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American National Standard for Industrial Head Protection

Secretariat

International Safety Equipment Association

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American National Standard

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Foreword (This Foreword is not part of ANSI/ISEA Z89.1-2014)

Voluntary industry consensus standards recognized by the American National Standards Institute are required to be reviewed every five years to account for improvements in technology, test methods and materials, user needs and trends in use and application of products covered under the respective standard. This seventh revision of the *American National Standard for Industrial Head Protection*, ANSI/ISEA Z89.1-2014 represents an effort to accommodate characteristics of industrial head protection that end-users identified as being important as work environments change and emerging hazards are identified. This edition was prepared by the ISEA Head Protection Group whose current members include: 3M Company, Bullard, ERB Industries, Gateway Safety, Honeywell Safety Products, Kimberly-Clark Professional, MSA Safety, OccuNomix International, Protective Industrial Products Inc., and Sellstrom Manufacturing Co.

The core performance requirements remain unchanged. However, this updated version incorporates optional preconditioning at higher temperatures than the standard test temperatures. Head protection devices that meet the applicable product performance criteria after having been exposed to these higher temperatures will bear a unique mark indicating such, to provide easy identification to the user.

This standard was processed and approved using consensus procedures prescribed by the American National Standards Institute. The following organizations were contacted prior to the approval of this standard. Inclusion in this list does not necessarily imply that the organization concurred with the submittal of the proposed standard to ANSI.

Atlas Industrial Contractors
Mr. James Byrnes
Center to Protect Workers Rights
City of San Diego
Entergy
INSPEC International
International Safety Equipment Association
International Staple, Nail and Tool Association
Mr. Michael Kertis
Kimberly-Clark Professional

Laborers Health and Safety Fund of North America
National Electrical Contractors Association
National Institute for Occupational Safety and Health
Oberon Company
Safety Equipment Institute
TAUC: The Association of Union Contractors
Waste Equipment Technology Association
U.S. Department of Labor – Occupational Safety and Health Administration

Suggestions for improvement of this standard are encouraged. Contact:

ISEA
1901 N. Moore Street #808
Arlington, VA 22209
isea@safetysiteequipment.org

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American National Standard for Industrial Head Protection

1 Scope, Purpose and Limitations

1.1 Scope

This standard establishes minimum performance and labeling requirements for protective helmets used in industrial and occupational settings under normal temperature conditions and optionally at high and low temperatures and when worn in the reversed position. It also includes requirements for high-visibility helmets and specifies test methods for evaluating all requirements.

Helmets conforming to the requirements of this standard are designated both by Type (based on location of impact force) and Class (based on electrical insulation) as well as any optional feature.

This standard does not cover bump caps, firefighting helmets or head protection devices used in recreational activities.

User cautions and recommendations on use and care of helmets are given in Appendix A of this standard.

1.2 Purpose

This standard establishes minimum performance requirements for protective helmets that reduce the forces of impact and penetration and that may provide protection from electric shock (not arc flash).

1.3 Limitations

Protective helmets reduce the amount of force from an impact blow but cannot provide complete head protection from severe impact and penetration. Helmets that meet this standard provide limited protection but should be effective against small tools, small pieces of wood, bolts, nuts, rivets, sparks and similar hazards. The use of protective helmets should never be viewed as a substitute for good safety practices and engineering controls. Alterations, attachments, or additions of accessories may affect the performance of the helmet. Helmets are designed to provide protection above the test lines, which are clearly defined in the standard. Helmets may extend below the test

lines for styling or practical purposes but no protection is to be implied below the test lines.

1.4 Units and Tolerances

In this standard, SI units of measurement are followed by an approximate imperial equivalent in parenthesis. Only the SI value shall be regarded as the requirement.

2 Compliance

Any statement(s) of compliance with this standard shall mean that the product meets all applicable performance and labeling requirements for the Type and Class. It is specifically intended that partial utilization of this standard is prohibited.

