BRITISH STANDARD

BS EN
168:2002

Personal eye-protection — Non-optical test methods

The European Standard EN 168:2001 has the status of a British Standard

ICS 13.340.20

National foreword

This British Standard is the official English language version of EN 168:2001. It supersedes BS EN 168:1995 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee PH/2, Eye protection, to Subcommittee PH/2/2, Industrial eye protectors, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

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This British Standard, having been prepared under the direction of the Health and Environment Sector Policy and Strategy Committee, was published under the authority of the Standards Policy and Strategy Committee on 28 January 2002

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EN 168

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English version

Personal eye-protection - Non-optical test methods

Protection individuelle de l'oeil - Méthodes d'essais autres qu'optiques

Persönlicher Augenschutz - Nichtoptische Prüfverfahren

This European Standard was approved by CEN on 2 September 2001.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Ref. No. EN 168:2001 E

Contents

Foreword

This European Standard has been prepared by Technical Committee CEN /TC 85, "Eye-protective equipment", the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2002, and conflicting national standards shall be withdrawn at the latest by May 2002.

This document replaces EN 168:1995.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative annex ZA, which is an integral part of this standard.

The annexes A and ZA are informative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies non-optical test methods for eye-protectors, the requirements for which are contained in other European Standards.

Alternative test methods may be used if shown to be equivalent.

The optical test methods are given in EN 167.

A definition of terms is given in EN 165.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 165, *Personal eye-protection — Vocabulary.*

EN 166, *Personal eye-protection — Specifications.*

EN 167, *Personal eye-protection — Optical test methods.*

ISO 565, *Test sieves — Metal wire cloth, perforated metal plate and electroformed sheet — Nominal sizes of openings.*

3 Test for increased robustness

New specimens shall be used for this test.

3.1 Unmounted oculars

3.1.1 Apparatus

The support for the ocular (see Figure 1) shall be a steel or rigid plastic cylinder with an internal diameter of (35,0 ± 0,1) mm and an outside diameter of (41,0 ± 0,1) mm. The cylinder shall be inserted into, or be an integral part of a steel base. The ocular shall be cushioned by a silicone seating ring firmly attached to the top of the tube.

This seating ring shall be made of silicone rubber of (40 ± 5) I.R.H.D and shall have an inside diameter of (35,0 ± 0,4) m and cross sections of 3 mm x 3 mm nominal dimensions.

The combined mass of the support shall be at least 12 kg.

A load ring of mass (250 ± 5) g is placed on the ocular. The ring has an inside diameter the same as that of the support tube, and any convenient outside diameter. A silicone seating ring having the same dimensions and hardness as the one attached to the top of the support tube is placed between the load ring and the ocular. A piece of carbon paper on a piece of white paper is placed at the base of the 1,5 mm deep cavity in the ocular support (see Figure 1).

For curved oculars with a cylindrical component, the test support tube and load ring shall be curved to conform to the concave and convex surfaces of the ocular respectively, and the dimensions of 3 mm and 4,5 mm shall apply to the deepest point of the circular support. (See Figure 1).

If the ocular is of insufficient dimensions to enable its entire periphery to be adequately supported, suitable adaptor sleeves shall be used.

3.1.2 Procedure

Centre the intended points of impact of the ocular on the support tube. Adjust the apparatus so that a 22 mm nominal diameter steel ball of 43 g minimum mass falling from $(1{,}3^{+0}_{-0{,}03})$ m strikes the ocular within a 5 mm radius from the centre of the support tube. This height will provide an impact speed of approximately 5,1 m/s.

Impacts shall be directed at the visual centre(s) of the oculars. For unmounted oculars covering one eye and for which the visual centre cannot be established, then the geometric centre shall be used.

NOTE Visual centre is as defined in EN 166.

The impacts are carried out in the following conditions:

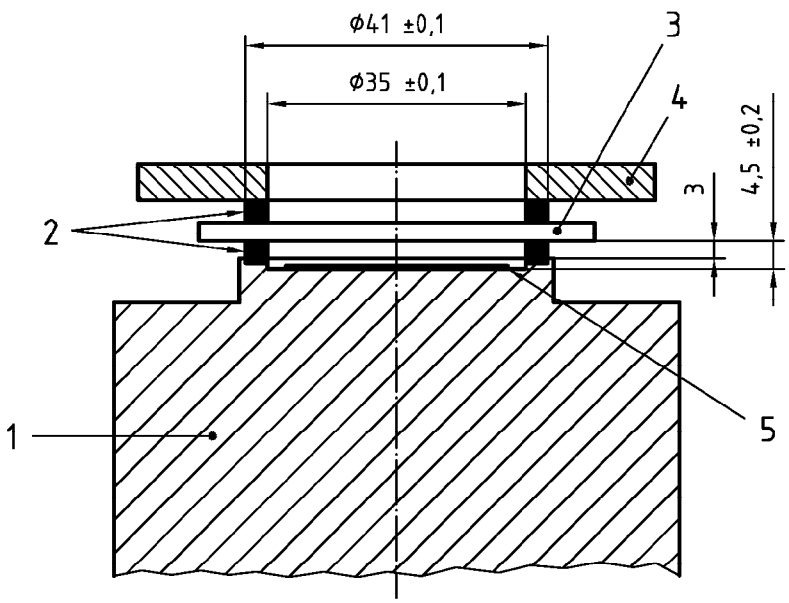
a) with the ocular heated to (55 ± 2) °C and maintained at this temperature for at least 1 h;

b) with the ocular cooled to a temperature of (-5 ± 2) °C and maintained at this temperature for at least 1 h.

New oculars shall be used for each individual impact and for each temperature condition. The impact shall be applied within 30 s of temperature conditioning.

The test shall be carried out at (23 ± 5) °C.

Dimensions in millimetres (nominal unless toleranced)



Key

1 Supporting plate (12 kg minimum)
2 Silicone seating rings
3 Ocular
4 Load ring (250 ± 5) g
5 Carbon paper on white paper

Figure 1 — Holding device for oculars for the increased robustness test

3.2 Complete eye-protectors and frames

3.2.1 Apparatus

3.2.1.1 Appropriate head-form, as defined in clause 17.

3.2.1.2 A device enabling a 22 mm nominal diameter steel ball of 43 g minimum mass to be projected at a specified point on the eye-protector at a speed of approximately 5,1 m/s.

3.2.2 Procedure

The eye-protector to be tested shall be placed on the appropriate head-form in the position corresponding to normal use.

If the frame only is to be assessed then oculars meeting the requirements of 3.1 (increased robustness) shall be fitted to the frame.

A sheet of carbon paper on top of a sheet of white paper is attached to the head-form behind the eye-protector. The head-form and eye-protector assembly is positioned in the test apparatus.

The ball is projected at the points of impact defined in 3.2.3.

For spectacles with no lateral protection the ball shall strike the sidearm within the prescribed lateral protection area on a vertical plane through the impact centre. (See 3.2.3).

The impacts are carried out in the following conditions:

a) with the eye-protector heated to (55 ± 2) °C and maintained at this temperature for at least 1 h;

b) with the eye-protector cooled to a temperature of (-5 ± 2) °C and maintained at this temperature for at least 1 h.

New eye-protectors shall be used for each individual point of impact and for each temperature condition. The impact shall be applied within 30 s of temperature conditioning.

The tests shall be conducted at an ambient temperature of (23 ± 5) °C.

3.2.3 Points of impact

There are four impact points, and these are defined with respect to the head-form rather than the eye-protector. The ball is aimed at these impact points with the eye-protector mounted in the normal use position.

The impact points shall be considered as any single point within a 10 mm radius of one of four impact centres. These impact centres are denoted by an asterisk (*) in Figure 11.

With respect to the test schedule contained in EN 166, the four impact points are defined as follows:

1. the left eye frontal;
2. the right eye frontal;
3. the left eye side;
4. the right eye side.

For frontal impacts at the two eye centres the ball is projected normal to the vertical axis of the head-form and parallel to its optical axis along each line of sight.

For lateral impacts the head-form is rotated about its vertical axis by 90° (left and right) from the frontal impact position.

The head-form may be moved horizontally and vertically to select any single impact point lying within 10 mm of the specified impact centres.

As stated in 3.2.2, new eye-protectors shall be used for each individual impact.

4 Test for minimum robustness of oculars with filtering effect and cover plates

New specimens are used for this test.

4.1 Apparatus

See Figure 2.

4.1.1 Loading device

A steel ball of 22 mm nominal diameter is fastened to the lower end of a tube, whose length is 70 mm nominal.

The total loading mass is such that the force acting on the ocular is (100 ± 2) N.

4.1.2 Specimen support

The support for the ocular (see Figure 2) shall be a steel cylinder with an internal diameter of (35,0 ± 0,1) mm and an outside diameter of (41,0 ± 0,1) mm. The cylinder shall be inserted into, or be part of, a steel base.

The specimen is placed between two seating rings made of silicone rubber of (40 ± 5) I.R.H.D. having an inside diameter of (35,0 ± 0,4) mm and cross sections of 3 mm x 3 mm nominal dimensions. The silicone seating rings are fixed to the steel supporting plate and the load ring respectively.

If the specimen ocular is of insufficient dimensions to enable its entire periphery to be adequately supported, suitable adaptor sleeves shall be used.

The load ring shall have a mass of (250 ± 5) g. By its weight, it presses the upper silicone seating ring against the upper surface of the specimen.

A sheet of carbon paper on top of a sheet of white paper is placed on the supporting steel plate at the base of the 1,5 mm deep cavity.

