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Eye and face protection — Sunglasses and related eyewear —

Part 2: Filters for direct observation of the sun

Protection des yeux et du visage — Lunettes de soleil et articles de lunetterie associés —

Partie 2: Filtres pour l'observation directe du soleil

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 6, *Eye and face protection*.

ISO 12312 consists of the following parts, under the general title *Eye and face protection — Sunglasses and related eyewear*:

— *Part 1: Sunglasses for general use*

— *Part 2: Filters for direct observation of the sun*

Eye and face protection — Sunglasses and related eyewear —

Part 2: Filters for direct observation of the sun

1 Scope

This part of ISO 12312 applies to all afocal (plano power) products intended for direct observation of the sun, such as solar eclipse viewing.

Information on the use of filters for direct observation of the sun is given in Annex A and Annex B.

This part of ISO 12312 does not apply to the following:

a) afocal (plano power) sunglasses and clip-ons for general use intended for protection against solar radiation;

b) eyewear for protection against radiation from artificial light sources, such as those used in solaria;

c) eye protectors specifically intended for sports (e.g. ski goggles or other types);

d) sunglasses that have been medically prescribed for attenuating solar radiation;

e) prescription sunglass lenses.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 12311:2013, *Personal protective equipment — Test methods for sunglasses and related eyewear*

ISO 4007, *Personal protective equipment — Eye and face protection — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and the definitions given in ISO 4007 apply.

4 Requirements and associated test methods

4.1 Transmittance

4.1.1 General

The transmittance requirements of filters for the direct observation of the sun are given in Table 1. Transmittance values shall be measured or calculated at the boxed centre of the filter for normal incidence, as described in ISO 12311:2013, 7.1.1, 7.1.2, 7.3.2, 7.3.3, and 7.5.

Table 1 — Transmittance requirements for filters for the direct observation of the sun

Maximum luminous transmittance (τ_V)	0,003 2 %
Minimum luminous transmittance (τ_V)	0,000 061 %
Maximum solar UVB transmittance (τ_{SUVB})	τ_V
Maximum solar UVA transmittance (τ_{SUVA})	τ_V
Maximum solar infrared transmittance (τ_{SIR})	3 %

Uncertainty of measurements of transmittance shall not be greater than 25 % of the measured value.

The measurement of spectral transmittance of filters with high optical density can be best accomplished with the use of a dual-beam spectrophotometer and comparison beam attenuators. The comparison beam attenuator should be a physical barrier, such as a perforated mesh, equivalent to a known uniform level of absorption across the entire waveband of measurement.

4.1.2 Uniformity of luminous transmittance

The relative difference in the luminous transmittance value between any two points of the filter shall not be greater than 10 % (relative to the higher value). This requirement shall apply within a circle 40 mm in diameter around the boxed centre or to the edge of the filter less the marginal zone 5 mm wide, whichever is greater.

4.2 Material and surface quality

4.2.1 Requirements

Except in a marginal area 5 mm wide, filters shall be free from defects likely to impair vision in use, such as bubbles, scratches, inclusions, dull spots, pitting, scouring, pocking, scaling, and undulations. Metal coated filter materials shall not exhibit more than one pinhole defect not greater than 200 µm in average diameter within any 5 mm diameter circular zone.

4.2.2 Test method

A filter shall be illuminated from one side by an intense white light source (e.g. projector beam or light table) and the opposite side viewed through a low power magnifying lens. Metal coated filters showing visible pinhole defects shall be examined in a light microscope at 25× to 40× magnification.

NOTE A magnifying lens of 4× to 10× magnification can be used.

4.3 Mounting

4.3.1 General

Filters may be made with or without a mounting. If mounted, a filter shall be held securely so that it cannot be dislodged by normal handling or by gusts of wind. Mountings may be handheld or shaped in the form of spectacles to be worn on the face in front of any corrective (spectacle or contact) lenses worn by the user.

4.3.2 Dimensions

The filter or filters and mounting assembly shall be of a size sufficient to cover both eyes of the user simultaneously and in no case shall have overall dimensions less than 115 mm in width and 35 mm in depth in the plane parallel to the facial plane. Spectacle shaped mountings may have a triangular cut-away area to accommodate the crest of the nose, not to exceed 15 mm in apical height and 35 mm width at the base and may have separate filters, one for each eye, provided that the overall dimensions are satisfied.

4.3.3 Material quality

The filter and mounting shall be free from roughness, sharp edges, projections, or other defects which could cause discomfort or injury during use. No part of the filter or mounting which is in contact with the wearer shall be made of materials which are known to cause any skin irritation.

5 Labelling

The filter and/or its packaging shall show the following information in the language(s) of the country where the product is to be offered for sale:

a) name and address of manufacturer of the product;

b) instructions for use in looking at the sun or a solar eclipse;

c) warnings that viewing the sun without an appropriate filter can result in permanent eye injury;

EXAMPLE "Direct viewing of the sun is dangerous if the proper precautions are not taken. Adequate eye protection specifically designed for viewing the sun is essential and shall be worn so that no direct radiation from the sun can reach the eye other than that passing through the filter."

d) warnings that filters that are damaged or separated from their mountings should be discarded;

e) advice on storage, cleaning, and maintenance, as appropriate;

f) obsolescence deadline or period of obsolescence, as appropriate.

