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Ophthalmic optics — Uncut finished spectacle lenses —

Part 3:
Transmittance specifications and test methods

Optique ophtalmique — Verres de lunettes finis non détourés —

Partie 3: Spécifications relatives au facteur de transmission et méthodes d'essai

Reference number
ISO 8980-3:2013(E)

Contents

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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. www.iso.org/directives

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The committee responsible for this document is ISO/TC 172, *Optics and photonics*, Subcommittee SC 7, *Ophthalmic optics and instruments*.

This third edition cancels and replaces the second edition (ISO 8980-3:2003), which has been technically revised. In particular, the requirement in 6.3.2 for lenses intended for road use and driving has been amended with an extension of three years for the continued manufacture of existing products.

ISO 8980 consists of the following parts, under the general title *Ophthalmic optics — Uncut finished spectacle lenses*:

— *Part 1: Specifications for single-vision and multifocal lenses*

— *Part 2: Specifications for progressive power lenses*

— *Part 3: Transmittance specifications and test methods*

— *Part 4: Specifications and test methods for anti-reflective coatings*

— *Part 5: Minimum requirements for spectacle lens surfaces claimed to be abrasion-resistant*

Ophthalmic optics — Uncut finished spectacle lenses —

Part 3:
Transmittance specifications and test methods

1 Scope

This part of ISO 8980 specifies requirements for the transmittance properties of uncut finished spectacle lenses and mounted pairs, including attenuation of solar radiation.

This part of ISO 8980 is not applicable to

— spectacle lenses having particular transmittance or absorption characteristics prescribed for medical reasons;

— products where specific personal protective equipment transmittance standards apply;

— products intended for direct observation of the sun, such as for solar-eclipse viewing.

NOTE Optical and geometric requirements for uncut finished spectacle lenses are specified in ISO 8980-1 and ISO 8980-2, and for mounted lenses, in ISO 21987.

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 11664-1, *Colorimetry — Part 1: CIE standard colorimetric observers*

ISO 11664-2, *Colorimetry — Part 2: CIE standard illuminants*

ISO 13666, *Ophthalmic optics — Spectacle lenses — Vocabulary*

ISO 14889, *Ophthalmic optics — Spectacle lenses — Fundamental requirements for uncut finished lenses*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13666 apply.

NOTE 1 For the convenience of the reader, the following definitions have been reproduced from ISO 13666.

NOTE 2 Absorptance, reflectance and transmittance are usually expressed as percentages. The equations in this clause are written in this form. Although the definitions use integrals, in practice summation, typically at 1 nm, 5 nm or 10 nm intervals, is performed to calculate the various transmittances.

3.1
mean UV-A transmittance
τ_{UVA}
mean transmittance between 315 nm and 380 nm

$$\tau_{\mathrm{UVA}} = 100 \times \frac{1}{65\ \mathrm{nm}} \int_{315\ \mathrm{nm}}^{380\ \mathrm{nm}} \tau(\lambda) \cdot \mathrm{d}\lambda\ \%$$

[ISO 13666:2012, definition 15.3.1]

3.2
solar UV-A transmittance

τ_{SUVA}

mean of the spectral transmittance between 315 nm and 380 nm weighted by the solar radiation distribution $E_S(\lambda)$ at sea level, for air mass 2, and the relative spectral effectiveness function for UV radiation $S(\lambda)$

$$\tau_{SUVA} = 100 \times \frac{\int_{315\ nm}^{380\ nm} \tau(\lambda) \cdot E_s(\lambda) \cdot S(\lambda) \cdot d\lambda}{\int_{315\ nm}^{380\ nm} E_s(\lambda) \cdot S(\lambda) \cdot d\lambda} \%$$

Note 1 to entry: The complete weighting function $W(\lambda)$ is the product of $E_s(\lambda)$ and $S(\lambda)$ and is given in Table B.1.