4.2 Procedure

4.2.1 The test is carried out at (23 ± 5) °C.

4.2.2 Align the central vertical axis of the loading tube with that of the specimen support.

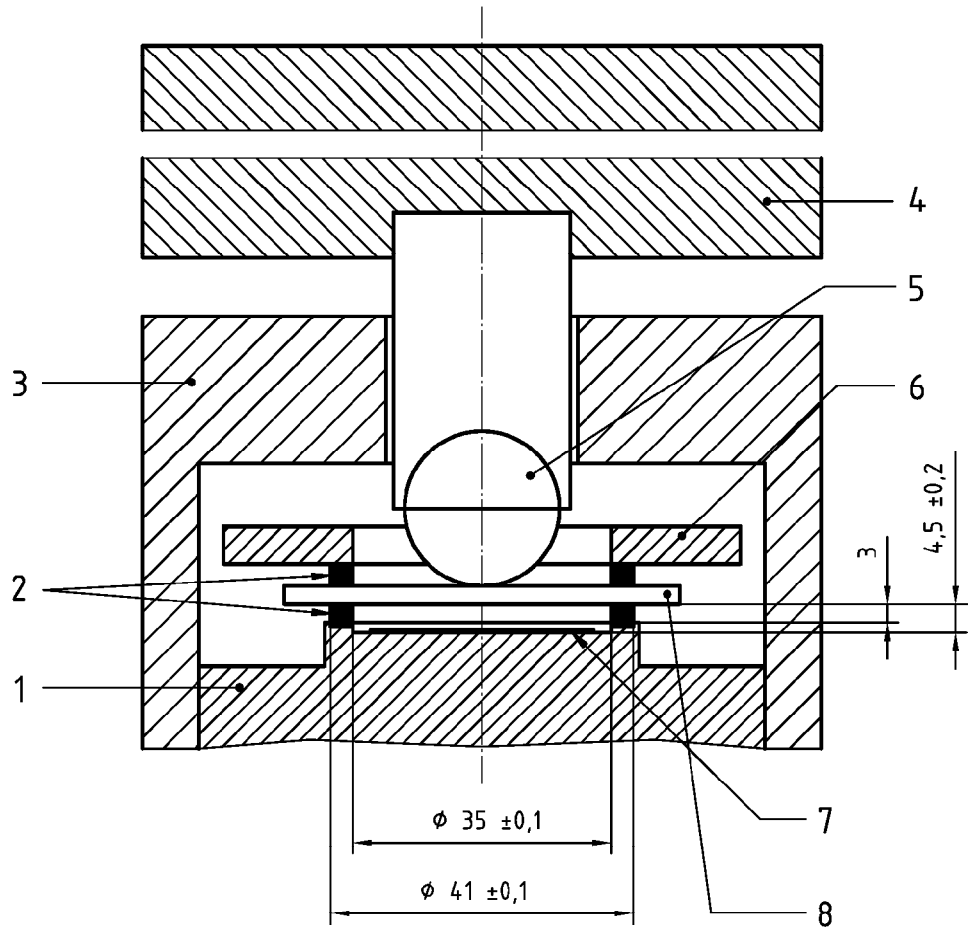
4.2.3 Position the specimen on the support with the "eye side" downwards and place the load ring on the specimen. For curved oculars with a cylindrical component the supporting plate and the load ring are curved to conform to the surface of the ocular, and the dimensions of 3 mm and 4,5 mm shall apply to the deepest point of the circular support.

4.2.4 Adjust the position of the specimen such that the load ring axis (4.2.2) passes through the visual centre of the specimen. If the visual centre cannot be established the geometric centre shall be used.

NOTE Visual centre is as defined in EN 166.

4.2.5 The loading mass is lowered on to the ocular at a speed not exceeding 400 mm/min. The force of (100 ± 2) N is maintained for (10 ± 2) s. The loading mass is then removed.

Dimensions in millimetres (nominal unless toleranced)



Key

1 Supporting plate
2 Silicone seating rings
3 Guiding block
4 Loading mass (100 ± 2) N
5 Steel ball
6 Load ring (250 ± 5) g
7 Carbon paper on white paper
8 Ocular

Figure 2 — Apparatus for minimum robustness (static deformation) test

5 Test for stability at elevated temperature

New specimens are used for this test.

5.1 Apparatus

Oven, capable of maintaining a temperature of (55 ± 2) °C.

5.2 Procedure

Place the specimen in a position corresponding to normal use, in the oven for (60 ± 5) min at a temperature of (55 ± 5) °C. Then remove it and allow to stabilise at (23 ± 5) °C for a minimum of 60 min prior to visual examination.

6 Test for resistance to ultraviolet radiation

6.1 Apparatus

Fused-silica envelope high-pressure xenon lamp. The power of the lamp shall be between 400 W and 500 W, with a preferred value of 450 W. The spectral transmittance of the lamp envelope shall be at least 30 % at 200 nm.

NOTE Suitable lamp references are XBO-450 W/4 and CSX-450 W/4. These lamps produce UV radiation with an appreciable amount of UVC radiation. This is appropriate, since industrial processes (for example, welding) produce appreciable amounts of UVC radiation.

WARNING Precautions should be taken against potential generation and build up of ozone.

6.2 Procedure

New specimens are used for this test. The test equipment is operated within an environment of temperature (23 ± 5) °C.

Expose the external face of the ocular to radiation from a fused silica envelope high-pressure xenon lamp (see 6.1).

The angle of incidence of the radiation on the specimen surface shall be essentially perpendicular. The distance from the axis of the lamp to the nearest point on the sample shall be (300 ± 10) mm. The exposure time shall be (50 ± 0,2) h at a lamp power of 450 W.

New lamps shall be burned in for (50 ± 0,2) h.

7 Test for resistance to ignition

7.1 Apparatus

7.1.1 Steel rod, (300 ± 3) mm long and 6 mm nominal diameter with end faces which are flat and perpendicular to its longitudinal axis.

7.1.2 Heat source.

7.1.3 Thermocouple and temperature indicating device.

7.1.4 Timer, capable of measuring an elapsed time of 10 s with an uncertainty of ± 0,1 s.

7.2 Procedure

Heat one end of the steel rod over a length of at least 50 mm to a temperature of (650 ± 20) °C. Measure the temperature of the rod by means of the thermocouple attached at a distance of (20 ± 1) mm from the heated end of the rod. Press the heated face of the rod (long axis vertically) against the surface of the test sample (the contact force being equal to the weight of the rod) for a period of (5,0 ± 0,5) s, and then remove it.

Carry out the test on all externally exposed parts of the eye-protector, except elastic headbands and textile edging.

Carry out a visual inspection during the test in order to establish whether the test samples ignite or continue to glow.

The tests are performed in an environment of temperature (23 ± 5) °C.

8 Test for resistance to corrosion

Remove all contamination, particularly oil and grease from the metal parts of the specimen.

Immerse the specimen for (15 ± 1) min in a boiling, aqueous, (10,0 ± 0,5) % by mass solution of sodium chloride.

Remove the specimen from this solution and immerse immediately in a (10,0 ± 0,5) % by mass aqueous solution of sodium chloride at room temperature for (15 ± 1) min.

Remove from this solution and without wiping off the adhering liquid, leave to dry for (24 ± 1) h at (23 ± 5) °C. Rinse in lukewarm water and leave to dry before inspecting.

9 Test for resistance to high-speed particles and resistance to high speed particles at extremes of temperature

New specimens shall be used for this test and each specimen shall only be subjected to one impact.

9.1 Apparatus

9.1.1 Head-form

Appropriate head-form, as defined in clause 17.

9.1.2 Propulsion equipment

The apparatus shall be capable of imparting known speeds of up to 195 m/s to a 6 mm nominal diameter steel ball of 0,86 g minimum mass.

NOTE 1 The apparatus consists fundamentally of a barrel or tube of sufficient length to ensure a reproducible exit speed of the steel ball, with a breech or loading mechanism ensuring that the ball is in a given position in relation to the tube or barrel end, and of a spring or compressed gas to provide propulsion.

The apparatus also includes a means of calibrating or measuring the exit speed of the ball; because of the speed and distances involved, a timing indicator, recording in multiples of not greater than 10 μs is required.

The measurement of speed should be made as near as possible to the point of impact. The end of the barrel or tube should be protected against ricochets.

The area surrounding the test specimen, the head-form and the barrel or tube should be enclosed.

NOTE 2 The tube length should be chosen to ensure that the required speed for the ball is achieved.

NOTE 3 For the time measurement, a method using an electronic timer operated by photoelectric cells through amplifiers has been found suitable.

The distance between the sensing elements should not exceed 150 mm.

9.2 Procedure

9.2.1 Resistance to high speed particles

Place the eye-protector to be tested on the head-form in the position corresponding to normal use and with the tension of the headband, if fitted, adjusted according to the manufacturer's instructions.

Insert a sheet of carbon paper on top of a sheet of white paper, between the eye-protector and the head-form. Position the eye-protector/head-form assembly in front of the propulsion equipment, the point of impact being not more than 250 mm from the exit end of the speed sensing equipment.

Project the steel ball at one of the speeds specified in EN 166. The points of impact are the same as those defined for the increased robustness test in 3.2.3. The ambient temperature shall be (23 ± 5) °C.

9.2.2 Resistance to high speed particles at extremes of temperature

The procedure is as 9.2.1 but with the impacts carried out under the following conditions:

a) with the ocular heated to (55 ± 2) °C and maintained at this temperature for at least 1 h;

b) with the ocular cooled to a temperature of (-5 ± 2) °C and maintained at this temperature for at least 1 h.

New oculars shall be used for each individual impact and for each temperature condition. The impact shall be applied within 30 s of temperature conditioning

10 Test for protection against molten metals

10.1 Test for non-adherence of molten metals

10.1.1 Principle

Molten metal is ejected onto an eye-protector specimen to test for non-adherence of molten metals.

10.1.2 Apparatus

10.1.2.1 Ejection system, fitted with an ejection head dished in the centre to accommodate a crucible of molten metal. The energy of ejection and the positioning of the fixed stop platform shall be such that the molten metal, consisting of a mass of (100 ± 5) g of grey iron (see 10.1.2.6), can be projected upwards from the ejection head to a height of (250 ± 25) mm above the position where the surface of the sample is to be tested.

An example of a suitable form of apparatus is shown in Figure 3.

10.1.2.2 Fixed stop platform, mounted above the ejector head and provided with a central opening large enough to allow the charge of molten metal to pass through (75 mm nominal diameter).

10.1.2.3 Metal seating ring, fixed to the stop platform and incorporating a central opening of 75 mm nominal diameter to allow the charge of metal to pass through. The seating ring supports the test specimen.

10.1.2.4 Metal cylindrical clamping ring, with 75 mm nominal diameter opening combined, if necessary, with an additional clamping weight to give a total nominal clamping mass of 7,5 kg.

NOTE If necessary, the surfaces of the seating ring and clamping ring are curved to conform to the specimen.