Annex A
(informative)

Use of filters for direct observation of the sun

For the direct observation of the sun, only specially designed protective filters should be used. Welding filters are designed to protect the eyes against ultraviolet, visible, and infrared light whereas the filters for direct observation of the sun need only to provide protection against visible light. Welding filters as specified in ISO 16321 with scale numbers 12 to 15 are equally suitable for use with the unaided eye, however, they should not be used in conjunction with telescopes (in front of the objective) for the observation of the sun. The selection of the welding filter scale number is a matter of personal preference in comfort (according to atmospheric conditions and personal glare sensitivity). Filters with category W12 should be adequate to protect the eyes, but the solar image can be uncomfortably bright. Some observers might find that the solar image viewed through a W14 filter is too dim. Table A.1 compares the transmittance properties of welding (W) and solar filters. In the visible spectral range, the transmittance values are for luminous transmittance as specified in ISO 12311:2013, 7.1.2 and denoted as τ_V.

Table A.1 — Comparison of transmittance properties (%) of solar and welding filters

Filter Category	Ultraviolet spectral range		Visible spectral range		Infrared spectral range
	280 nm to 315 nm	315 nm to 380 nm	Maximum	Minimum	Maximum 780 nm to 1 400 nm
Solar for direct observation	τ_V	τ_V	0,003 2	0,000 061	3
Welding W12	0,000 3	0,001 2	0,003 2	0,001 2	12
Welding W13	0,000 3	0,000 44	0,001 2	0,000 44	8
Welding W14	0,000 16	0,000 16	0,000 44	0,000 16	6
Welding W15	0,000 061	0,000 061	0,000 16	0,000 061	4

NOTE Ultraviolet welding filter transmittances are maximum levels of spectral transmittance measured at 313 nm and 365 nm. Infrared transmittance is mean transmittance in the specified waveband.

Eye protectors for direct observation of the sun should be worn so that no direct radiation from the sun can reach the eye other than that passing through the filter.

During eclipses of the sun, eye protectors shall be worn whenever a part of the disk of the sun is **not** covered by the moon (i.e. during partial eclipse). The only time it is safe to view the sun without an eye protector is when the moon completely covers the sun in total eclipse.

Retinal safety calculation

Detailed calculations and analysis of retinal hazards from direct viewing of the sun demonstrate that a thermal injury of the retina is normally not possible unless the pupil is well dilated or unless the solar disc is viewed through a telescope[1][2]. The temperature rise in the irradiated retinal image is insufficient to produce a retinal burn for the unaided eye; even with a 3 mm diameter pupil (which would be quite large for bright daylight) will normally be less than 4 °C[1][2][3].

The sun, instead, poses a photochemical hazard ("blue-light hazard") not from momentary viewing but from prolonged staring (as during a partial eclipse) for minutes. The terrestrial radiance of the sun when overhead is approximately $1{,}3 \times 10^7$ W·m^{-2}·sr^{-1} and spectral weighting of the solar spectrum with the blue-light-hazard function B(λ) provides effective blue-light radiance values ranging from 4×10^5 W·m^{-2}·sr^{-1} to $1{,}8 \times 10^6$ W·m^{-2}·sr^{-1}, depending upon solar elevation angles greater than 10° above the horizon.

The maximum staring durations that relate to these blue-light radiances from the ACGIH limits[4] vary from only 0,6 s for solar zenith to 2,5 s for the sun at 10° above the horizon (very clear sky conditions)[5] [6]. Of course, actual injuries will only occur at greater durations since the exposure limits incorporate a large safety factor and the limits assume a relatively large pupil size of 3 mm, whereas, the pupil will be typically 1,5-2 mm under such viewing conditions.

Nevertheless, to provide an example for calculating a required attenuation factor, consider a staring duration of 1 000 s (~17 min). One would need an attenuation factor of (1 000 s)/(0,6 s) = 1 670, which would correspond to a neutral filter having a luminous transmittance of 0,06 %. However, practice shows that one would find it very difficult to stare at the sun with a filter transmitting 0,06 %. Most observers would find a luminance of ~10 kcd·m^{-2} as an upper value of luminance that could be comfortably viewed. Since the luminance of the overhead sun[7] is 1,6 × 10^{9} cd·m^{-2}, a minimum attenuation factor of 160,000 would be required for comfortable viewing (i.e. visual transmittance <0,000 6 % at solar noon. Hence, the filter transmittances in this part of ISO 12312 are far lower than required to prevent retinal injury (solar maculopathy). Since the luminance of the solar disc decreases with solar zenith angle, the comfortable luminous transmittance can be higher than 0,000 44 %. Finally, at sunset, the solar disc is safe to view on the horizon without protection as the blue light has been scattered out of the image[2][6].