[SOURCE: ISO 13666:2012, definition 15.3.2]

3.3
solar UV-B transmittance

τ_{SUVB}

mean of the spectral transmittance between 280 nm and 315 nm weighted by the solar radiation distribution $E_S(\lambda)$ at sea level, for air mass 2, and the relative spectral effectiveness function for UV radiation $S(\lambda)$

$$\tau_{SUVB} = 100 \times \frac{\int_{280\ nm}^{315\ nm} \tau(\lambda) \cdot E_s(\lambda) \cdot S(\lambda) \cdot d\lambda}{\int_{280\ nm}^{315\ nm} E_s(\lambda) \cdot S(\lambda) \cdot d\lambda} \%$$

Note 1 to entry: The complete weighting function $W(\lambda)$ is the product of $E_s(\lambda)$ and $S(\lambda)$ and is given in Table B.1.

[SOURCE: ISO 13666:2012, definition 15.3.3]

3.4
luminous transmittance

τ_V

ratio of the luminous flux transmitted by the lens or filter to the incident luminous flux

$$\tau_V = 100 \times \frac{\int_{380\ nm}^{780\ nm} \tau(\lambda) \cdot V(\lambda) \cdot S_{D65}(\lambda) \cdot d\lambda}{\int_{380\ nm}^{780\ nm} V(\lambda) \cdot S_{D65}(\lambda) \cdot d\lambda} \%$$

where

$\tau(\lambda)$ is the spectral transmittance of the spectacle lens;

$V(\lambda)$ is the spectral luminous efficiency function for daylight (see ISO 11664-1);

$S_{D65}(\lambda)$ is the spectral distribution of radiation of CIE standard illuminant D65 (see ISO 11664-2).

Note 1 to entry: The spectral values of the product of the spectral radiation distributions $S_{D65}(\lambda)$ of the CIE standard illuminant D65 and the eye's spectral luminous efficiency function $V(\lambda)$ are given in Table A.2.

[SOURCE: ISO 13666:2012, definition 15.4]

3.5
relative visual attenuation coefficient (quotient) for incandescent traffic signal light recognition/detection
Q-value
ratio of the luminous transmittance of a tinted lens for the spectral radiant power distribution of the light emitted by a traffic signal τ_{signal} to the luminous transmittance of the same lens for CIE standard illuminant D65 (τ_V)

$$Q = \frac{\tau_{signal}}{\tau_V}$$

where

τ_{signal} is the luminous transmittance of the lens for the spectral radiant power distribution of the traffic signal light.

Note 1 to entry: *Q*-values can be determined for each of blue, green, amber (yellow) and red signal lights. τ_{signal} is given by the equation:

$$\tau_{signal} = 100 \times \frac{\int_{380\ nm}^{780\ nm} \tau(\lambda) \cdot \tau_S(\lambda) \cdot V(\lambda) \cdot S_A(\lambda) \cdot d\lambda}{\int_{380\ nm}^{780\ nm} \tau_S(\lambda) \cdot V(\lambda) \cdot S_A(\lambda) \cdot d\lambda} \%$$

where

$\tau_S(\lambda)$ is the spectral transmittance of the traffic signal lens;

$S_A(\lambda)$ is the spectral distribution of radiation of CIE standard illuminant A (or 3 200 K light source for blue signal light) (see ISO 11664-2);

Note 2 to entry: The spectral values of the products of the spectral distributions $S_A(\lambda)$ of the illuminant A, the spectral luminous efficiency function $V(\lambda)$ of the eye and the spectral transmittance $\tau_S(\lambda)$ of the traffic signal lens are given in Table A.1, where $E_{Signal}(\lambda)=S_A(\lambda) \times \tau_S(\lambda)$.

Note 3 to entry: Calculations are currently based on the measured values of $E(\lambda)$ for traffic signal lights using incandescent quartz-halogen lamps. They previously used the product $\tau_S(\lambda) \cdot S_A(\lambda)$ of the spectral transmittance of the traffic signal filter and the spectral distribution of radiation of CIE standard illuminant A. Calculations using the values for quartz-halogen lamps and LED signals will give different results

Note 4 to entry: Adapted from ISO 13666:2012, definition 15.5.