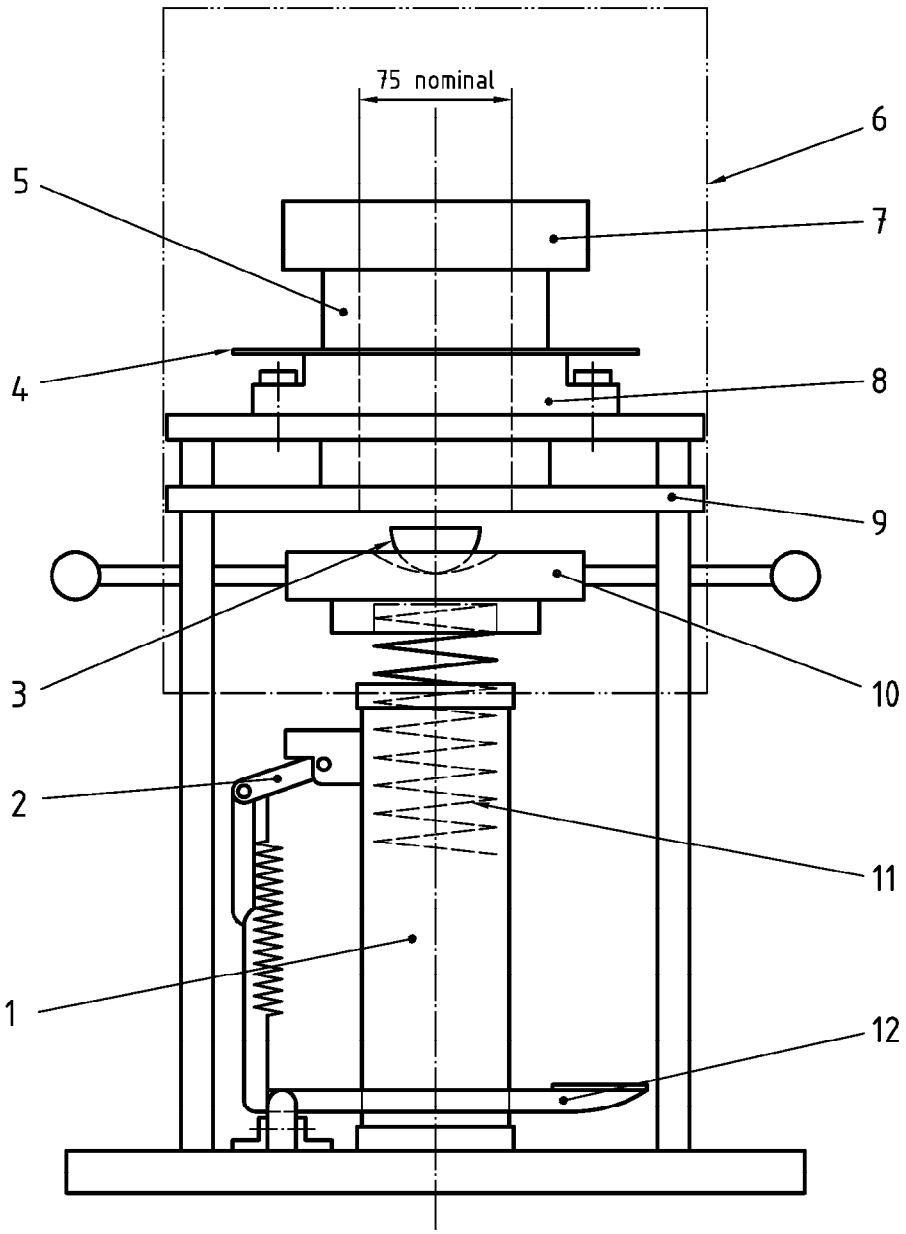
10.1.2.5 Ceramic crucible of approximately 60 ml capacity, 40 mm nominal depth, 2 mm nominal thickness and 58 mm nominal lip diameter.

NOTE When ejected, the crucible and its contents are projected onto the specimen.

10.1.2.6 Grey iron (100 ± 5) g.

10.1.2.7 Aluminium (38 ± 2) g.

10.1.2.8 Protective housing, enclosing the whole assembly to ensure safe operation.



Key

1	Ejector cylinder	7	Clamping weight (7,5 kg nominal)
2	Spring release trigger	8	Protector seating jig
3	Crucible	9	Stop platform
4	Protector	10	Ejector head
5	Clamping ring	11	Ejector spring
6	Protective housing	12	Release pedal

Figure 3 — Example of apparatus for assessment of non adherence of molten metal

10.1.3 Procedure

Mount the eye-protector or specimen above the opening so that the area being tested is immediately above the centre of the ejector head. Secure with the clamping ring weight, or rubber/elastic straps, etc.

Load the ejector head with a crucible containing (100 ± 5) g of grey iron at a temperature of (1 450 ± 20) °C.

Release the catch, so that the ejector head is driven vertically upwards until it strikes the stop platform and ejects the crucible of molten metal on to the eye-protector.

Remove the eye-protector and examine it to see if any molten metal has adhered to any part of it. Repeat the test

using a second eye-protector and using (38 ± 2) g of aluminium at (750 ± 20) °C.

The tests are conducted at an ambient temperature of (23 ± 5) °C.

Report if any molten metal has adhered to any part of the eye-protector.

10.2 Test for area of coverage of face shields

10.2.1 Principle

A face-shield is mounted on a head-form, and the extent of coverage is assessed by observing the assembly as the head-form is rotated about its horizontal and vertical axes.

NOTE The observation method describes the use of a laser beam; alternatively, observations may be made by viewing through a cylindrical tube fitted with cross-wires.

10.2.2 Apparatus

10.2.2.1 Appropriate head-form, as defined in clause 17. Inscribed on the head-form is a rectangle ABCD enclosing the eye-region, as indicated by the dotted lines shown in Figure 11.

10.2.2.2 Support frame, (see Figure 4) which enables the head-form to be rotated about a horizontal axis A and a vertical axis B. The head-form can be moved sideways along axis A.

NOTE Axis A passes through the centre of the pupils of the head-form. Axis B is the vertical axis through the nasion. Axis C is the axis of the laser.

10.2.2.3 Visible laser with maximum beam diameter 5 mm and which may move vertically up and down but cannot rotate about its horizontal or vertical axis.

10.2.3 Procedure

The apparatus is arranged as shown in Figure 4 such that the axis of rotation A and the axis C intersect on the surface of the head-form at the mid-point of a line joining the eye centres.

The face-shield is fitted to the head-form in accordance with the manufacturer's instructions.

The laser beam is projected at all relevant points within the eye-region rectangle with the head-form set in the following positions:

— facing forwards and rotated (45 ± 1)° forwards about horizontal axis A;

— facing forwards and rotated (45 ± 1)° backwards about horizontal axis A;

— Rotated (90 ± 1)° to the left about vertical axis B and rotated (45 ± 1)° forwards about horizontal axis A;

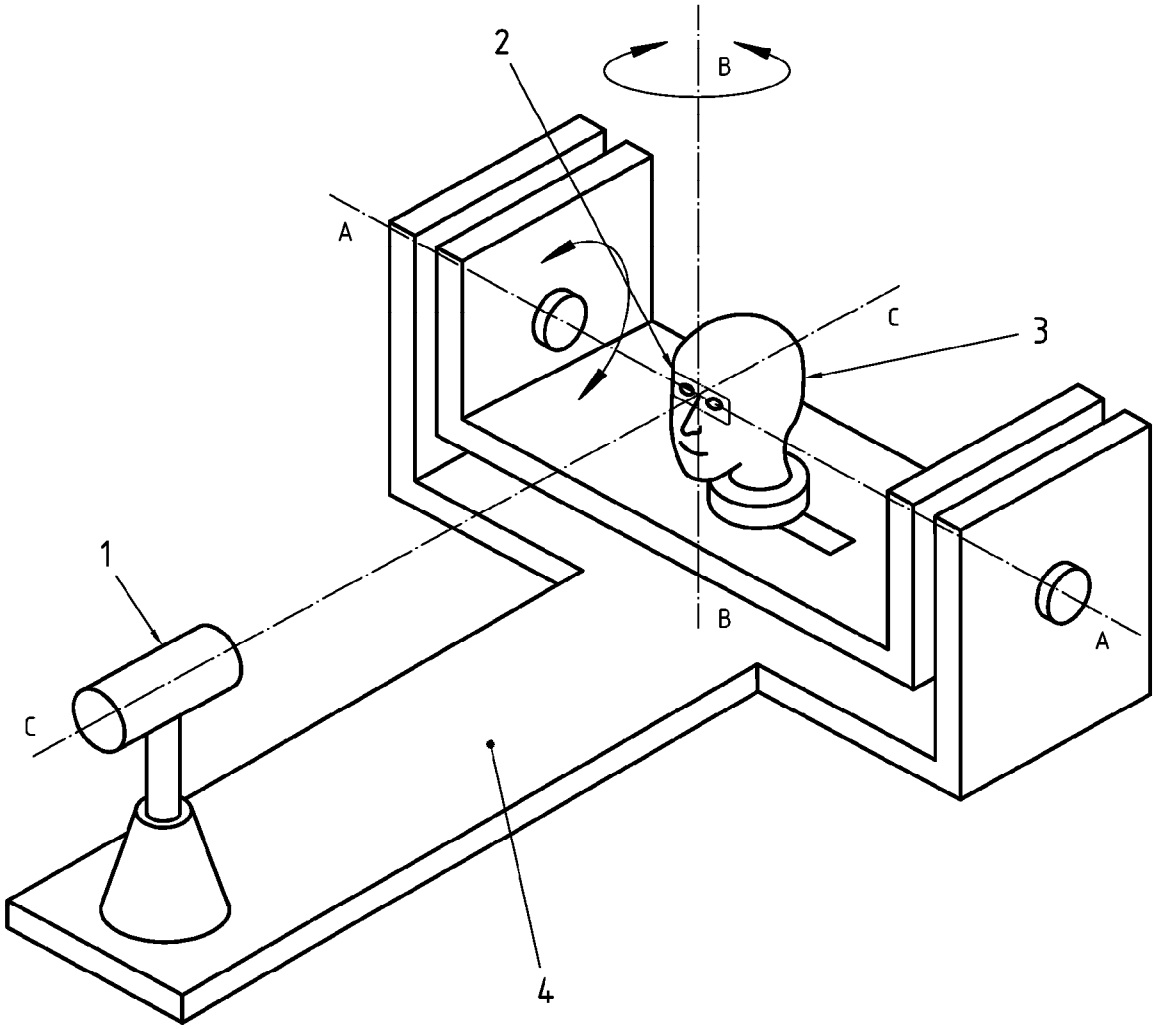
— Rotated (90 ± 1)° to the left about vertical axis B and rotated (45 ± 1)° backwards about horizontal axis A;

— Rotated (90 ± 1)° to the right about vertical axis B and rotated (45 ± 1)° forwards about horizontal axis A;

— Rotated (90 ± 1)° to the right about vertical axis B and rotated (45 ± 1)° backwards about horizontal axis A.

