International Standard 4849

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Personal eye-protectors — Specifications

Protecteurs individuels de l'œil — Spécifications

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4849 was developed by Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, and was circulated to the member bodies in July 1978.

It has been approved by the member bodies of the following countries :

Australia	Iran	Poland
Austria	Ireland	Romania
Belgium	Israel	South Africa, Rep. of
Czechoslovakia	Italy	Spain
France	Mexico	Switzerland
Germany, F. R.	Netherlands	
Hungary	New Zealand	

The member bodies of the following countries expressed disapproval of the document on technical grounds :

Denmark
United Kingdom
USA
USSR

Printed in Switzerland

Contents

Personal eye-protectors — Specifications

0 Introduction

This International Standard deals with general considerations relating to eye-protectors, such as :

— designation;

— classification;

— requirements applicable to all eye-protectors;

— some particular requirements;

— sampling;

— identification.

The transmittance requirements and methods of test for eye-protectors for particular uses are given in the International Standards listed in clause 3.

1 Scope

This International Standard specifies functional requirements for the various types of personal eye-protectors used mainly in industry.

2 Field of application

This International Standard applies to all types of personal eye-protectors used against various hazards, particularly those encountered in industry, which are likely to damage the eye or impair vision, with the exception of nuclear radiation, X-rays, laser beams and low-temperature infrared radiation.

This International Standard is not applicable to sunglasses for general use or to "fashion" spectacles which are used principally as a part of costume or of fancy dress.

Eye-protectors fitted with prescription lenses are not excluded from the field of application. The refractive power tolerances and other special characteristics dependant upon the prescription requirement will be the subject of a separate International Standard[1]. Until this International Standard is available, national standards may apply.

3 References

ISO 4007, *Personal eye-protectors — Vocabulary.*

ISO 4850, *Personal eye-protectors for welding and related techniques — Filters — Utilisation and transmittance requirements.*

ISO 4851, *Personal eye-protectors — Ultraviolet filters — Utilisation and transmittance requirements.*

ISO 4852, *Personal eye-protectors — Infrared filters — Utilisation and transmittance requirements.*

ISO 4853, *Personal eye-protectors — Daylight filters — Utilisation and transmittance requirements.*[2]

ISO 4854, *Personal eye-protectors — Optical test methods.*

ISO 4855, *Personal eye-protectors — Non-optical test methods.*

4 Numbering of filters

The transmittance characteristics of a filter are represented by a combination of two numbers separated by a dash :

— a code number;

— the shade number of the filter.

1) Standard to be prepared by TC 172, *Optics and optical instruments*.

2) At present at the stage of draft.

The symbol for welding filters does not include a code number.

Table 1 gives the numbering of the various types of filters specified in this International Standard.

Table 1 — Numbering of filters

Welding filters	Ultraviolet filters		Infrared filters	Filters for daylight	
Without code number	Code number 2	Code number 3	Code number 4	Code number 5	Code number 6
1.2	2 – 1.2	3 – 1.2	4 – 1.2	5 – 1.1	6 – 1.1
1.4	2 – 1.4	3 – 1.4	4 – 1.4	5 – 1.4	6 – 1.4
1.7		3 – 1.7	4 – 1.7	5 – 1.7	6 – 1.7
2		3 – 2	4 – 2	5 – 2	6 – 2
			4 – 2.a		
2.5		3 – 2.5	4 – 2.5	5 – 2.5	6 – 2.5
			4 – 2.5a		
3		3 – 3	4 – 3	5 – 3	6 – 3
4		3 – 4	4 – 4	5 – 4	6 – 4
5		3 – 5	4 – 5		
6			4 – 6		
7			4 – 7		
8			4 – 8		
9			4 – 9		
10			4 – 10		
11					
12					
13					
14					
15					
16					

5 Classification

5.1 Types of eye-protector

5.1.1 Spectacles, with or without side-shields (see ISO 4007, sub-clause 3.5).

5.1.2 Goggles (see ISO 4007, sub-clause 3.6).

5.1.3 Face-shield (see ISO 4007, sub-clause 3.4).

5.1.4 Hand shield (hand-held device which protects the eyes, face and neck).

5.1.5 Helmet (device worn on the head, protecting the eyes, face, neck and part of the top of the cranium).

5.2 Types of ocular

5.2.1 Mineral oculars

5.2.1.1 Untoughened mineral oculars.

5.2.1.2 Toughened mineral oculars (toughened chemically, thermally or by another process) : Mineral oculars which, as a result of the manufacturing process or subsequent treatment, possess mechanical resistance to impact superior to that of untoughened oculars and which, when broken, produce fragments which are less cutting than those of untoughened oculars.