3.6
polarizing efficiency
property of a polarizing lens, describing the percentage of the transmitted light that is polarised, defined by the equation

$$P = 100 \times \frac{\tau_{p,max} - \tau_{p,min}}{\tau_{p,max} + \tau_{p,min}} \%$$

where

$\tau_{p,max}$ is the maximum value of **luminous transmittance** as determined with 100% linearly polarised radiation;

$\tau_{p,min}$ is the minimum value of **luminous transmittance** as determined with 100% linearly polarised radiation.

Note 1 to entry: Adapted from ISO 13666:2012, definition 8.1.12.3.

4 Symbols

The symbols for the characteristic luminous transmittances of photochromic lenses are given in Table 1.

Table 1 — Symbols for the characteristic luminous transmittances of photochromic lenses

Symbols	Characteristic luminous transmittances
τ_{V0}	Luminous transmittance in the faded state as reached at (23 ± 2) °C after specified conditioning.
τ_{V1}	Luminous transmittance in the darkened state as reached at (23 ± 2) °C after specified irradiation simulating mean outdoor conditions.
τ_{VW}	Luminous transmittance in the darkened state as reached at (5± 2) °C after specified irradiation simulating outdoor conditions at low temperatures.
τ_{VS}	Luminous transmittance in the darkened state as reached at (35± 2) °C after specified irradiation simulating outdoor conditions at high temperatures.
τ_{VA}	Luminous transmittance in the darkened state as reached at (23 ± 2) °C after specified irradiation simulating reduced light conditions.

5 Classification

Spectacle lenses are classified with respect to transmittance as follows:

a) clear spectacle lenses, having no intended colour (including grey) in transmission;

b) uniformly tinted spectacle lenses;

c) gradient-tinted spectacle lenses;

d) photochromic spectacle lenses;

e) polarizing spectacle lenses.

NOTE Two or more of the above classifications may be combined.

6 Requirements

6.1 General

The fundamental requirements for uncut finished lenses, including reference to 6.3 in this part of ISO 8980, are in ISO 14889. The requirements shall apply at a temperature of (23 ± 5) °C, and shall apply at the design reference point, unless specified otherwise.

6.2 General transmittance requirements

6.2.1 Tint descriptions, categories, and UV transmittance requirements

Spectacle lenses shall be attributed to one of five tint descriptions or luminous transmittance categories as specified in Table 2, and shall be tested as described in Clause 7.

A spectacle lens intended to have a luminous transmittance τ_V that is in categories 0, 1, 2 and 3 shall have a luminous transmittance at its design reference point that shall not lie outside the limits of the stated category by more than 2 % absolute. For example, a lens intended to have a luminous transmittance of 40 % but actually having a transmittance of 45 % shall comply with the UV requirements of a category 2 lens.

A spectacle lens intended to have a luminous transmittance τ_V that is in category 4 shall have a luminous transmittance τ_V at its design reference point that shall not lie outside the limits of that category by more than 20 % relative to the stated luminous transmittance.

All lenses shall meet the specified UV requirements corresponding to their intended luminous transmittance τ_V in Table 2, but those clear glass spectacle lenses of category 0 for which no specific claim is made as to UV transmittance performance are excluded from the UV requirements of Table 2.

NOTE This exclusion applies because some clear crown glass lenses cannot meet the UV-B requirement.

6.2.2 Tolerances on luminous transmittance of tinted lenses

It is recommended that a tint should be ordered by reference to a manufacturer's sample. Such a tint shall not be obviously dissimilar from the tint of the sample and its assessment is not restricted by its luminous transmittance τ_V measured by spectrophotometer.

For a lens ordered by a specific luminous transmittance τ_V shall have a measured τ_V at the design reference point within ± 8 % absolute of that ordered. The tint of the two lenses of a pair should not be obviously dissimilar.