10.2.4 Evaluation

Report if during any of the observations the laser beam makes direct contact with any point on the eye-region rectangle without being intercepted by the face-shield, in which case the area of coverage is considered to be insufficient.



NOTE Face-shield deleted for clarity.

Key

1 Laser beam or cylindrical tube fitted with cross-wires
2 Rectangle enclosing the eye region (see Figure 11)
3 Head-form
4 Support frame

Figure 4 — Apparatus for assessment of area of coverage of face shields

11 Test for resistance to penetration by hot solids

11.1 Apparatus

NOTE An example of a suitable apparatus is shown in Figure 5. It consists of:

11.1.1 Metal cylinder to support the specimen.

11.1.2 Funnel of heat insulating material to centre a steel ball on the specimen.

11.1.3 Heat source, capable of maintaining the steel ball at a temperature of (900 ± 20) °C.

11.1.4 Steel ball of 6 mm nominal diameter.

11.1.5 Timer, capable of measuring an elapsed time of 10 s with an uncertainty of ± 0,1 s.

11.2 Procedure

The tests are conducted at an ambient temperature of (23 ± 5) °C.

Place the specimen to be tested on the cylinder and the funnel on top of the specimen. Heat the steel ball to (900 ± 20) °C. Withdraw the ball from the heat source and drop it as quickly as possible into the funnel.

Start the timer. If the ball drops, indicating complete penetration, record the time it has taken to penetrate.

Dimensions in millimetres (nominal unless toleranced)

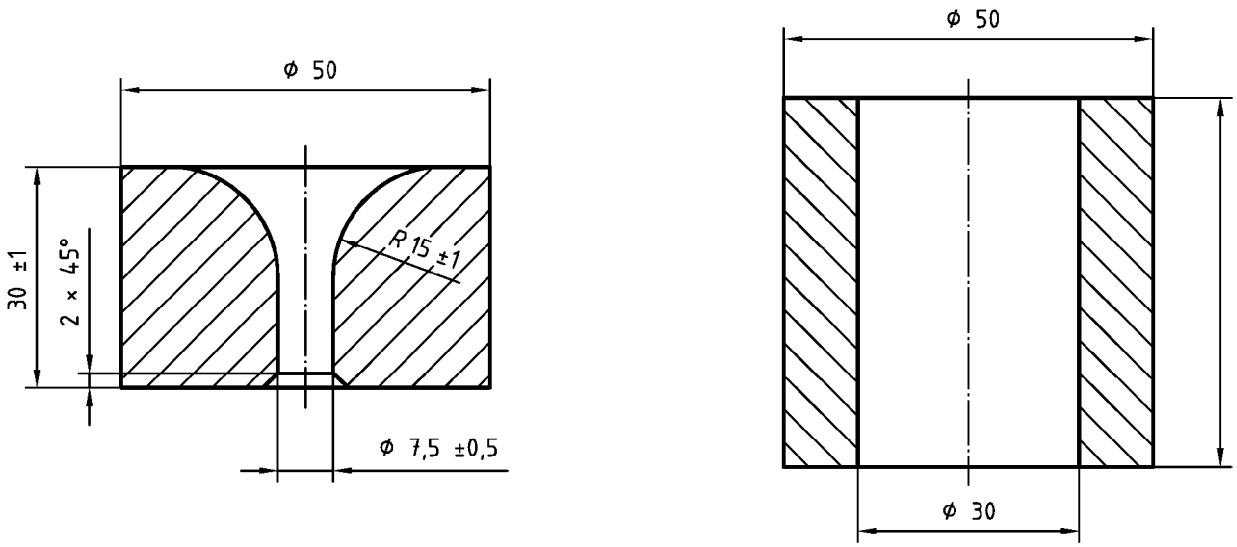


Figure 5 — Apparatus for testing resistance to penetration of hot solid

12 Test for protection against droplets and liquid splashes

12.1 Test for protection against droplets (for goggle type eye-protectors)

12.1.1 Apparatus

12.1.1.1 Appropriate head-form, as described in clause 17.

12.1.1.2 Hand operated atomiser, producing fine droplets (not mist).

12.1.1.3 White blotting paper of sufficient size to protrude at least 20 mm all around the periphery of the eye-protector under test. The blotting paper is marked with two circles of (52 ± 1) mm or (48 ± 1) mm diameter at a centre distance of (64 ± 1) mm or (54 ± 1) mm respectively, corresponding to the ocular areas of the appropriate size of head-form specified in clause 17.

12.1.1.4 Detecting solution, prepared by dissolving (5,0 ± 0,5) g phenolphthalein in (500 ± 50) ml ethanol and adding (500 ± 50) ml of water, stirring constantly (filter if a precipitate forms) to obtain (1,0 ± 0,1) l of solution.

12.1.1.5 Absorbent cotton lint (surgical dressing), mass per unit area approximately 185 g/m².

12.1.1.6 Spray solution, 0,1 mol/l solution of sodium carbonate in water.

12.1.2 Procedure

Cover the ocular region of the head-form with layers of cotton lint then blotting paper previously dipped in the detecting solution 12.1.1.4.

Fit the protector onto the head-form in the normal wearing position so that the blotting paper protrudes all around its periphery by at least 20 mm. Adjust the headband to a normal degree of tension. Adjust the number of layers of lint, as necessary, to ensure a good seal between the eye-protector and the head-form.

Spray the mounted protector with the spray solution (12.1.1.6) holding the atomiser at a distance of approximately 600 mm from the head-form, spraying from all directions. Spraying is carried out with a spray solution volume of 5 ml – 10 ml until the blotting paper around the periphery of the eye-protector turns a uniform crimson colour. The blotting paper shall not be over-wetted to cause it to drip.

The tests are conducted at an ambient temperature of (23 ± 5) °C.

12.1.3 Evaluation

Observe whether the blotting paper shows a crimson colouration within either of the two circles indicating that the spray solution has penetrated the eye-protector.

12.2 Test for protection against liquid splashes (for face-shields)

Carry out the procedure given in 10.2 to determine if the face-shield covers the defined ocular area.

13 Test for protection against large dust particles

13.1 Apparatus

13.1.1 Dust-chamber, (see Figure 6), glass fronted, with nominal internal dimensions 560 mm × 560 mm × 560 mm, with a hopper-shaped bottom and a tightly sealed, hinged lid. A blower is connected to the bottom of the inverted hopper capable of delivering approximately 2,8 m^3/min at a pressure of 2 250 Pa. A suitable agitator, capable of inducing swirling in the air stream from the blower should be arranged immediately above the air inlet. The dust-chamber outlet is connected to the blower inlet. The chamber is fitted with bars to support a head-form, the spacing of the bars allows for free circulation of the dust within the chamber.

13.1.2 Test dust, (1 000 ± 50) g of pulverized coal shall be placed inside the dust-chamber; the coal dust shall have the following particle size distribution:

Table 1 – Particle size distribution of test dust

Nominal mesh dimension of sieve (see ISO 565) mm	Minimum percentage pass %
0,300	95
0,150	85
0,090	40
0,040	3

13.1.3 Appropriate head-form, as described in clause 17. It shall be covered with layers of absorbent cotton lint (surgical dressing) the approximate mass per unit area of which is 185 g/m^2. This lint shall be covered by a sheet of moist white blotting paper on which have been marked in pencil two circles (52 ± 1) mm or (48 ± 1) mm in diameter, the horizontal distance between centres being (64 ± 1) mm or (54 ± 1) mm respectively corresponding to the ocular areas of the appropriate size of head-form specified in clause 17.

13.1.4 Photoelectric reflectometer, incorporating a light source radiating energy within the visible range and a detector only sensitive in the visible range, with peak sensitivity in the green part of the spectrum. An example of a suitable arrangement is shown in Figure 7.

13.1.5 White comparison sample

Any white material capable of retaining a constant reflectance for the duration of the test, e.g. pot-opal glass, ceramic tile, pressing of barium sulfate, magnesium carbonate block, several thicknesses of clean, dry white paper.

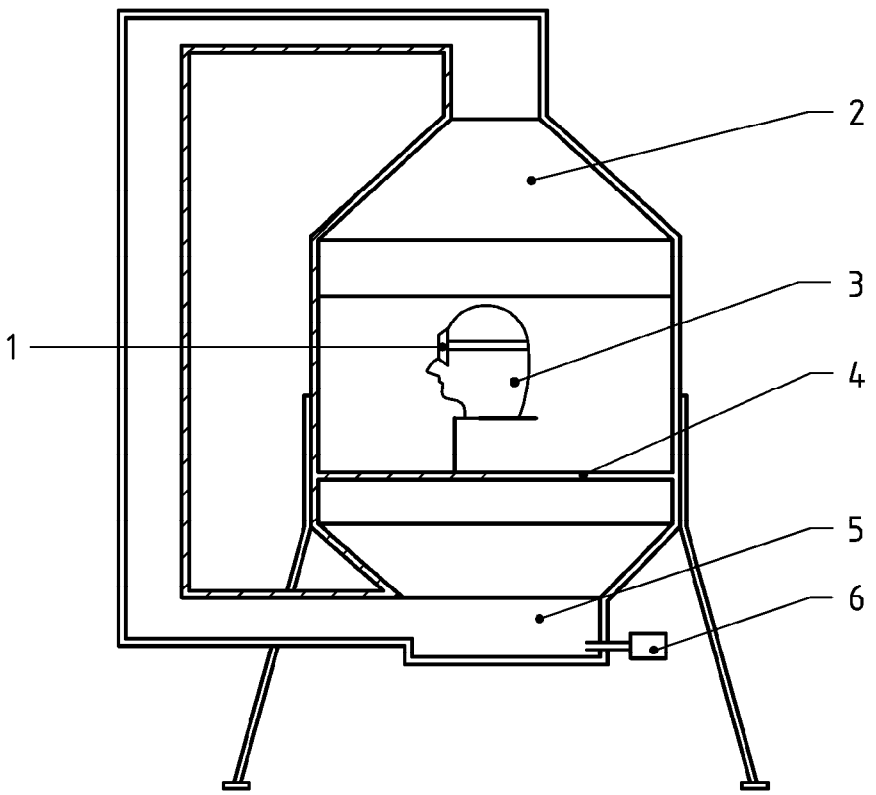
13.2 Procedure

The tests are conducted at an ambient temperature of (23 ± 5) °C. Soak the blotting paper and then shake off any excess water Using the photoelectric reflectometer (13.1.4), measure the reflectance of each of the two circles on the wetted blotting paper, relative to the white comparison sample (13.1.5) and calculate the mean. Mount the eye-protector on the head-form (13.1.3). Adjust the number of layers of cotton lint, as necessary, to ensure a good seal between the eye-protector and the head-form. Place this assembly in the dust chamber (13.1.1) and operate the blower for (60 ± 2) s. Allow the dust chamber to remain undisturbed for (30 ± 2) min, then open it and remove the blotting paper from the head-form, being careful not to allow more dust to be deposited on the areas of the circles.

