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**Protective Filters for
Direct Visual Observation of the Sun
Technical Specification**

This technical specification applies to filters intended to protect the eyes during direct visual observations of the sun (e.g. during partial and annular eclipses of the sun), with or without the use of an optical aid such as binoculars or a telescope. Requirements for filter material, transmittance of optical radiation, mounting and labels are provided. This specification was prepared in accordance with Annex II (Basic Health and Safety Requirements) of the European Community Directive on Personal Protective Equipment.

A. Filters intended for unaided visual observation of the sun

A.1. Material

Filters may be made of tempered glass (minimum thickness 3 mm), polycarbonate, mylar film, or any other material which provides a suitable substrate for an absorptive filter, or vacuum-deposited metallic reflective coating, which meets the requirements for filter transmittance.

A.2. Filter transmittance

The luminous transmittance of the filter, when determined as described in clause 6 of EN167, shall not exceed 0.0032%. Filter transmittance in the waveband 290 to 315 nm (ultraviolet B radiation) shall not exceed 0.003% at any wavelength. For ultraviolet A radiation (315 to 385 nm) the transmittance shall not exceed 0.02% at any wavelength. Transmittance in the near infrared waveband (780 to 1400 nm) shall not exceed 0.5% at any wavelength.

Filters with luminous transmittance (in the waveband 380 to 780 nm) equivalent to scale number 12 to 16 as specified in Table 1 of EN169:1992 are considered suitable for direct observation of the sun. It should be noted that many observers will find the solar image uncomfortably bright when filters with scale numbers of 12 or 13 are used.

A.3. Filter mounting

Filters may be made with or without a mounting. A mounting shall hold the filter 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.

The filter or filter 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.

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.

A.4. Labelling

The filter and/or its packaging shall show the following information:

- a) name and address of manufacturer and/or distributor of the product;
- b) instructions for use in looking at the sun or a solar eclipse;
- c) warnings that filters that are damaged or separated from their mountings should be discarded; and
- d) warnings against the use of the filter with optical devices such as binoculars, telescopes or cameras
- e) advice on storage, cleaning, and maintenance, as appropriate.
- f) the relevant protection-factor number of the filter.
- g) the obsolescence deadline or period of obsolescence, as appropriate.

B.Filters intended for direct observation of the sun with an optical aid

B.1. Material

Filters may be made of tempered glass (minimum thickness 2 mm), polycarbonate, mylar film, or any other material which provides a suitable substrate for an absorptive filter, or vacuum-deposited metallic reflective coating, which meets the requirements for filter transmittance.

B.2. Filter transmittance

The luminous transmittance of the filter, when determined as described in clause 6 of EN167, shall not exceed 0.0032%. Filter transmittance in the waveband 290 to 315 nm (ultraviolet B radiation) shall not exceed 0.003% at any wavelength. For ultraviolet A radiation (315 to 385 nm) the transmittance shall not exceed 0.02% at any wavelength. Transmittance in the near infrared waveband (780 to 1400 nm) shall not exceed 0.5% at any wavelength.

Filters with luminous transmittance (in the waveband 380 to 780 nm) equivalent to scale number 12 to 16 as specified in Table 1 of EN69:1992 are considered suitable for direct observation of the sun. It should be noted that many observers will find the solar image uncomfortably bright when filters with scale numbers of 12 or 13 are used.

B.3. Labelling

The filter and/or its packaging shall show the following information:

- a) name and address of manufacturer and/or distributor of the product;
- b) instructions for use in looking at the sun or a solar eclipse;
- c) warnings that filters that are damaged or separated from their mountings should be discarded; and
- d) warnings against use of the filter at the eyepiece of the optical device, which may cause failure or breakage due to extreme heating, and result in eye injury.

C.Rationale

C.1. Materials

Materials recommended for use in filters for direct observation of the sun include welder's filters (shade or scale numbers 12 to 16 with glass or polycarbonate substrates), metal-coated glass or mylar, dyed plastic with high infrared absorption (Thousand Oaks Black Polymer), and silver-bearing black and white photographic emulsion (exposed to light and development to maximum density) (Chou, 1981, 1998; Chou and Abel, 1993). This specification accommodates these recommended filter substrates, as well as new materials which may be developed with similar or superior physical characteristics.

C.2. Filter transmittance

Filters with luminous transmittance levels equivalent to scale number 12 or higher attenuate visible light in sunlight to a level several orders of magnitude below the threshold level for thermal retinal damage. Because of the relatively low levels of ultraviolet A radiation and short wavelength (blue) visible light in solar radiation, the requirements for transmittance of UV radiation (200 to 380 nm) and visible light between 400 and 480 nm by solar filters need not be as restrictive as those specified in EN169:1992 for welding filters. Welding filters are intended to protect against the emission of UV radiation from artificial sources (electric welding arcs) which is several orders of magnitude greater in the UV wavebands than sunlight. The levels of UVB (280 to 315 nm) and UVA (315 to 380 nm) in sunlight transmitted by filters commonly used by solar observers is insufficient to cause photokeratitis (welder's flash) or other anterior eye damage (Chou, 1981, 1996; Pitts, 1993).

The normal human eye transmits radiation between 400 and 1400 nm to the retina (Boettner and Wolter, 1962). Filters should attenuate solar radiation in this waveband to levels of exposure below the threshold dosages for photochemical and thermal retinal damage (Chou, 1981).

C.3. Filter mounting

Where used, mountings should retain the filter securely in front of the face or optical system to prevent solar radiation from reaching the eyes and/or optical system, except by transmission through the filter. The specification permits the use of mountings held in front of the face, or worn as spectacle frames directly in front of the user's eyes and corrective lenses for direct viewing of the sun without an optical aid. Filters used in front of the objective lens(es) of an optical aid may be mounted as full-aperture or reduced aperture filters for the purpose of direct visual solar observation.

C.4. Labelling

The requirements for labelling provide the end user with information on the source and the safe use of the product, as well as warnings against improper use.

References

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