Table 2 — Categories for luminous transmittance and the related permissible transmittance in the ultraviolet solar spectral range

		Visible spectral range		Ultraviolet spectral range	
		Range of luminous transmittance τ_V		Maximum value of solar UV-A transmittance τ_{SUVA}	Maximum value of solar UV-B transmittance τ_{SUVB}
Tint description	**Luminous transmittance category**	from over %	to %	> 315 nm to 380 nm UV-A	> 280 nm to 315 nm UV-B
Clear or very light tint	0	80,0	100	τ_V	0,05 τ_V
Light tint	1	43,0	80,0	τ_V	0,05 τ_V
Medium tint	2	18,0	43,0	0,5 τ_V	1,0 % absolute or 0,05 τ_V, whichever is greater
Dark tint	3	8,0	18,0	0,5 τ_V	1,0 % absolute
Very dark tint	4	3,0	8,0	1,0 % absolute or 0,25 τ_V, whichever is greater	1,0 % absolute

6.3 Spectral transmittance requirements of spectacle lenses intended for road use and driving

6.3.1 General

Spectacle lenses having a luminous transmittance τ_V less than or equal to 8 % are not intended for road use and driving. This clause therefore does not contain requirements for such lenses.

6.3.2 Spectral transmittance

The spectral transmittance $\tau(\lambda)$ at any wavelength in the range 475 nm to 650 nm shall be not less than 0,2 τ_V.

For a period of three years from the date of publication of this part of ISO 8980, products that are existing at the date of publication of this part of ISO 8980 that satisfy the requirement that the spectral transmittance, $\tau(\lambda)$ at any wavelength in the range 500 nm to 650 nm shall be not less than 0,2 τ_V will be deemed to pass the requirement of this part of ISO 8980.

6.3.3 Daylight use

When using illuminant D65, the luminous transmittance τ_V of spectacle lenses for road use and driving during daylight shall be more than 8 % at the design reference point.

6.3.4 Driving in twilight or at night

Spectacle lenses with a luminous transmittance τ_V less than 75 % shall not be used for road use and driving in twilight or at night. In the case of photochromic spectacle lenses, this requirement applies when tested in accordance with 7.5.3.5.

6.3.5 Relative visual attenuation coefficient (quotient) for recognition/detection of incandescent signal lights

Spectacle lenses shall have a relative visual attenuation coefficient (quotient) Q not less than:

a) 0,8 for Q_{red};

b) 0,6 for Q_{yellow};

c) 0,6 for Q_{green};

d) 0,4 for Q_{blue}.

The relative visual attenuation coefficient (quotient) Q shall be calculated according to 3.5, in accordance with Table A.1.

6.4 Additional transmittance requirements for special types of spectacle lenses

6.4.1 Photochromic spectacle lenses

6.4.1.1 General

Photochromic spectacle lenses are usually attributed to two categories, corresponding to the faded state and to the darkened state. The faded and darkened state transmittances shall be determined according to the method in 7.5. The UV transmittance in both the faded and darkened states shall conform to the values specified for both categories in Table 2.

NOTE It is not required to claim the category of the lens in its darkened state.

6.4.1.2 Photochromic response

When tested by the methods described in 7.5.3.1 to 7.5.3.3, the ratio of the luminous transmittance of a photochromic specimen (see 7.5.1) in its faded state τ_{V0} and, after 15 min irradiation, in its darkened state τ_{V1} shall be at least 1,25, i.e.

$$\frac{\tau_{V0}}{\tau_{V1}} \geq 1{,}25$$

6.4.1.3 Photochromic response at various temperatures

If photochromic temperature influence is stated, it shall be determined by measuring the luminous transmittance of the specimen (see 7.5.1) in the darkened state using the procedure described in 7.5.3.6 at 5 °C (τ_{VW}), 23 °C (τ_{V1}) and 35 °C (τ_{VS}).

NOTE The manufacturer may use additional temperatures, provided this information is made available.