Within 2 min, re-measure the reflectance of the two circles relative to the white comparison sample and again calculate the mean.

13.3 Evaluation

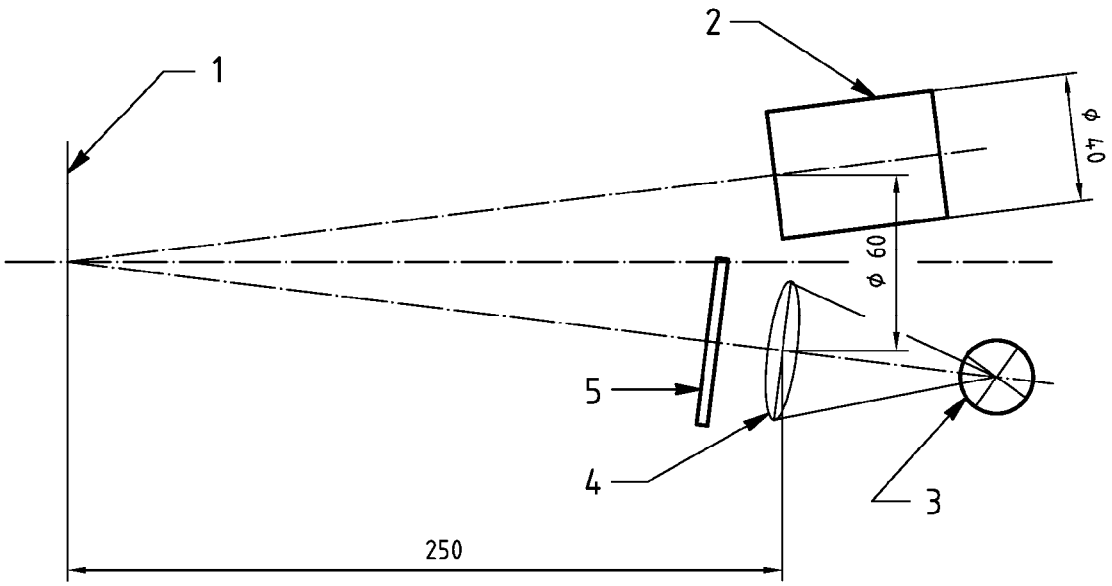
Calculate the ratio of the mean reflectance after exposure in the dust chamber to the mean reflectance before exposure and express this ratio as a percentage.



Key

1 Eye-protector
2 Dust chamber (560 mm x 560 mm x 560 mm nominal dimensions)
3 Head-forms
4 Bars
5 Dust collector
6 Blower

Figure 6 — Test apparatus for protection against large dust particles



Key

1 Test paper
2 Photoreceptor
3 Mercury vapour lamp
4 Lens
5 Interference filter (λ = 546 nm nominal)

Figure 7 — Example of photoelectric reflectometer

14 Test for protection against gases and fine dust particles

14.1 Apparatus

14.1.1 Appropriate head-form, as defined in clause 17.

14.1.2 Gas-chamber, a gas-tight glass-fronted enclosure, with nominal internal dimensions 560 mm × 560 mm × 560 mm and a tightly sealing, hinged lid. The gas-chamber shall be ventilated by means of a small blower with a typical capacity of 1,4 m^3/min and a vent pipe leading to a suitable removal/treatment system.

14.1.3 Supply of ammonia gas, for example by bubbling air through a washing bottle containing a concentrated solution of ammonia (ϭ = 0,9 g/ml approximately) or by using a cylinder of ammonia. The outlet from the generator or cylinder is connected to the gas-chamber.

14.1.4 Test paper, white blotting paper, of sufficient size to protrude at least 20 mm all around the periphery of the eye-protector under test.

14.1.5 Detecting solution, prepared by dissolving (5,0 ± 0,5) g of phenolphthalein in (500 ± 50) ml of ethanol and adding (500 ± 50) ml of water with constant stirring (filtering if a precipitate forms) to obtain (1,0 ± 0,1) l of solution.

14.1.6 Absorbent cotton lint (surgical dressing), approximately 185 g/m^2 mass/unit area.

14.2 Procedure

Mount the eye-protector on the head-form symmetrically over the test paper which has been previously dipped in the solution according to 14.1.5. The test paper rests on a number of layers of cotton lint. Adjust the number of layers of cotton lint, as necessary, to ensure a good seal between the eye-protector and the head-form. Place the assembly in the gas-chamber with a control strip of test paper placed on the floor of the chamber. Open the gas generator slightly, the vent being slightly open, and fill the gas-chamber with ammonia gas. The reaction is shown by the colouration of the control slip. Close the vent and leave the test specimen in the gas for (5,0 ± 0,2) min. At the end of this time evacuate the chamber by operating the ventilating blower. After the chamber has been cleared of the gas, remove the eye-protector and examine the test paper.

The tests are conducted at an ambient temperature of (23 ± 5) °C.

14.3 Evaluation

Observe if the test paper under the eye-protector has turned red.

15 Test for resistance to surface damage by fine particles

The results of this test shall only be used to classify oculars as resistant to surface damage by fine particles or not, and should not be used to rank order the performance of various ocular materials or surface treatments.

15.1 Apparatus

15.1.1 Falling sand apparatus

See Figures 8 and 9. The gravity tube is made from three separate rigid PVC tubes of the same diameter, with two polyamide sieves inserted between them. The sieves have a mesh size of 1,6 mm. The speed of rotation of the plate is (250 ± 10) min^{-1}.

NOTE It is recommended that the motor which drives the rotating sample holder is provided with a suitable casing to prevent the ingress of sand.

15.1.2 Sand

Natural quartz sand, grain size 0,5/0,7 mm, without oversize, obtained by sieving onto the wire sieve floor in accordance with ISO 565 `test sieves' R 20/3 with a mesh size of 0,5 mm and 0,71 mm. The sand may be used for up to 10 tests.

15.1.3 Measuring apparatus

Equipment capable of measuring the reduced luminance factor l^* as described in EN 167.

15.1.4 Reference samples

Two reference samples approximately 40 mm diameter or 40 mm square made from materials for which the increase in light diffusion caused by the surface damage test is known. Suitable materials for reference samples are B270 drawn Crown glass with natural fire-polished surfaces (as used for spectacle oculars) and cast PMMA.

The reference value of B270 = $(3{,}0 \pm 0{,}3)\frac{\mathrm{cd}}{\mathrm{m}^2 \cdot \mathrm{lx}} = l_1^*$

The reference value of PMMA = $(23 \pm 2)\frac{\mathrm{cd}}{\mathrm{m}^2 \cdot \mathrm{lx}} = l_2^*$

15.2 Samples

The shape of the samples is to be selected so that the measurement areas of the samples do not project beyond the revolving plate. Depending on the size of the samples, up to four samples of 40 mm diameter may be fixed on the revolving plate. Two of these samples should be reference samples.

The samples may be flat or convex and of different thicknesses.

The surfaces of the samples are cleaned with a solution of (1,0 ± 0,2) % detergent in water at a temperature of (27 ± 3) °C. Cleaning liquid residues are rinsed off firstly under running water and then with distilled or de-mineralized water. The samples are then carefully dried with a cloth that is free from dust and grease.

After cleaning, the samples shall only be held by the edges and shall be stored in such a way that their surfaces are not damaged or soiled.

15.3 Procedure

After cleaning, the samples are fixed onto the revolving plate in such a way that the area of measurement of the sample does not project beyond the revolving plate. Whilst the plate is being rotated, (3,00 ± 0,05) kg of sand is trickled onto the samples. The test is carried out at (23 ± 5) °C.

After the sand has been trickled onto them, the samples are removed from the rotary plate and then cleaned again as described in 15.2.

The diffusion of the samples is then measured as described in EN 167.

15.4 Evaluation

If one or more of the values measured for the reference samples is outside the tolerances given in 15.1.4, the values measured for the test samples shall be corrected using the following formula.

NOTE 1 This formula is not applicable for measured values which are greater than $25\,\frac{\text{cd}}{\text{m}^2 \cdot \text{lx}}$.