3 Definitions

accessory: A device intended to be mounted on or used with protective helmets. (See Section 5)

apex: The point on the outer surface of the shell coincident with the vertical axis of the headform when the helmet is mounted in the as-worn position according to the manufacturer's instructions.

basic plane: A plane at the level of the external auditory meatus (external ear opening) and the inferior margin of the orbit (lower edge of the eye socket).

chin strap: A strap which fits under the chin and is attached to the helmet.

component: A functional part of a complete device addressed by the performance requirements of this standard.

crown straps: The part of the suspension that passes over the head.

dynamic test line (DTL): A test line used as a boundary for conducting impact energy attenuation and off-center penetration tests.

flammability: The ability of a helmet shell to support combustion upon removal of the test flame.

harness: The complete assembly used to maintain a helmet in correct wearing position on the wearer's head, exclusive of a chin strap or other retention device.

headband: The part of the harness that encircles the head.

helmet: A device worn on the head designed to provide limited protection against impact, flying particles or electric shock.

manufacturer: The business entity that marks or directs the permanent marking of the components or complete device as compliant with this standard and sells them as compliant.

midsagittal plane: A longitudinal plane, perpendicular to the basic plane, which passes through the vertex and geometrically bisects the head.

permanent: Such as can be expected to remain present and legible throughout the expected service life of the product.

positioning index: A perpendicular distance, as specified by the manufacturer, from some point on the helmet to the basic plane when the helmet is properly seated on a reference headform.

projection: Rigid features that extend or protrude beyond the normal internal or external surface or contour of the helmet.

protective padding: Any material used to absorb the kinetic energy of impact.

reference plane: A plane at a given distance above and parallel to the basic plane.

reference headform: A measuring device contoured to specified dimensions with surface markings indicating the locations of the basic, midsagittal and reference planes, as well as any required test lines.

shall: In this standard, use of the word "shall" indicates a mandatory requirement.

shell: The part of a helmet which includes the outermost surface.

should: In this standard, use of the word "should" indicates a recommendation.

suspension: The portion of the harness which is designed to act as an energy-absorbing mechanism. It may consist of crown straps, protective padding, or a similar mechanism.

static test line (STL): A test line used as a boundary for conducting electrical insulation, flammability tests and for mounting for the force transmission test.

test line: A line or combination of lines marked on a reference headform used to provide limits or a boundary beyond which protection is not considered.

test plaque: A sample of the helmet or representative shell material with a thickness of $3 \text{ mm} \pm 0.5 \text{ mm}$ ($0.12 \text{ in.} \pm 0.02 \text{ in.}$).

4 Types and Classes

Protective helmets are described by impact type and electrical class. All protective helmets shall meet either Type I or Type II requirements. All helmets shall be further classified as meeting Class G, Class E, or Class C electrical requirements.

4.1 Impact Types

4.1.1 Type I

Type I helmets are intended to reduce the force of impact resulting from a blow only to the top of the head.

4.1.2 Type II

Type II helmets are intended to reduce the force of impact resulting from a blow to the top or sides of the head.

4.2 Electrical Classes

4.2.1 Class G (General)

Class G helmets are intended to reduce the danger of contact with low voltage conductors. Test samples shall be proof-tested at 2200 volts (phase to ground). This voltage is not intended as an indication of the voltage at which the helmet protects the wearer.

4.2.2 Class E (Electrical)

Class E helmets are intended to reduce the danger of contact with higher voltage conductors. Test samples are proof-tested at 20,000 volts (phase to ground). This voltage is not intended as an indication of the voltage at which the helmet protects the wearer.

4.2.3 Class C (Conductive)

Class C helmets are not intended to provide protection against contact with electrical hazards.

5 Accessories and Replacement Components

Accessories or replacement components, when installed, shall not cause the helmet to fail the requirements of this standard.

The entity claiming that an accessory or replacement component, when installed, does not cause the helmet to fail the requirements of this standard is responsible for providing justification upon request.

6 Instructions and Marking

6.1 Each helmet shall be accompanied by manufacturers' instructions explaining the application(s) of use, proper method of size adjustment and fitting (including, if applicable, reverse wearing) and, guidelines for care and useful service life.

NOTE: Useful service life guidelines are intended to provide the user with information that certain conditions may affect a specific helmet's continued protection over time. A specific service life, defined in terms of number of years, is not required though individual manufacturers may choose to include such information for their respective helmets.

6.2 Each helmet shall bear permanent markings in at least 1.5 mm (0.06 in.) high letters stating the following information:

- a. Name or identification mark of the manufacturer.
- b. The date of manufacture.

- c. The American National Standard designation, ANSI/ISEA Z89.1-2014.
- d. The applicable Type and Class designations, followed by applicable optional criteria markings;
- e. The approximate headsize range (see Table 2).

6.3 If optional performance features are satisfied, the appropriate marking below shall be applied in the sequence as specified below:



- Reverse donning;

LT - Lower temperature

HV - High visibility

HT – Higher temperature

The size of the reverse donning symbol shall be large enough to be legible.