6.4.1.4 Photochromic response at moderate light levels

If the photochromic response at moderate light levels is stated, it shall be determined by measuring the luminous transmittance of the specimen (see 7.5.1) in the darkened state τ_{VA} using the procedure described in 7.5.3.4 after exposure to the illumination specified in 7.5.2.1 attenuated to an intensity of 30 %.

6.4.2 Polarizing spectacle lenses

6.4.2.1 Individual uncut polarizing lenses

When tested according to the method in 7.6, the polarizing efficiency as calculated in 3.6 shall be > 78 % for luminous transmittance categories 2, 3, 4 and > 60 % for luminous transmittance category 1.

If there is a marking on the spectacle lens indicating the intended direction of horizontal orientation, then the actual plane of transmittance shall be at (90 ± 3)° from this marking.

6.4.2.2 Mounted pairs of polarizing lenses

If the lenses mounted in spectacles are claimed to be polarizing for sun glare attenuation, the lenses shall be fitted in the frame so that their planes of transmission do not deviate from the vertical by more than ± 5º when tested according to the method in 7.6.

6.4.3 Gradient-tinted spectacle lenses

The requirements for gradient-tinted spectacle lenses shall be determined at the design reference point of the spectacle lens. It is recommended that gradient tints be ordered by reference to a manufacturer's sample lens, identification code, name or reference number.

6.5 Resistance to radiation

Following irradiation as specified in 7.7, the absolute change in the luminous transmittance ($\tau_V' - \tau_V$) of the lenses shall be less than or equal to 5 % absolute where τ_V' is the luminous transmittance after irradiation. In addition, the following shall be met:

a) for photochromic filters $\frac{\tau_{V0}}{\tau_{V1}}$ shall be ≥ 1,25;

b) the UV requirements for the initial τ_V shall continue to be satisfied;

c) if originally intended for road use and driving, the requirements of 6.3 shall continue to be satisfied;

d) where a UV transmittance lower (i.e. better) than that specified in Table 2 is claimed, then this transmittance shall continue to be satisfied.

7 Test methods

7.1 General

This clause specifies reference methods for transmittance properties of spectacle lenses.

For purposes of quality control, etc., alternative test methods may be used if shown to be equivalent.

7.2 Spectral transmittance

The uncertainties of the test methods determining transmittance values shall be not greater than:

— 2 % absolute, for transmittance > 20%;

— 1 % absolute, for luminous transmittance ≤ 20%;

— 10 % relative, for UV transmittance of lenses with luminous transmittance ≤ 20%.

These measurement uncertainties shall be based on a confidence level of 95 %.

7.3 Luminous transmittance and relative visual attenuation coefficient (quotient)

7.3.1 The spectral distribution of standard illuminant D65 as specified in ISO 11664-2 and the luminous efficiency of the average human eye for daylight vision (2° observer) as specified in ISO 11664-1 shall be used to determine the luminous transmittance, τ_V. When calculating the luminous transmittance, τ_V , from the spectral transmittance $\tau(\lambda)$, the step width shall not exceed 10 nm.

7.3.2 Relative visual attenuation coefficient for signal light recognition/detection [incandescent]. When calculating the relative visual attenuation coefficient (quotient), Q, for signal lights from the spectral transmittance $\tau(\lambda)$, the step width shall not exceed 10 nm. The relevant formula, from ISO 13666, is:

$$Q = \frac{\tau_{\text{signal}}}{\tau_V}$$

where

τ_V is given in 3.4;

τ_{signal} is given in 3.5;

$E_{\text{Signal}}(\lambda) \times V(\lambda)$ for red, yellow, green and blue incandescent lamps are listed in Table A.1.

NOTE For information, $E_{\text{Signal}}(\lambda) \times V(\lambda)$ for red, yellow, green and blue light emitting diode (LED) signals lights are listed in informative Annex D.

7.4 Ultraviolet transmittance

7.4.1 Principle

The ultraviolet transmittance in the spectral range from 280 nm to 380 nm of the uncut finished spectacle lens shall be determined using a spectrophotometer.