The light diffusion coefficient l^* of the sample is obtained using the following formula:

$$l^* = l^*_{\text{MV}} \left[\frac{(l^*_3 - l^*_{\text{MV}})\frac{l^*_2}{l^*_4} + (l^*_{\text{MV}} - l^*_4)\frac{l^*_1}{l^*_3}}{l^*_3 - l^*_4} \right]$$

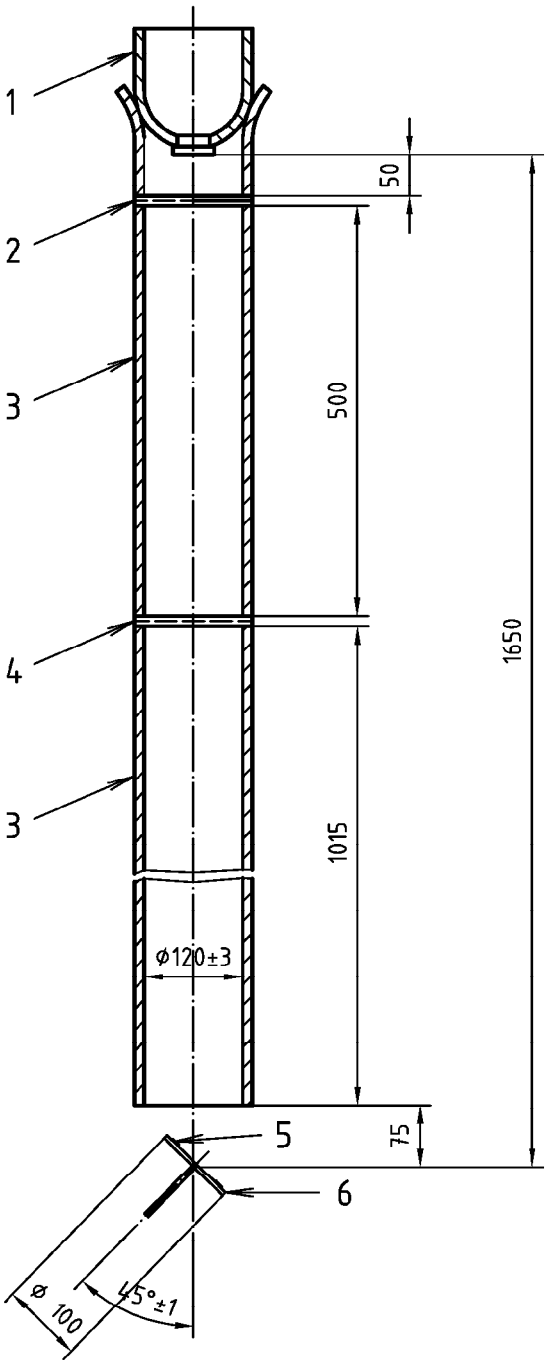
where

l^*_3 is the measured value of B270 sample;

l^*_4 is the measured value of PMMA sample;

l^*_{MV} is the measured value of sample under test.

Dimensions in millimetres (nominal unless toleranced)



Key

1 Container to hold at least 3 kg of sand with an outlet nozzle as Figure 9
2 Upper sieve
3 Gravity tube component
4 Lower sieve
5 Test samples
6 Sample holder (rotating plate connected to electric motor)

Figure 8 — Falling sand test apparatus

Dimensions in millimetres (nominal unless toleranced)

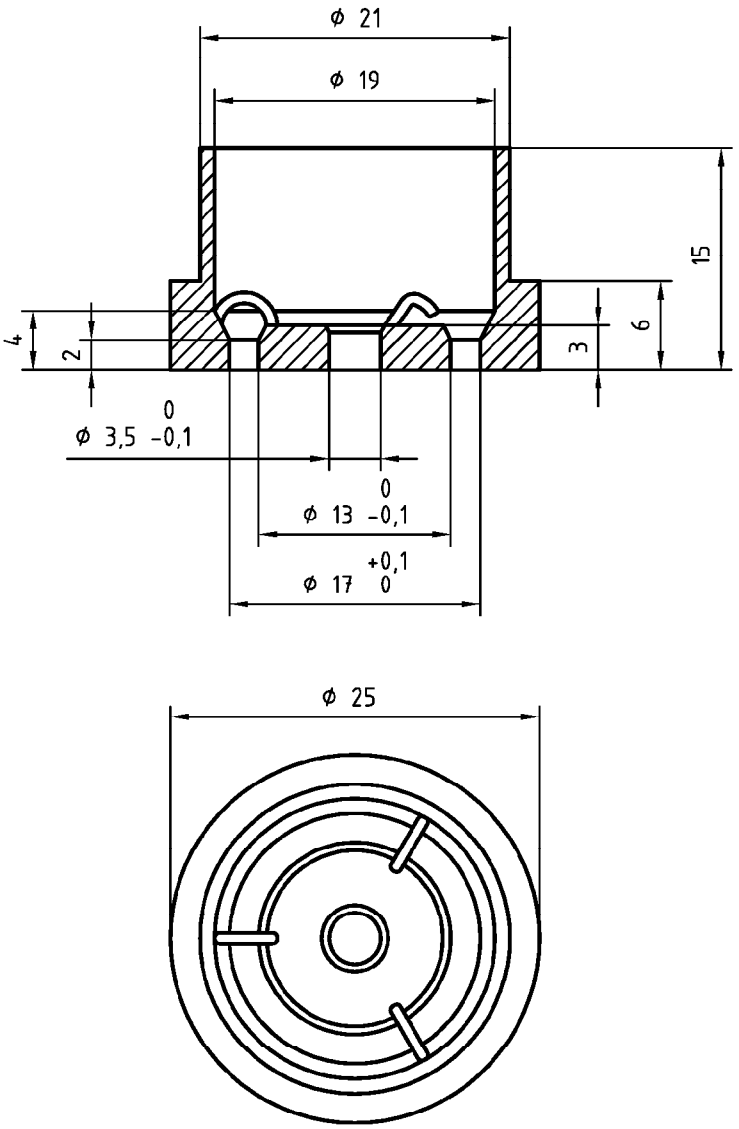


Figure 9 — Outlet nozzle for falling sand test apparatus (manufactured from brass with perforated plates held centrally by three connecting pieces)

NOTE 2 The simultaneous testing of two reference samples and adjustment to their known results is intended to eliminate the effect of different sand qualities.

16 Test for resistance to fogging of oculars

16.1 Apparatus

Apparatus, to determine the change in the non-diffused transmittance value, as shown in Figure 10.

The nominal diameter of the parallel beam is 10 mm. The size of the beam divider, reflector R and lens L_3 shall be selected in such a way that diffused light is captured up to an angle of 0,75°. If a lens L_3 with a nominal focal length f_3 = 400 mm is used, the nominal diameter of a diaphragm is 10 mm. The plane of the diaphragm must lie within the focal plane of the lens L_3.

The following focal lengths f_i of the lenses L_i are nominal examples and will not affect the test results:

f_1 = 10 mm and f_2 = 100 mm.

The light source shall be a laser with a wavelength of (600 ± 70) nm.

The volume of air above the water bath is at least 4 l. The seating ring has a nominal diameter of 35 mm and a nominal height of 24 mm from the underside of the lid of the water bath. If the samples are cylindrically curved, the curve on the top side of the seating ring is to be adjusted to fit the curve of the sample. The height of 24 mm is then measured to the highest point of the seating ring. A soft rubber ring, 3 mm thick and 3 mm wide (nominal dimensions), is inserted between the sample and the seating ring.

The water bath container also contains a ventilator to circulate the air. In addition, there must also be a device to stabilise the temperature of the water bath.

16.2 Samples

At least four samples of the same type are to be tested. Before the test, the samples are conditioned for between one and two hours in distilled water (at least 5 cm^3 water per cm^2 sample surface area) at (23 ± 5) °C, then dabbed dry and then conditioned in air for at least 12 h at (23 ± 5) °C and 50 % nominal relative humidity.

16.3 Procedure and evaluation

The ambient temperature during the measurement is (23 ± 5) °C.

The temperature of the water bath is set at (50 ± 0,5) °C. The air above the water bath is circulated using a ventilator, so that it becomes saturated with water vapour. During this time, the measurement opening is to be covered. The ventilator is switched off before measurement. The sample must be placed in the test position within 2 s of the opening being uncovered.

To measure the change in the value of the transmittance τ_r the sample is placed on the seating ring and the time determined until the square of τ_r has dropped to less than 80 % of the initial value of the sample without fogging (time without fogging).

$$\tau_r^{\,2} = \frac{\Phi_b}{\Phi_u}$$

where

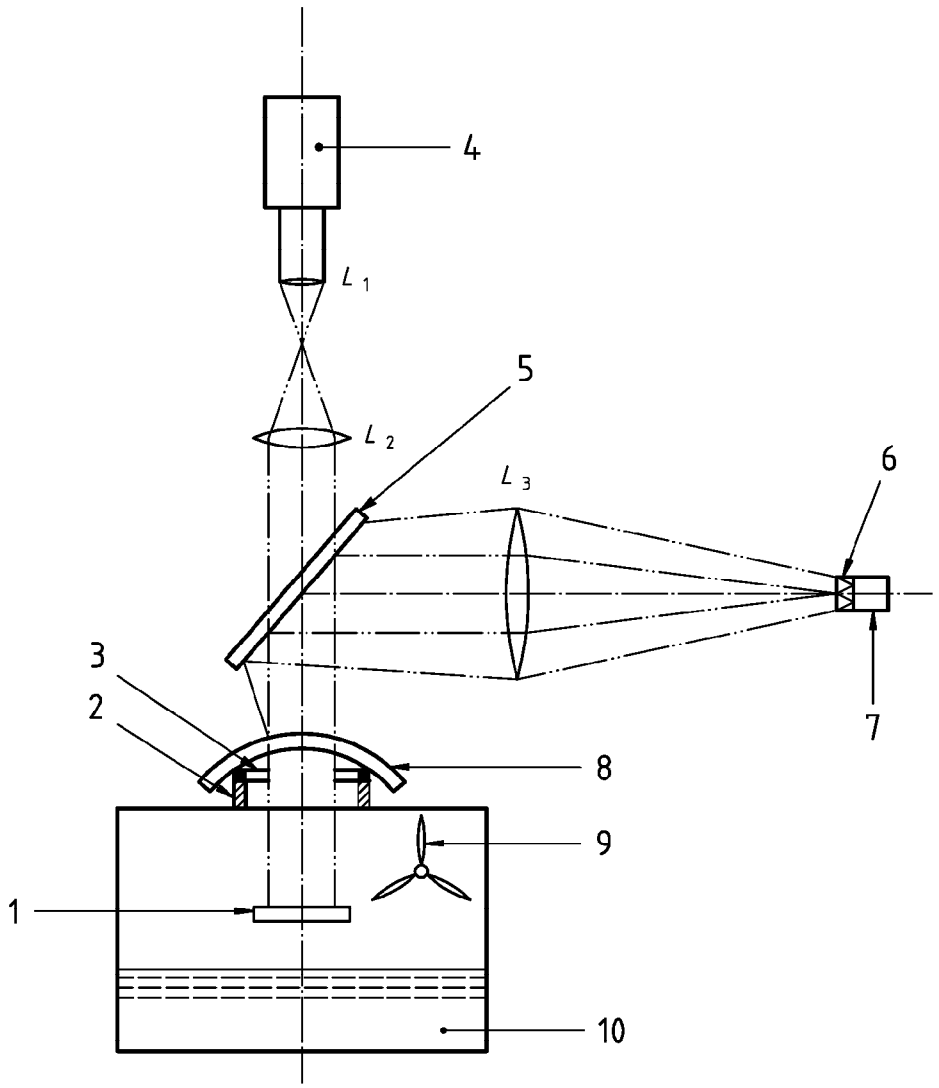
Φ_b is the luminous flux when there is fogging on the sample ;

Φ_u is the luminous flux before fogging.

