -30 °C
  — 2 helmets for the test for enhanced resistance to penetration at -10 °C and +50 °C

Type II helmets: The minimum number of samples required for one set of tests per model and size is as follows:

— Mandatory tests
  — 2 helmets for striker drop test and impact energy attenuation tests at -10 °C and dynamic strength of retention system;
  — 2 helmets for striker drop test and impact energy attenuation tests in wet conditions and dynamic strength of retention system;
  — 2 helmets for striker drop test and impact energy attenuation tests at +50 °C, then for resistance to ignition;
  — 1 helmet for resistance to penetration tests and dynamic stability.
— Optional tests
  — 1 helmet for electrical performance test;
  — 2 helmets for the test for resistance to penetration at -30 °C.
  — 2 helmets for the test for impact energy attenuation at -30 °C
  — 2 helmets for the test for enhanced resistance to penetration at -10 °C and +50 °C

6.2 Conditioning for testing

6.2.1 Conditioning cabinet

This shall be sufficiently large to ensure that the helmets can be positioned so that they do not touch one another or the sides. It shall be fitted with a fan to provide effective air circulation.

6.2.2 Pre-conditioning

All helmets shall be pre-conditioned for at least 24 h at a temperature of 20 °C ± 6 °C and a relative humidity of 55 % ± 33 % before applying the following individual conditioning treatments.

6.2.3 Low temperature

The helmet shall be exposed to a temperature as specified of either -10 °C ± 2 °C for not less than 4 h or -30 °C ±2 °C for not less than 4 h.

6.2.4 High temperature

The helmet shall be exposed to a temperature of 50 °C ± 2 °C for a period of not less than 4 h.

6.2.5 Wet

The helmet shall be fully immersed in water at 20 °C ± 5 °C for a period of not less than 4 h.

6.3 Test schedule

6.3.1 Type I helmet

Mandatory tests shall be conducted on Type I helmets as shown in Table 2. Tests shall be conducted in the sequence shown. For example, sample No. 3 helmet is first tested for impact energy attenuation and then for resistance to ignition.

Table 2 — Test schedule for Type I helmets

Sample No.	Conditioning	Tests
1	Low temperature (– 10 °C)	Striker drop test
2	Wet	Striker drop test
3	High temperature	(i) Striker drop test (ii) Resistance to ignition
4	Low temperature (– 10 °C)	Resistance to penetration
5	Wet	Resistance to penetration
6	High temperature	Resistance to penetration

6.3.2 Type II helmet

Mandatory tests shall be conducted on Type II helmets as shown in Table 3. Seven helmets are required for the mandatory tests for each headform size. Each conditioned helmet shall be tested at five locations: the crown, the three prescribed locations (front, side and rear) and one shall be the laboratory determined non-prescribed location. Tests shall be conducted in the sequence shown.

Table 3 — Test schedule for Type II helmets

Sample No.	Conditioning	Tests
1	Low temperature (– 10 °C)	(i) Striker drop test at crown (ii) Impact energy attenuation front prescribed impact site.
2	Low temperature (– 10 °C)	(i) Impact energy attenuation at side and rear prescribed sites and non-prescribed site. (ii) Dynamic strength of retention system
3	Wet	(i) Striker drop test at crown (ii) Impact energy attenuation front prescribed impact site
4	Wet	(i) Impact energy attenuation at side and rear prescribed sites and non-prescribed site. (ii) Dynamic strength of retention system
5	High temperature	(i) Striker drop test at crown (ii) Impact energy attenuation front prescribed impact site (iii) Resistance to ignition
6	High temperature	(i) Impact energy attenuation at side and rear prescribed sites and non-prescribed site. (ii) Resistance to ignition
7	Low temperature (– 10 °C)	(i) Dynamic stability. (ii) Resistance to penetration

6.4 Headforms

6.4.1 Striker drop tests

6.4.1.1 Construction

Tests shall be conducted on headform sizes 495, 535, 575, 605 or 625 as specified in EN 960. The smallest and largest headforms appropriate for the nominated helmet size range shall be used headforms used in the tests shall be either hardwood or metal.

