The New ISO Standard for Solar Filters

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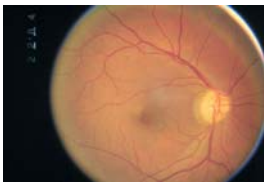
Solar Eclipse Eye Injuries

- Intense visible light
  - Photochemical retinopathy
- Sustained/repeated viewing
  - Partial eclipse phases



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Solar retinal phototoxicity

- Presentation highly variable
  - slight visual loss to profound
- Recovery highly variable
  - >50% recover to pre-injury VA
  - unpredictable on basis of presentation
- More appropriately “solar retinal phototoxicity”

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Solar retinal phototoxicity

- Typical patient
  - young adult male (15 years +)
  - unaware of, or ignored warnings
  - no or inappropriate protection
  - first symptoms on morning after eclipse

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Solar retinal phototoxicity

- Painless
  - no pain sensors in retina
- Latent period
  - 12 to 48 h delay of onset of symptoms
  - wavelength dependent
- Visual recovery highly variable
  - depends on exposure conditions
- Optical aids increase severity
  - thermal effects add to photochemical

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Retinal exposure

- Unaided eye at sea level, air mass 1

Solar irradiance	70 $\mu W.cm^{-2}$
Sun angular subtense	9.3 mrad
Retinal image size	160 μm

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Retinal exposure

	2 mm pupil	3 mm pupil
Retinal irradiance	8 $W.cm^{-2}$	18 $W.cm^{-2}$
Retinal temperature increase	1.3° C	3.0° C
Threshold exposure	100 s	40 s

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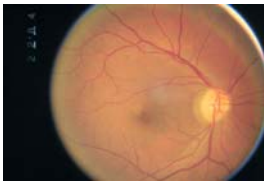
Retinal phototoxicity Mechanism of injury

Photochemical

- short wavelength light (blue)
- threshold 3 $W.m^{-2}$
- usually temporary visual loss
- most common type of injury



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Retinal phototoxicity Mechanism of injury

Thermal

- long wavelength visible, IRA, extended short wavelength visible
- threshold 2.8 X 10^4 $W.m^{-2}$
- permanent injury with visual loss
- more common if optical aid was used
- More associated with class4 lasers

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EN 1836

- Transmission and other requirements
  - Non-prescription sunglasses
  - Filters for direct observation of the sun
- Solar filter requirements introduced in 2005 by CEN
  - European Directive 89/686 Personal protective equipment
  - Mandatory compliance for sale in EEC

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Application

- TSE 2012 November
  - Queensland government directive
    - Solar eclipse glasses and filters certified as meeting transmittance requirements of EN1836 or AS/NZS 1338.1

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ISO 12312-2

- Eye and face protection – Sunglasses and related eyewear – Part 2: Filters for direct observation of the sun
  - Developed by ISO TC94SC6 Eye Protection
  - Companion to ISO 12312-1 – Part 1: Sunglasses for general use
  - Will replace EN 1836 for compliance with ED 89/686 under Vienna Agreement

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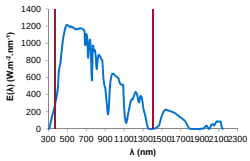
Radiation hazard

Solar spectrum (Moon, 1940)



- Sun vs welding sources
- Compare exposure to
  - Visible light
  - UV
  - IR

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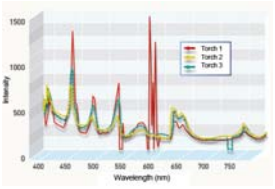
Welding sources

Oxyaceteylene flame



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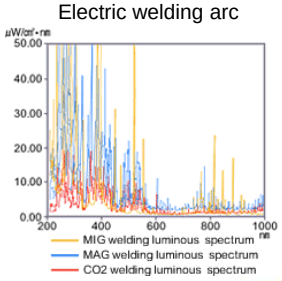
Welding Sources

Electric welding arc



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Retinal hazard assessment

- Solar UV and IR relatively lower than visible radiation
- Welding sources vary widely
  - Electric arcs UV rich, vary with flux and shielding gases used
  - Welding flames predominantly visible light
- Welding protector standards are inappropriate for solar viewers

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Rationale

- Retinal hazard due to phototoxicity from prolonged exposure to sunlight in visible range
- Solar IR, UV are insignificant for retinal damage
- For visual comfort, filter attenuation in visible range should be at least 160,000X
- Permitted luminous transmittance range is less than this level

Sliney & Chou, 2013

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ISO 12312-2

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

Maximum luminous transmittance (τ_v)	0,0032%
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%

Luminous transmittance range SN15 to SN12

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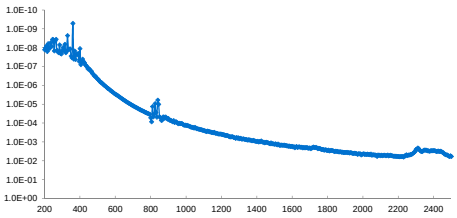
Rainbow Symphony Designer Eclipse Viewers



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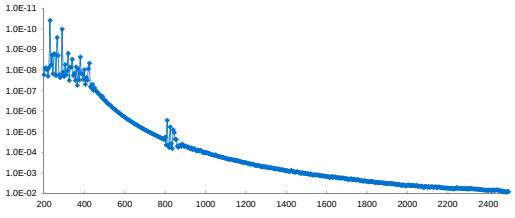
Rainbow Symphony Sheet Solar Filter



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Filter Data

	Designer glasses	Sheet filter
Luminous transmittance (τ_v)	0.0002 %	0.0001 %
Scale Number	14.4	14.8
Maximum solar UVB transmittance (τ_{SUVB})	2 x 10^{-6} %	2 x 10^{-6} %
Maximum solar UVA transmittance (τ_{SUVA})	5 x 10^{-6}%	6 x 10^{-6} %
Maximum solar IR transmittance (τ_{SIR})	0.09 %	0.08%

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Schedule

- ISO 12312-2
  - FDIS vote Fall 2014
  - Publication 2015
  - Certification of product 2015 +
- EN 1836
  - CEN to withdraw upon publication of ISO 12312-2

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