Initial fogging of maximum 0,5 s duration shall not be taken into consideration in the evaluation.

NOTE 1 Since the light beam passes through the sample twice, this measurement defines τ_r^2.

NOTE 2 The period until the start of the fogging can usually be determined visually. However, with some types of coating the formation of surface water causes diffusion to increase more slowly so that visual evaluation is difficult. The detection apparatus described in 16.1 should then be used.



Key

1	Mirror	6	Diaphragm
2	Seating ring	7	Receptor
3	Soft rubber ring	8	Sample
4	Laser	9	Ventilator
5	Beam divider	10	Water bath

Figure 10 — Apparatus for determining the resistance for fogging of ocular

17 Head-form

There are two sizes of reference head-form for the non-optical tests described in the preceding clauses.

The medium head-form approximates a 50th percentile adult male. The small head-form approximates a 60th percentile, 12 year old child.

The nominal dimensions are shown in Figure 11; the constructional details are given below and in the notes to the figure.

Where reference is made in this standard to a head-form specified in this clause, the size of head-form (medium or small) to be used, shall be that which is appropriate to the eye protector being assessed.

Unless otherwise specified by the manufacturer of the eye protector, the medium size head-form shall be used.

The appropriateness of the head form specified for the eye protector shall be confirmed by the test house.

All tests on the eye protector shall be performed using only the one size of head-form selected

Each head-form is available constructed in three materials:

a) cast epoxy resin, inscribed with the areas to be protected;

b) all aluminium;

c) an internal core covered by a nominal 12 mm thick layer of polyurethane of hardness (50 ± 5) IRHD.

The cast epoxy resin head-form is best suited for use in the tests specified in 10.2.

The all aluminium head-form is best suited for use in the tests specified in 12.1, clause 13 and clause 14.

For the tests specified in 3.2 and 9 the polyurethane covered head-form only shall be used.

Other head-forms may be used if known or demonstrated to give equivalent results.

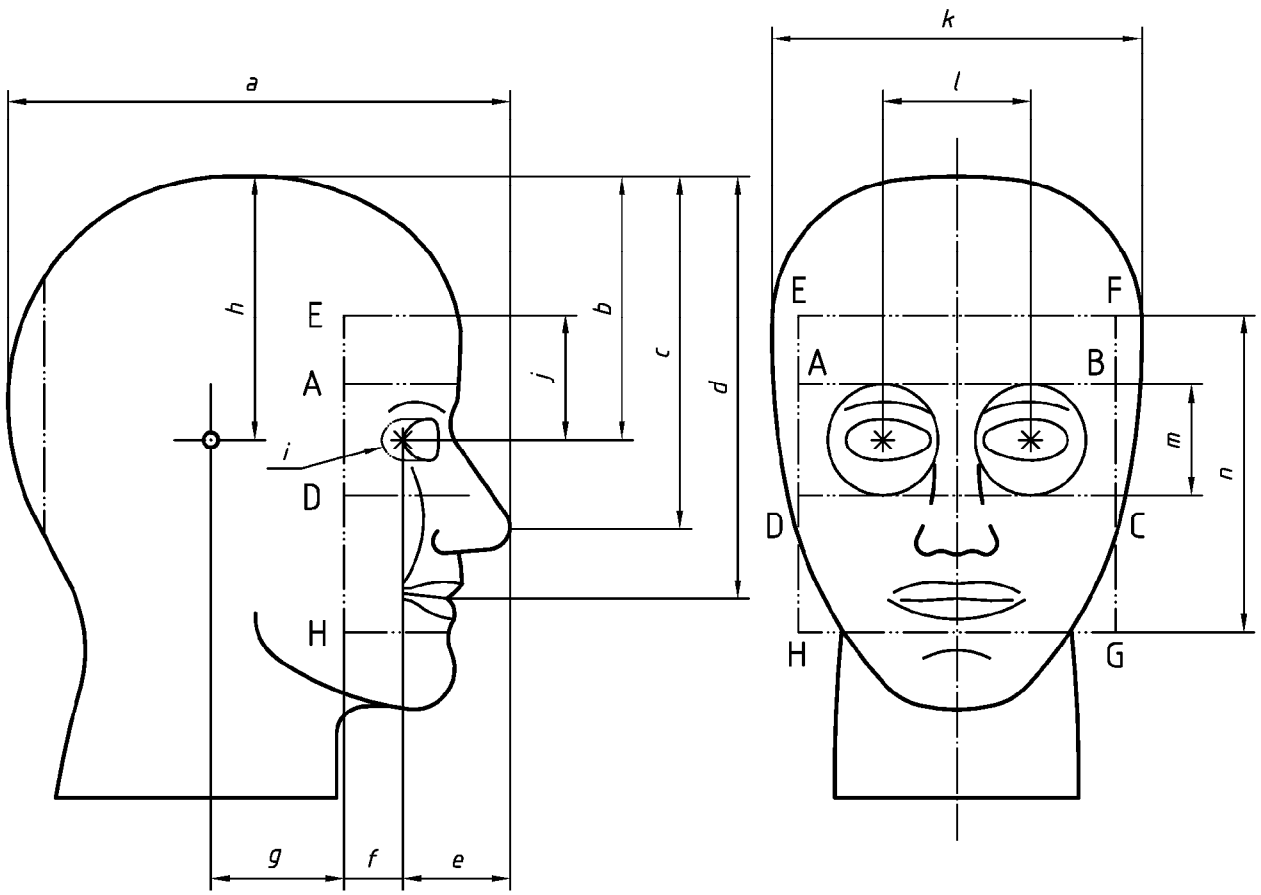


Figure 11 — Reference head-form

Dimension	Value mm	
	Medium size head	Small size head
a	218	206
b	111	110
c	144	131
d	178	166
e	45	42
f	18	18
g	60	53
h	111	110
Radius i	10	10
j	56	48
k	156	146
l	84	54
m	52	48
n	134	118

NOTE 1 All dimensions which are horizontal and are from the front of the headform to the rear of the headform are parallel to a line from the tragion to the sub-orbital.

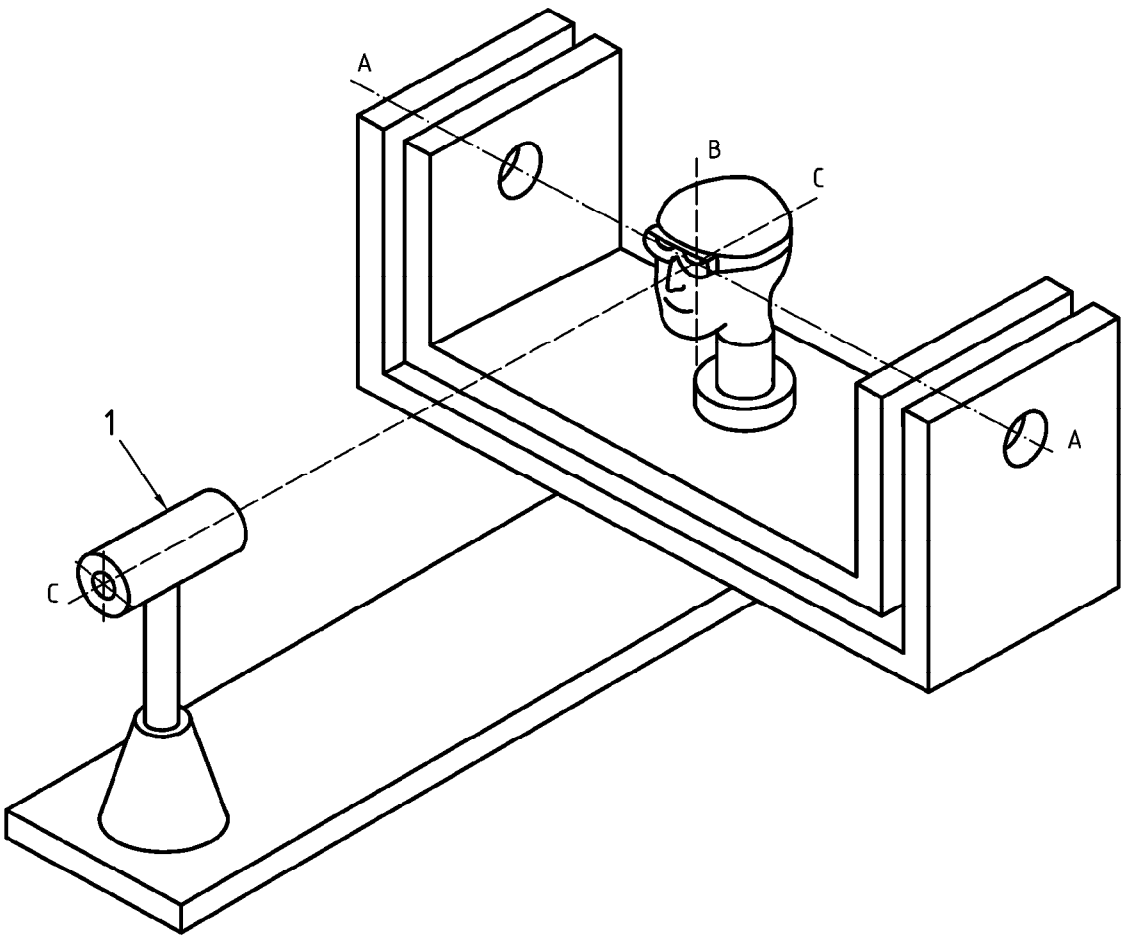
NOTE 2 The dotted lines show the ocular area to be protected against molten metal and liquid splashes by a face-shield.

NOTE 3 The points marked * are the impact centres specified for the increased robustness and high speed particle tests. There are two impact points corresponding to the single mark * on the side projection of the head; one impact point is on the right side of the head, the other impact point is on the left side of the head. Together with the two frontal impact points (indicated by the two marks * shown on the frontal projection of the head), this gives a total of four impact points.

18 Assessment of Field of Vision

The size of the field of vision shall be measured with a perimeter in conjunction with the appropriate head-form as defined in clause 17.