A recommended method of constructing wooden headforms is given in Annex B.

6.4.1.2 Selection of size

Helmets with adjustable harnesses shall be tested on the appropriate headform as selected by adjusting the harness to the middle size of the adjustment range.

Helmets with non-adjustable harnesses shall be tested on the appropriate size of headform.

6.4.2 Headform drop tests

Tests shall be conducted on headform sizes 495, 535, 575, 605 or 625 as specified in EN 960. The smallest and largest headforms appropriate for the nominated helmet size range shall be used.

If the helmet is intended to fit a wide range of head sizes, the test schedule shown in table 3 shall be repeated for the smallest and largest headforms. Therefore, a helmet supplier may need to provide 14 helmets so that the schedule in table 3 can be repeated on the smallest headform, e.g. 535, and the largest, e.g. 605, for the helmet model and size.

6.5 Impact energy attenuation tests

6.5.1 Striker drop test

6.5.1.1 Principle

A striker is dropped onto a rigidly mounted helmeted headform. The maximum force transmitted to the headform is measured.

6.5.1.2 Apparatus

The base of the apparatus shall be monolithic and sufficiently large to offer full resistance to the effect of the impact. It shall have a mass of at least 500 kg and shall be suitably installed to obviate the return compression wave. The headform shall be rigidly mounted in a vertical position on the base.

A striker, having a mass of $5{,}0\ ^{0}_{-0{,}1}$ kg and a hemispherical striking face of 48 mm radius, shall be positioned above the headform so that its axis coincides with the vertical axis of the headform and so that it may be dropped in guided fall with a minimum retardation from the guides. The impact force shall be measured by a non-inertial force transducer firmly attached to the base. It shall be so positioned that its axis is co-axial with the path of the striker. The system of measurement used shall be able to measure without distortion forces of up to 40 kN and shall have a flat frequency response within ±5 % between 5 and 1 000 Hz. It should be noted that, where a force transducer is used in conjunction with the headform, the headform and its mount form part of the measuring system.

6.5.1.3 Test procedure

Each of the requisite sample helmets specified in 6.1 shall be conditioned appropriately in accordance with 6.2. Within 1 min of its removal from the conditioning atmosphere it shall be placed firmly, and fastened securely, on the appropriate headform. The striker shall be allowed to fall on the centre of the crown of the helmet shell.

A recording shall be made allowing the determination of the maximum force of impact.

6.5.2 Headform drop test

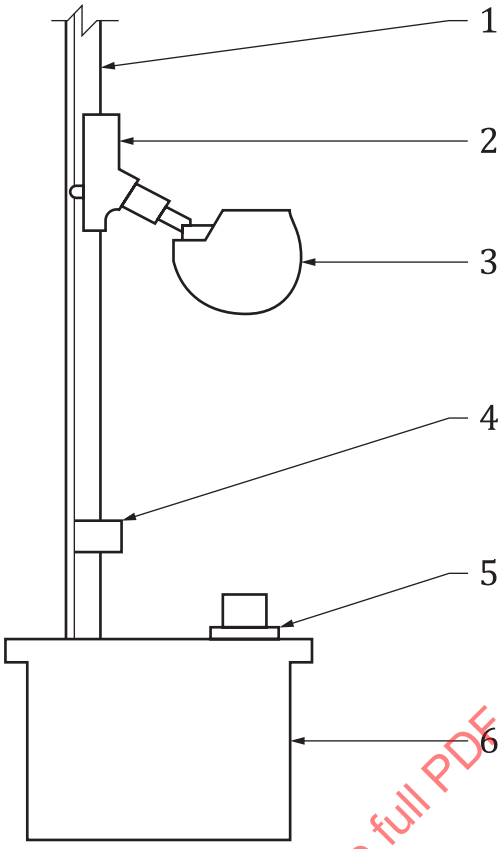
6.5.2.1 Principle

A helmet is mounted onto an instrumented headform and dropped onto a rigidly mounted hemispherical anvil. The headform is attached to an assembly that permits a guided free-fall.

Impact energy attenuation is assessed by the measurement of the maximum resultant linear acceleration of the combined headform and assembly.