7 Performance Requirements

7.1 Requirements for Type I and Type II Helmets

7.1.1 Flammability

Helmets shall be tested in accordance with Section 10.1. No flame shall be visible 5 seconds after removal of the test flame.

7.1.2 Force Transmission

Helmets shall be tested in accordance with Section 10.2 and shall not transmit a force to the test headform that exceeds 4,450 N (1,000 lbf). Additionally, for each preconditioning specified, the maximum transmitted force of individual test samples shall be averaged. The averaged values shall not exceed 3,780 N (850 lbf).

7.1.3 Apex Penetration

Helmets shall be tested in accordance with Section 10.3. The penetrator shall not make contact with the top of the test headform.

7.1.4 Electrical Insulation Requirements

7.1.4.1 General

Class G and Class E helmets shall meet their appropriate performance requirement as listed below. Class C helmets are not tested for electrical insulation.

7.1.4.2 Class G Requirements

Class G helmets shall be tested in accordance with Section 10.7 and shall withstand 2,200 volts (root mean square) AC, 60 hertz, for 1 minute. Leakage shall not exceed 3 milliamperes.

7.1.4.3 Class E Requirements

After first passing the force transmission test specified in Section 7.1.2, Class E helmets shall be tested in accordance with Section 10.7 and shall withstand 20,000 volts (root mean square) AC, 60 hertz, for 3 minutes. Leakage shall not exceed 9 milliamperes.

At 30,000 volts, the test sample shall not burn through.

7.2 Additional Requirements for Type II Helmets

7.2.1 Impact Energy Attenuation

Type II helmets shall be tested in accordance with Section 10.4. Maximum acceleration shall not exceed 150g.

7.2.2 Off-center Penetration

Type II helmets shall be tested in accordance with Section 10.5.

For each helmet tested, the penetrator shall not make contact with the test headform.

7.2.3 Chin Strap

Chin straps shall be made of material not less than 12.7 mm (0.50 in.) in width.

Type II helmets which are provided with chin straps shall be tested for retention in accordance with Section 10.6.

For each helmet tested,, the chin strap shall remain attached to the helmet. The residual

elongation of the strap shall not exceed 25 mm (1.0 in.).

7.3 Requirements for Optional Features

7.3.1 Reverse Wearing

Type I Helmets that are to be marked with the reverse wearing marking shall pass the force transmission test when mounted in the reverse position on the headform.

Type II Helmets that are to be marked with the reverse wearing mark shall pass the force transmission, impact attenuation, and off-center penetration tests when mounted in the reverse wearing position on the test headform.

7.3.2 High-Visibility

When measured in accordance with Section 10.8, helmets marked "HV" for high-visibility shall demonstrate, for the appropriate color in Table 1:

- Chromaticity that lies within one of the sets of coordinates in Table 1
- Total luminance factor (Y expressed as a percentage) that meets or exceeds the corresponding minimum value in Table 1.

Table 1. Color, High-Visibility Helmets

Color	Chromaticity coordinates		Minimum total luminance factor
	x	y	Y (%)
Fluorescent yellow-green	0.387	0.610	70
	0.356	0.494	
	0.398	0.452	
	0.460	0.540	
Fluorescent orange-red	0.610	0.390	40
	0.535	0.375	
	0.570	0.340	
	0.655	0.344	
Fluorescent red	0.655	0.344	25
	0.570	0.340	
	0.595	0.315	
	0.690	0.310	

7.3.3 Higher temperature

When preconditioned in accordance with Section 8.5.3, helmets marked "HT" for higher temperature shall meet all testing and marking requirements applicable to the Type and Class of the helmet.

7.3.4 Lower temperature

When preconditioned in accordance with Section 8.5.5, helmets marked "LT" for lower temperature shall meet all testing and marking requirements applicable to the Type and Class of the helmet.

8 Testing Preparation

8.1 Test Sample Selection

8.1.1 A minimum of 30 test samples is required for compliance testing in accordance with the performance requirements of Section 7.

8.1.2 A minimum of 36 test samples is required for compliance testing for helmets that are to be marked for wearing in the reverse position.

8.1.3 It is not intended that the testing schedule given in Table 3 be used for a manufacturer's quality assurance program.