5.2.2 Organic oculars (plastics)

5.2.3 Laminated oculars : Oculars made in multiple layers joined together by a binder.

NOTE — All these types of ocular may have coatings on their surface(s) to give additional characteristics.

5.3 Function of eye-protectors

The function of eye-protectors is to provide protection against :

— impacts of different severities;

— optical radiations (0,1 µm to 1 000 µm);

— molten metal splashes;

— liquid droplets and splashes;

— dust;

— gases;

or any combination of these.

6 Design and manufacture

6.1 General construction

Eye-protectors shall be soundly constructed of appropriate materials and shall not have metallic coating or metallic parts except screws and hinges. Eye-protectors shall be free from obvious defects and shall meet the relevant performance requirements.

6.2 Comfort for the wearer

Eye-protectors shall be free from projections, sharp edges or other features which could cause discomfort. Furthermore, the materials used shall be so selected as to avoid any skin irritation and, in the case of anti-dust goggles, the construction shall allow for the special risk of irritation.

6.3 Headband

Headbands, when used, shall be of good quality, durable and at least 10 mm in width.

6.4 Fittings

Adjustable parts or components incorporated in eye-protectors shall be easily adjusted and replaced.

6.5 Ventilation

Except where double-glazed or specially coated filters are used to reduce misting, appropriate ventilation shall be provided.

6.6 Thermal conductivity

Except for spectacle frames, all materials which are likely to be exposed to radiation during use and which come into contact with the operator shall have a thermal conductivity of less than 0,2 $W \cdot m^{-1} \cdot K^{-1}$.

6.7 Composition of oculars

Oculars shall be made of plastics or other suitable synthetic materials, of toughened or laminated glass or any combination of these materials. Untreated glass may be used only if it is backed with one of the foregoing materials, except in the case of oculars used solely against radiation, for example for welding and against sun-glare, or as cover oculars for the protection of filters.

7 Requirements

All eye-protectors shall meet the general requirements given in 7.1. Furthermore, according to their intended use, eye-protectors shall meet one or more of the particular requirements given in 7.2.

7.1 General requirements

7.1.1 Dimensions

Oculars shall have the following minimum dimensions :

Circular oculars : diameter 40 mm

Spectacles : 32 mm (horizontal length) × 25 mm (vertical depth)

One-piece lens goggles, face-shields : 105 mm × 50 mm.

Eye-protectors shall ensure a sufficiently wide field of vision for it to be possible to do the work for which they are provided, without either risk or discomfort.

7.1.2 Optical requirements

7.1.2.1 Refractive, astigmatic and prismatic powers

7.1.2.1.1 Unmounted oculars

The optical defects of unmounted oculars shall be measured by the method specified in sub-clause 3.1 of ISO 4854. These measurements may also be made by another method using, not the telescope, as in the reference method above, but a laser beam source. This optional method is described in annex A of ISO 4854. The measurements shall be taken :

a) for spherical effect and astigmatism :

— at a minimum of four points (one of which shall be the centre) in an area of 40 mm diameter around the geometrical centre of the ocular or at any point chosen by agreement between the manufacturer of the oculars and the manufacturer of the eye-protectors using these oculars. When the optical and geometrical centres are not identical, the examination shall be the subject of agreement between client and supplier.

b) for prismatic effect :

— at the geometrical centre of the ocular.

The permissible tolerances are given in table 2.

Table 2 — Permissible tolerances for unmounted oculars

Grade	Spherical effect m^{-1}	Astigmatism m^{-1}	Prismatic effect m^{-1}
1	± 0,06	0,06	0,12
2	± 0,12	0,12	0,25

7.1.2.1.2 Mounted oculars

The optical defects of mounted oculars, spectacles or face-shields shall be measured in accordance with the method specified in sub-clause 3.2 of ISO 4854, eye-protectors being positioned on the standard support.