6.5.2.2 Apparatus

The apparatus shall consist of a headform, drop assembly, release mechanism, a means to control the direction of the free fall, an anvil, a base, instrumentation and data acquisition. See Figure 3.



Key

1 monorail
2 follower mechanism
3 headform
4 velocity sensor
5 anvil
6 base

Figure 3 — Example of guided free-fall test rig for headform drop tests

Headform and assembly: The mass of the headform and assembly shall vary by the test headform size as presented in Table 4 with the supporting assembly contributing to no more than 20 % of the total. The assembly supporting the headform shall be such that its characteristics do not affect the measurement of acceleration at the centre of gravity of the headform. It shall also be such that any impact site can be positioned vertically above the centre of the anvil. The headform shall have no natural resonant frequencies below 3 000 Hz.

Table 4 — Masses of headform and assembly by headform size for headform drop tests

Headform size mm	Mass of headform and assembly kg
A (495)	3,1 ± 0,05
E (535)	4,1 ± 0,05
J (575)	4,7 ± 0,05
M (605)	5,6 ± 0,05
O (625)	6,1 ± 0,05

The acceleration of the centre of mass of the headform and assembly shall be measured. The acceleration data shall be conditioned according to the channel class 1 000 requirements of SAE J211.

A monorail, two-wire or three- wire guidance system with an adjustable mounting for the helmeted headform to permit impacts to be delivered to any location on the helmet above the test line.

A system for acquiring and recording the test data.

Anvil — A hemispherical steel anvil with a radius of 48 mm shall be used.

Base — The anvil shall be mounted to a solid based that is sufficiently large to offer full resistance to the effect of the impact. It shall have a mass of at least 500 kg and shall be suitably installed to obviate the return compression wave. The top surface of the base shall be faced with a steel plate with minimum thickness of 25 mm and a minimum top surface area of 0,09 m^2.

6.5.2.3 Test procedure

The helmet shall be positioned on the headform as specified by the manufacturer's helmet positioning index (HPI).

Each of the requisite sample helmets specified in 6.1 shall be conditioned appropriately in accordance with 6.2. Within 1 min of its removal from the conditioning atmosphere, it shall be placed firmly, and fastened securely, onto the appropriate headform (see 6.4.2).

For maintenance of conditioning, it may be necessary to return the helmet back into the conditioning environment, e.g. oven, after each test for a period of at least 5 min. The laboratory should apply a period that is suitable for their test practices and systems.

Impact tests shall be conducted at the following four prescribed locations (crown, front, side and rear) and one laboratory selected (non-prescribed) locations as per Table 5 and Figure 4. The one non-prescribed test location shall be on or above the test line and at least one-fifth of the circumference of the headform from any prior impact location on that helmet. For the impact at the one non-prescribed location, the centre of the anvil may be on the test line. The impact direction shall be perpendicular to the headform surface at all impact locations.

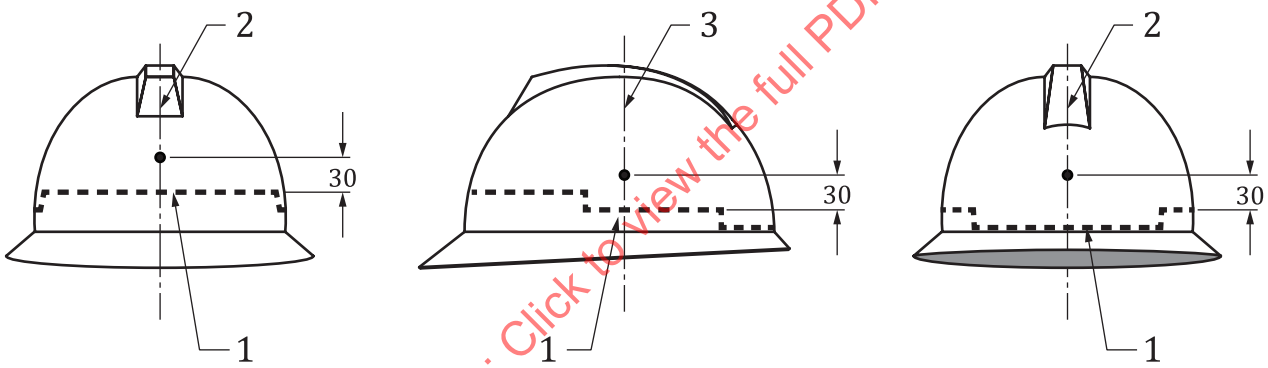
The headform shall be positioned so that the impact location is the first point of contact with the anvil.