8.2 Sequence of Testing

Testing shall be conducted in accordance with the testing schedule given in Table 3. Some test samples may be used for performing more than one test. Helmets meeting the requirements of this standard are intended to provide protection against only one blow (impact and/or penetration). If a test sample fails to meet the requirements of a given test (with the exception of Class E electrical insulation test) and the sample has previously been subjected to an impact or penetration test, a new helmet shall be tested to verify the "failing" result of that particular test. Should the new helmet meet the test requirements, then the "failing" result shall be discounted.

8.3 Testing Conditions

All testing and sample marking shall be performed at room temperature $23^{\circ}\text{C} \pm 3^{\circ}\text{C}$ ($73.4^{\circ}\text{F} \pm 5.4^{\circ}\text{F}$). If there is a disagreement in

the test results among different laboratories, the helmets shall be re-tested at a controlled relative humidity of $50 \pm 5\%$.

8.4 Test Sample Markings

8.4.1 General

Test samples shall be marked to indicate the location of the Static Test Line (STL) and Dynamic Test Line (DTL). The largest size of ISO headform appropriate for the helmet being tested, whose circumference is not greater than the internal circumference of the helmet headband when adjusted to its largest setting, shall be used. If no headband is provided, the corresponding interior surface circumference of the helmet shall be used to determine the appropriate headform. Once the appropriate reference headform is chosen, the test samples shall be adjusted to provide a snug, but not tight, fit on the headform.

NOTE: There is no requirement for helmets to cover down to the STL or DTL.

8.4.2 Dynamic Test Line (DTL) Marking Procedure

Seat the headform firmly with the basic plane being horizontal. Place the test sample on the headform, centered laterally oriented in the normal wearing position, and seated firmly according to its positioning index.

For samples that are marked to be worn in the reverse position, install the headband in the shell according to the manufacturer's wearing instructions for reverse donning. Place the sample on the headform, centered laterally, rotated 180 degrees from the normal wearing position along the basic plane of the headform, and seated firmly accordingly to the manufacturer's positioning index.

Apply a $50 \pm 2\text{ N}$ ($11 \pm 0.45\text{ lb}$) static force normal to the helmet's apex. Maintaining the force and position described above, draw a line on the outer surface of the helmet coinciding with the intersections of the helmet surface and the following planes, as defined in Figure 2:

- a. A plane "k" mm above and parallel to the reference plane in the anterior portion of the reference headform.

- b. A vertical transverse plane "b" mm behind the center of the central vertical axis in a side view.
- c. A plane "j" mm above and parallel to the reference plane in the posterior portion of the reference headform.

One sample marked with the DTL for normal wearing and one marked with the DTL for the reverse wearing option should suffice for use in setting up the subsequent testing.

8.4.3 Static Test Line (STL) Marking Procedure

Secure the headform with the basic plane being horizontal. Place the test sample on the headform, centered laterally, leveled side-to-side and seated firmly according to its positioning index.

Apply a 50 ± 2 N (11 ± 0.45 lb) static force normal to the helmet's apex. Maintaining the force and position described above, draw a line on the outer surface of the helmet coinciding with the dimensions shown in Figure 11.

8.5 Helmet Preconditioning

8.5.1 Preconditioning Environments

Test samples shall be preconditioned prior to performing the impact, penetration and chin strap retention tests.

8.5.2 Hot

Place test samples in a forced air circulating oven maintained at $49^\circ\text{C} \pm 2^\circ\text{C}$ ($120^\circ\text{F} \pm 3.6^\circ\text{F}$) for at least two hours. Place all samples horizontal and in such a manner as to not block the flow of circulating air, at least 5 cm (2.9 in.) from any internal oven wall.

8.5.3 Higher Temperature (Optional)

As an alternative to hot preconditioning as specified in Section 8.5.2, higher temperature preconditioning may be used. Place test samples in a forced air circulating oven maintained at $60^\circ\text{C} \pm 2^\circ\text{C}$ ($140^\circ\text{F} \pm 3.6^\circ\text{F}$) for at least four hours.

8.5.4 Cold

Place test samples in a freezer maintained at $18^\circ\text{C} \pm 2^\circ\text{C}$ ($0^\circ\text{F} \pm 3.6^\circ\text{F}$) for at least two hours.

8.5.5 Lower Temperature (Optional)

As an alternative to cold preconditioning as specified in Section 8.5.4, lower temperature preconditioning may be used. Place test samples in a freezer maintained at $-30^\circ\text{C} \pm 2^\circ\text{C}$ ($-22^\circ\text{F} \pm 3.6^\circ\text{F}$) for at least four hours with the base of the helmet facing upward (i.e., above the crown).