The eye-protector shall be mounted as shown in Figure 12 so that the two axes of rotation A and B and the optical axis C intersect in the front surface of one eye at the interpupillary distance. Radiation is provided by a laser beam with (1 ± 0,5) mm diameter of along axis C.



Key

1 Laser

Figure 12 — Test assembly for the measurement of field of vision

At (250 ± 5) mm distance from the surface of the eyes of the test head a transparent screen is placed centered to the middle of the eyes. On this screen the two ellipses shown in Figure 13 are drawn. The horizontal length of the ellipses shall be of 220 mm, the vertical width of the ellipses shall be of 200 mm. The centre distance of the two ellipses shall be $d' = c + (60 \pm 1)$ mm, where c is the pupillary distance. The pupillary distance is 64 mm, if not specified differently by the manufacturer. The horizontal axis shall be parallel to and 7 mm below the height of the line connecting the centres of the two eyes. The plane of the ellipses shall be parallel to the back flat portion of the head-form.

The arrangement is rotated around axis A and the axis B so that the circumference of the ellipse is hit by the laser beam. Such a beam shall not be shielded by the frame of the ski goggle. The test shall be done for both eyes.

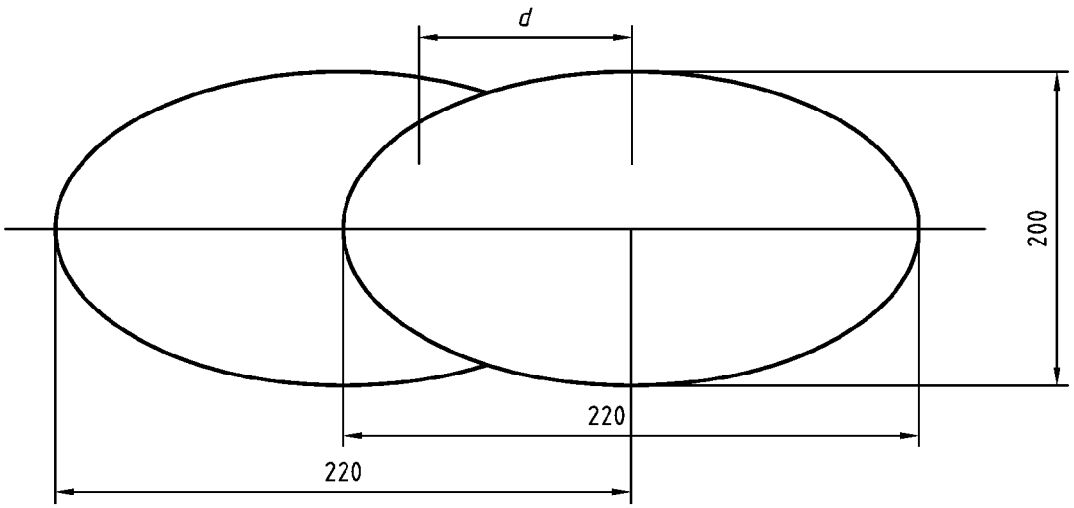


Figure 13 — Test ellipses for the measurement of the field of vision

19 Assessment of lateral protection

19.1 Apparatus

Appropriate head-form as described in clause 17.

Rod, 2 mm dia. (nominal), (125 ± 25) mm long.

19.2 Procedure

Place the eye-protector on the head-form in accordance with the manufacturer instructions, if any. Holding the rod horizontally, probe the front and side planes of the assembly attempting to touch the impact point regions on the head-form. These regions being a 20 mm wide area with 10 mm radial ends struck from the front and side impact points.

19.3 Evaluation

The lateral protection of the eye-protector shall be deemed to be satisfactory if the eye-protector prevents the tip of the rod from touching the impact regions on the head-form.

Annex A
(informative)

Uncertainty of measurement and results interpretation

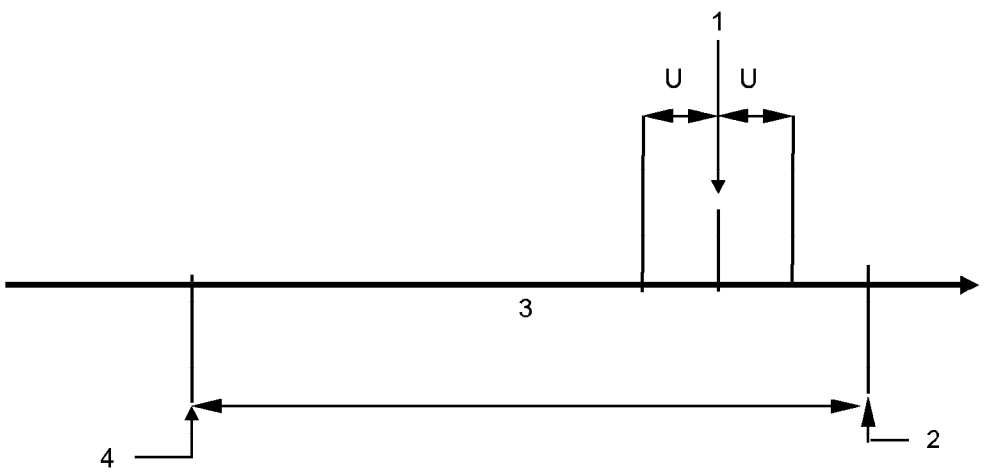
A.1 Test report and uncertainty of measurement

For each of the required measurements performed in accordance with this standard, a corresponding estimate of the uncertainty of measurement shall be evaluated.

This estimate of uncertainty shall be applied and stated when reporting test results, in order to enable the user of the test report to assess the reliability of the data.

The following protocol with regard to uncertainty of measurement shall be applied to test results:

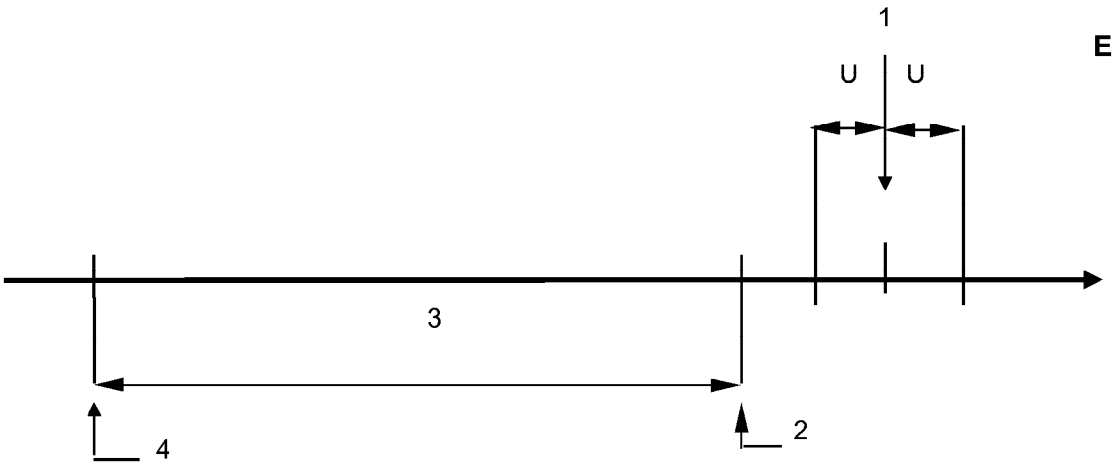
If the limit value for the particular test given in the standard, falls outside of the range of values calculated from the test data plus/minus the uncertainty U of measurement, then the result shall be deemed to be a straightforward pass or fail (Figures A.1 and A.2).



Key

1 Result of a measurement
2 Upper specification limit (USL)
3 Specification zone
4 Lower specification limit (LSL)

Figure A.1 — Result pass

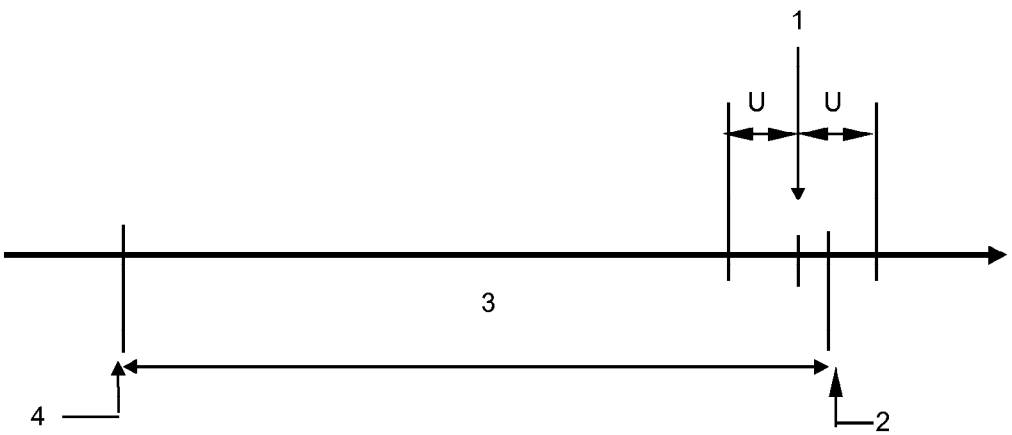


Key

1 Result of a measurement
2 Upper specification limit (USL)
3 Specification zone
4 Lower specification limit (LSL)

Figure A.2 — Result fail

If the limit value for the particular test given in the standard, falls within the range of values calculated from the test data plus/minus the uncertainty U of measurement, then the assessment of passor fail shall be determined on the basis of safety, that is considering the safest conditions for the user of the PPE (Figure A.3).



Key

1 Result of a measurement
2 Upper specification limit (USL)
3 Specification zone
4 Lower specification limit (LSL)

Figure A.3 — Result fail

Annex ZA
(informative)

Clauses of this European Standard addressing essential requirements or other provisions of EU Directives

This European Standard has been prepared under a mandate given to CEN] by the European Commission and the European Free Trade Association and supports essential requirements of EU Directive 89/686/EEC.

WARNING Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

The clauses of this standard specify test methods relating to EN 166 and other European Standards to support requirements of Directive 89/686/EEC, Annex II, clauses 1.1.2.1, 1.1.2.2, 1.2.1.3, 2.2, 2.3 and 3.9.1

Compliance with the clauses of this standard provides one means of conforming with the specific essential requirements of the Directive concerned and associated EFTA regulations.

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