The helmeted headform shall contact the centre of the anvil with a velocity of $5{,}05\ ^{+0{,}05}_{0}\ \mathrm{m/s}$ measured over the last 40 mm of fall. The impact velocity equates to a nominal drop height of 1 300 mm.

Table 5 — Type II helmet. Test locations and impact test methods

Location	Definition	Method	Energy or impact speed
Crown	Centre of the crown of the helmet shell	Striker drop test	98 J
Front	At centre front of helmet. 30 mm above test line in mid-sagittal plane (median plane).	Headform drop test	5,05 m/s
Side	At side of helmet. 30 mm above test line in mid-coronal plane (frontal plane)	Headform drop test	5,05 m/s
Rear	Centre rear of helmet. 30 mm above test line in mid-sagittal plane.	Headform drop test	5,05 m/s
Non-prescribed (Determined by laboratory)	Centre of impact on or within test line. At least one-fifth of the circumference of the headform from any prior impact location on that helmet	Headform drop test	5,05 m/s

Dimensions in millimetres



a) Impact location, front **b) Impact location, side** **c) Impact location, rear**

Key

1 test line
2 mid-sagittal plane
3 mid-coronal plane

Figure 4 — Impact locations for headform drop tests involving Type II helmets

6.6 Penetration test

6.6.1 Apparatus

A test striker is allowed to fall freely onto a helmet securely fastened to a suitable headform. The contactable surface of the headform shall be of a metal that will readily permit detection should contact by the striker occur, and that can be restored after contact, if necessary.

The striker has the following characteristics:

Mass : $3{,}0\ ^{+0{,}05}_{0}$ kg

Angle of point : 60°

Radius of point : 0,5 mm

Minimum height of cone : 40 mm

Hardness of tip: between 50 and 45 Rockwell hardness

6.6.2 Test procedure

A Type I helmet shall be conditioned to wet, high temperature and low temperature. A Type II helmet shall be conditioned to low temperature and high temperature.

Within 1 min of its removal from the conditioning atmosphere, it shall be placed firmly, and fastened securely, on the appropriate headform (6.4). If the helmet has a harness, it shall be placed at its greatest possible wearing height and with a total clearance of approximately 10 mm between the headband and the headform, measured by the insertion of a 10 mm diameter rod.

The striker shall be allowed to fall on to the top of the helmet at a velocity of $4,43\ ^{+0,05}_{0}\ \mathrm{m/s}$, within a circular area of 100 mm diameter. The nominal fall height is 1 000 mm measured from the top of the helmet to the point of the striker. The striker may fall freely or may be guided but the speed of impact of a guided striker shall equal that of a free fall.

Note is taken of whether or not contact is made between the striker and the headform. Contact may be verified electrically but a physical check shall be made on the contact surface. If necessary, the surface shall be restored prior to a subsequent test.