Two other optional test methods are described in annexes B and C of ISO 4854.

The permissible tolerances are given in table 3.

Table 3 — Permissible tolerances for mounted oculars

Grade	Spherical effect (power in meridian of maximum error) m^{-1}	Astigmatism m^{-1}	Prismatic effect		
			Horizontal		Vertical
			base out cm/m	base in cm/m	cm/m
1	± 0,06	0,06	1,00	0,25	0,25
2	± 0,12	0,12			
3	+ 0,12 − 0,25	0,25*			

* Axes shall be parallel.

The specifications for prismatic effect correspond to the difference between the values at the specified measuring points of the eye-protector.

7.1.2.2 Diffusion of light

If an ocular diffuses light appreciably, the contrast may be reduced and the visual performances adversely affected. Consequently, diffusion characteristics should be specified, but in the present state of knowledge, it is not possible to specify limiting values.

The scattered light shall be measured in accordance with the reference method involving small solid angles specified in sub-clause 4.2 of ISO 4854. Alternative methods for filters having a transmittance value (τ_v) in excess of 10 % may be used, for example a hazemeter or visual inspection, provided that correlation has been established for the material under test.

The limiting value of light diffusion which would be convenient appears to be 1,0 $cd \cdot m^{-2} \cdot lx^{-1}$ for welding filters and 0,5 $cd \cdot m^{-2} \cdot lx^{-1}$ for all other filters.

7.1.2.3 Colour recognition

As far as possible, filters shall permit recognition of colours sufficient to the task and the observation of safety signs. Colour tint limits shall be established on the basis of experimental information obtained on filters under actual use conditions and the chromatic adaptation of the human eye.

7.1.3 Quality of material and surface

Except for a marginal area 5 mm wide, filters for eye-protectors shall be free from any significant defects likely to impair vision in use, such as bubbles, scratches, inclusions, dull spots, holes, mould marks, scoring or other defects originating from the manufacturing process. The test shall be carried out in accordance with the method specified in clause 5 of ISO 4854 or by any other appropriate method of examination.

7.1.4 Robustness of construction

This specification concerns mechanical hazards. The tests specified in 7.1.4.1 and 7.1.4.2 are not applicable to protectors against optical radiation, unless the filters are worn in areas of mechanical hazards. However, protectors against optical radiation shall also ensure a minimum resistance to mechanical risks. As such protectors are made according to different requirements and techniques in different countries, further studies are being conducted to develop a common specification and corresponding test method.

7.1.4.1 Unmounted oculars (oculars for protection against high-mass, low-velocity flying objects)

The oculars shall be designed to withstand the impact of a 22 mm diameter steel ball, of mass 44 g, dropped from a height of $1{,}3\ ^{0}_{-0{,}03}$ m.

The test shall be carried out in accordance with the method specified in sub-clause 3.1 of ISO 4855.

On so testing, there shall not be ocular fracture : an ocular shall be considered to have fractured if it cracks through its entire thickness into two or more pieces, or if more than 5 mg of the ocular material becomes detached from the surface remote from that struck by the ball, or if the ball passes through the ocular.

7.1.4.2 Mounted oculars

Mounted oculars shall meet the requirements of the robustness test which consists in withstanding the impact of a 22 mm diameter steel ball, of mass 44 g, dropped from a height of $1{,}3\ ^{0}_{-0{,}03}$ m. The test shall be carried out in accordance with the reference method specified in sub-clause 3.2 of ISO 4855.

On so testing, the following defects shall not occur :

a) Ocular fracture : an ocular shall be considered to have fractured if it cracks through its entire thickness into two or more pieces, or if more than 5 mg of the ocular material becomes detached from the surface remote from that struck by the ball, or if the ball passes through the ocular.

b) Ocular deformation : an ocular shall be considered to have deformed if a mark appears on the white paper on the opposite side to that stuck by the ball.

c) Ocular housing or frame failure : an ocular housing or frame shall be considered to have failed if it separates into several parts, if it is no longer capable of holding an ocular in position, or if an unbroken ocular separates from the frame.