8.5.6 Wet

Submerge test sample in fresh tap water maintained at $23^\circ\text{C} \pm 3^\circ\text{C}$ ($73.4^\circ\text{F} \pm 5.4^\circ\text{F}$) for at least two hours.

8.6 Testing Time

8.6.1 Hot-, cold-, higher- and lower-temperature preconditioned samples shall be tested for impact and penetration within 30 seconds after their removal from the conditioning environment.

8.6.2 Hot-, cold-, higher- and lower-temperature preconditioned samples shall be tested for chin strap retention within 60 seconds after their removal from the conditioning environment.

8.6.3 Wet samples shall be withdrawn from the water bath and positioned upright and horizontal for a maximum of 30 seconds to allow excess water to drain. The wet samples shall then be mounted on the applicable test apparatus and tested within 90 seconds from their removal of the water bath.

9 Headforms

9.1 General

Only that part of the headform above the reference plane is intended to represent the human head. Damaged or deformed headforms shall not be used.

9.2 Headform Sizes

The ISEA headform size 7 shall be used for the force transmission test.

For all other tests, one of three sizes of ISO headforms described in ISO/DIS 6220 shall be used. If headform size is not specified by the manufacturer, the testing facility is to decide the most suitable size (See Figure 1).

9.3 Headform for Force Transmission

The headform used for the force transmission test (Section 7.1.2) shall be the "ISEA standard headform," size 7 (approximate dimensions are contained in Figure 3 for reference only). The headform shall be made of low-resonance magnesium K-1A, or aluminum. The mass of the headform shall be $3.64 \text{ kg} \pm 0.45 \text{ kg}$ ($8 \text{ lb} \pm 1 \text{ lb}$).

9.4 Headform for Penetration Tests

A headform as specified in ISO/DIS 6220 and made from electrically conductive material shall be used for the apex penetration test (Section 7.1.3) and the off-center penetration test (Section 7.2.2) and shall be mounted on a ball joint so it can be pivoted into various positions.

9.5 Headform for Impact Energy Attenuation Tests

An ISO headform used for the impact energy attenuation test (Section 7.2.1), shall be made of a low resonance material such as cast silica urethane, and have a Shore "D" durometer of 60 ± 6 . The headform, together with its supporting assemblies, shall have a mass of $5.0 \text{ kg} \pm 0.05 \text{ kg}$ ($11 \text{ lb} \pm 0.1 \text{ lb}$), with the center of gravity roughly corresponding to the center of the mounting ball.

10 Test Methods

10.1 Flammability

10.1.1 Preparation of Test Samples

Test samples shall be marked in accordance with Section 8.

10.1.2 Apparatus

The test apparatus shall consist of the following components:

- a. A laboratory test stand of sufficient size and strength to hold the test sample in an as-worn, upright position (see Figure 12). The

stand, including the attached test sample, shall be placed inside a draft free fume hood.

- b. Bunsen burner with a 10 mm (0.4 in.) bore.
- c. Source of gas. The use of natural methane (laboratory grade) gas with a heat content of $1000 \text{ BTU} \pm 100 \text{ BTU}$ per cubic foot is recommended.
- d. Gas regulator.
- e. Timing device.
- f. Temperature measurement device.

10.1.3 Calibration

Use a temperature measurement device to verify the temperature of the Bunsen burner flame. With the Bunsen burner in a vertical position, adjust it to produce a 50 mm (2.0 in.) blue flame with an inner cone of 25 mm (1.0 in.). Using the temperature probe, measure the temperature of the flame at the tip of the inner cone. It shall be $800 - 900^\circ\text{C}$ ($1472 - 1652^\circ\text{F}$).

10.1.4 Test Procedures

Attach the test sample to the laboratory test stand so that it is held in an as-worn, upright position (see Figure 12). Choose any point on the outer surface of the helmet above the STL and apply the flame of the Bunsen burner such that the tip of the inner cone is within 2 mm (0.08 in.) from the helmet surface. The Bunsen burner shall be held with its barrel horizontal. Apply the flame to the chosen test point for 5 seconds +1 second, -0 second, then remove the flame. Inspect the test sample for any visible flame 5 seconds after removal of the test flame.

10.1.5 Recording

Record results as "pass" or "fail" based on whether any flame is visible 5 seconds after removal of the test flame.

10.2 Force Transmission

10.2.1 Preparation of Test Samples

Test samples shall be preconditioned according to Section 8.5.