6.7 Dynamic strength of the retention system

6.7.1 Principle

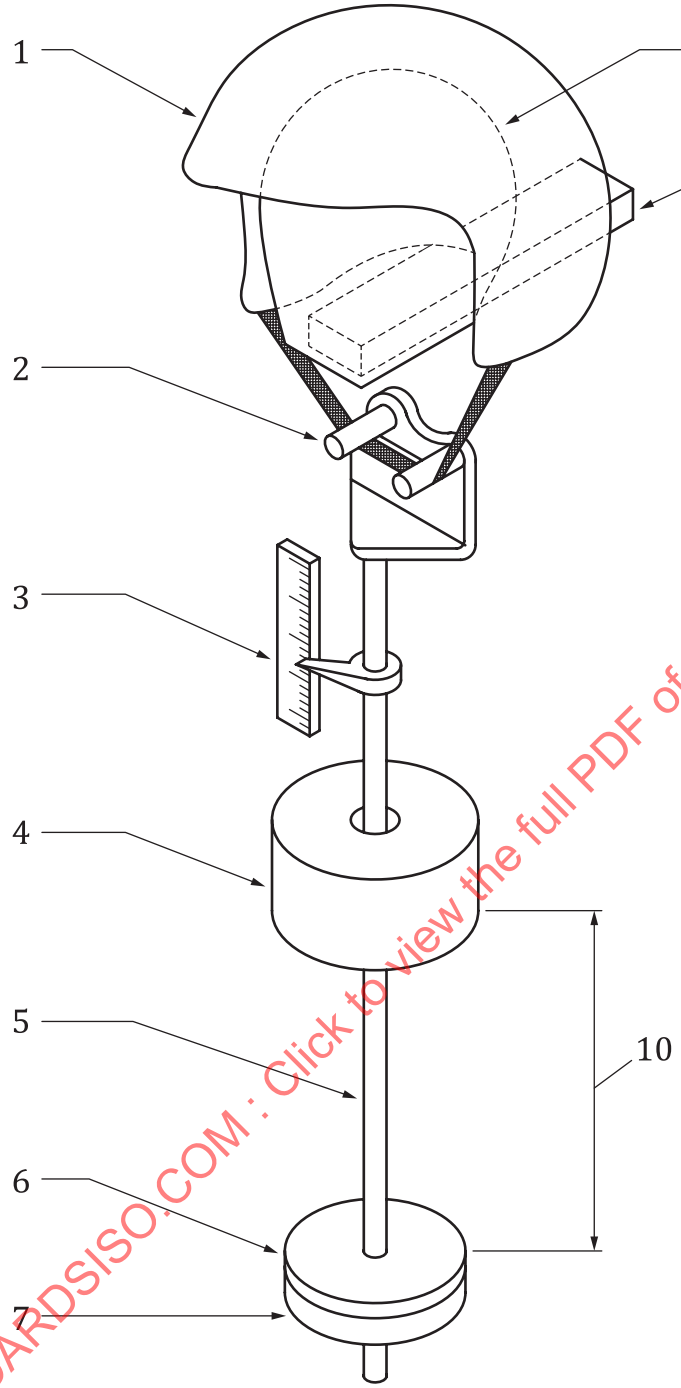
A helmet is mounted onto a fixed headform and the retention system is loaded dynamically. The displacement of the retention system is measured.

6.7.2 Apparatus

The test apparatus consists of a headform, headform support, retention system strap stirrup, displacement measuring device, drop mass, guide bar, stop anvil and stop pad (Figure 5).

The loadbearing device shall have a mass of 7,0 kg ± 0,1 kg and consist of the retention system strap stirrup, guide bar of diameter no greater than 3 mm, stop anvil and stop pad. The retention system strap stirrup shall consist of two metal rollers each with a diameter of 12,7 mm ± 1,0 mm that have a centre-to-centre distance of 75,0 mm ± 1,5 mm. The stop anvil shall be steel with a diameter of 125 mm ± 25 mm. The stop anvil shall be covered by a 2 mm thick stop pad with Shore A durometer hardness of 50 to 70.

The drop mass shall be a steel cylinder of mass 10,0 kg ± 0,1 kg that can fall guided by the guide bar.



Key

1 helmet
2 retention system stirrup
3 displacement measurement device
4 drop weight 10,0 kg ± 0,1 kg
5 guide bar
6 rubber pad
7 stop anvil

8 headform
9 headform support
10 drop height

Figure 5 — Typical apparatus for dynamic strength of retention system test

6.7.3 Test procedure

Following impact energy attenuation tests, helmets will be tested for strength of the retention system according to the schedule in Table 3. The helmet shall be positioned on a complete headform and the retention system adjusted and fastened according to supplier's instructions. The helmet shall be removed and placed on the test headform, while maintaining the retention system adjustment.

The retention system strap shall be fastened under the stirrup bars. In this configuration, the load bearing device shall be suspended fully by the retention system. The load bearing device applies a static pre-load to the retention system.