7.1.5 Stability at elevated temperature

The assembled eye-protectors shall be stable at elevated temperature (55 ± 2 °C), and, when tested by the method specified in clause 4 of ISO 4855, shall show no apparent deformation. At the end of the test, the optical qualities shall not have deteriorated beyond the limits laid down in 7.1.2.1.2.

7.1.6 Stability in presence of ultraviolet radiation

Eye-protectors shall be subjected to the test for resistance with the method specified in clause 5 of ISO 4855.

At the end of the test, the eye-protectors shall meet the following mechanical and optical requirements :

— the robustness of oculars shall not have fallen below that specified in 7.1.4;

— the ultraviolet, infrared and visible transmittances shall remain within the limits of the shade to which the ocular belongs before the test (see corresponding specifications in 7.2.1.1);

— the amount of diffused light should not exceed the permissible limit in 7.1.2.2 by more than 25 %.

7.1.7 Resistance to corrosion

After having undergone the test for resistance to corrosion specified in clause 7 of ISO 4855, all metal parts of an eye-protector shall display smooth surfaces free from oxidation when they are examined by the naked eye (or, if necessary, with spectacles) by a trained observer.

7.1.8 Suitability for disinfection

All parts of eye-protectors shall be capable of withstanding disinfection without visible damage, and cleaning, either by the method specified in clause 8 of ISO 4855, or in accordance with the manufacturer's recommended method if this has been shown to be equally effective.

7.2 Particular requirements

7.2.1 Oculars

7.2.1.1 Transmittance

Transmittance variations measured by scanning with a light beam of 5 mm diameter over the entire area of an ocular, except in a marginal area 5 mm wide, shall remain within the limits defined in table 4.

Table 4 — Transmittance variations

Transmittance value, %		Permissible variation %
from	to	
100	17,9	5
17,9	8,5	10
8,5	0,44	10
0,44	0,023	15
0,023	0,001 2	20
0,001 2	0,000 023	30

In the case of curved oculars, the limits apply only to the optical viewing area.

7.2.1.1.1 Oculars without filtering action

If oculars are used solely to protect the eyes against mechanical or chemical hazards, their luminous transmittance shall be within the limits of shade number 1.2 ($\tau_{V_{max}}$ = 100 %; $\tau_{V_{min}}$ = 74,4 %).

7.2.1.1.2 Welding filters

See ISO 4850.

7.2.1.1.3 Ultraviolet filters

See ISO 4851.

7.2.1.1.4 Infrared filters

See ISO 4852.

7.2.1.1.5 Daylight filters

See ISO 4853.

7.2.2 Complete eye-protectors

7.2.2.1 Ignition

7.2.2.1.1 Industrial protectors

Eye-protectors shall be tested in accordance with the method specified in sub-clause 6.1 of ISO 4855.

The test pieces may be considered as satisfactory if they do not ignite or continue to glow after removal of the welding rod.

7.2.2.1.2 Eye-protectors used by professionals solely for the attenuation of daylight

Oculars and frames shall not be made of flammable materials such as cellulose nitrate. Oculars and frames made of cellulose acetate and cellulose acetate butyrate are considered acceptable.

The test method is specified in sub-clause 6.2 of ISO 4855.

The eye-protector may be regarded as satisfactory if it does not ignite during the test period. If the material composition in the eye-protector is changed, the eye-protector shall be retested.

7.2.2.2 Protection against high-speed particles

Eye-protectors (goggles and face-shields) intended to provide protection against impacts from objects or high-speed flying particles shall be designed and constructed to withstand the impact of a 6 mm diameter steel ball striking the ocular at a known selected speed up to 190 m/s $^{+3}_{0}$ %.

The test method is specified in clause 9 of ISO 4855.

For speeds greater than 100 m/s, face-shields are recommended.

Ballistic testing of eye-protectors with other projectile sizes and speeds is permitted, provided that the dimension of the steel ball and its speed are comparable to those found in the work place.

When so tested, the eye-protector shall not display the following defects :

a) Ocular fracture : an ocular shall be considered to have fractured if it cracks through its entire thickness and on its entire diameter, if two or more pieces visible to the naked eye become detached from the surface remote from that struck by the ball, or if the ball passes through the ocular.

b) Ocular deformation : an ocular shall be considered as deformed if a mark appears on the white paper on the opposite side to that struck by the ball.