The drop mass is raised by 150 mm and allowed to fall onto the stop anvil.

Measure the maximum dynamic displacement.

Measure the permanent displacement of the retention system strap stirrup after 30 s.

Release the load and ascertain the functionality of the retention system buckle.

6.8 Dynamic stability

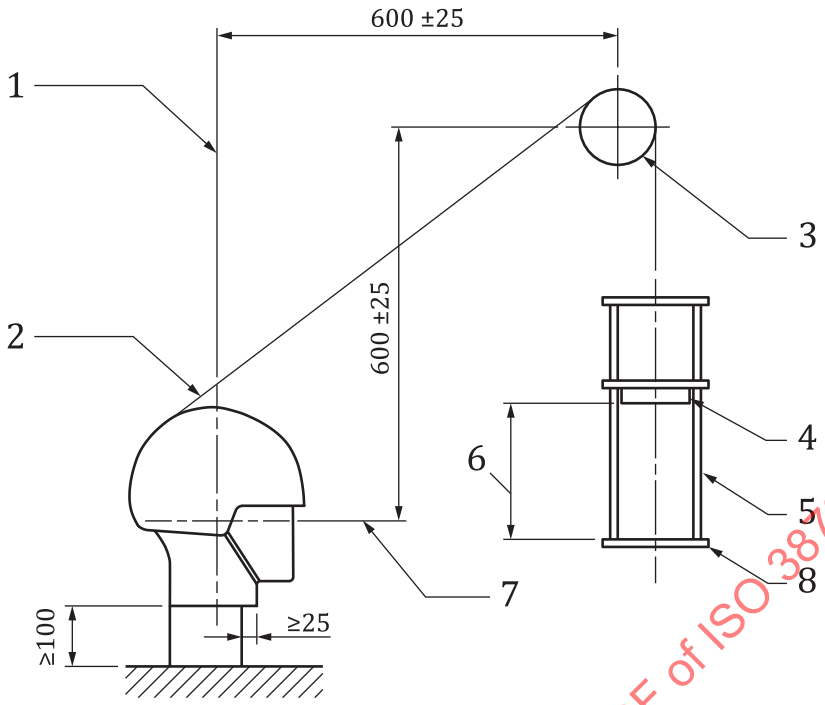
6.8.1 Principle

A helmet is mounted onto a fixed headform and the helmet is loaded dynamically. The displacement of the helmet is measured. Stability of the helmet is assessed by the degree of helmet rotation on the headform.

6.8.2 Apparatus

The test apparatus consists of a complete headform, rigid mount to hold headform, guiding system of mass 3,0 kg ± 0,1 kg, drop mass of 10,0 kg ± 0,1 kg, flexible strap and hook to attached the guiding system, pulley, end stop covered by a 1,5 mm thick stop pad with Shore A durometer hardness of 50 to 70 (Figure 6).

Dimensions in millimetres



Key

1 central vertical axis
2 flexible strap
3 pulley, Ø 100 mm ± 2 mm
4 drop mass 10,0 kg ± 0,1 kg
5 guiding system mass 3,0 kg ± 0,1 kg
6 drop height
7 reference plane
8 stop pad 1,5 mm

NOTE A flat strap is recommended for the loading device since it is less likely to slip when placed across the apex of the helmet than a round cord.

Figure 6 — Typical apparatus for dynamic stability test

6.8.3 Test procedure

Mount the headform so that the basic plane (Frankfurt plane) is horizontal. Place the helmet on the headform. To ensure that the helmet is seated on the headform, apply a static load of 45,0 + 0, -0,5 N vertically downwards onto the apex. Remove all the slack from the retention system. Remove the vertical force. Attach the strap to the rear edge of the helmet so that the strap is aligned with the mid-sagittal plane. Raise the drop mass by 100 mm. Release the drop mass. Measure the degree of rotation of the helmet on the headform.

6.9 Resistance to ignition

6.9.1 Principle

The test is intended to show that specified components of the protector resist ignition.

A steel rod is heated to a known temperature and applied to the shell.

NOTE The ignitability test is carried out to assess external shell material properties.