American National Standard for Ophthalmics –

Nonprescription Sunglasses and Fashion Eyewear – Requirements

1 Scope and purpose

1.1 Scope

This standard applies to all nonprescription sunglasses and fashion eyewear, normally used for casual, dress, and recreational purposes, having lenses of substantially plano power. This standard specifically excludes products covered by ANSI Z87.1-1989 and ANSI Z80.1-1995. Sunglass needs for aphakics may not be met by this standard.

1.2 Purpose

The purpose of this standard is to establish standards for noncorrective (essentially plano power) lenses that are intended for attenuation of light and for fashionwear, and the flammability of frames and lenses. These products are commonly called sunglasses and are not designed to be industrial safety eyewear as defined in ANSI Z87.1-1989, or to provide corrective prescriptions as defined in ANSI Z80.1-1995. Lenses covered by this standard are not intended for use under conditions of reduced illumination, such as for night driving.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this American National Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

ANSI Z80.1-1995, *Recommendations for Prescription Ophthalmic Lenses* [1]

ANSI Z87.1-1989, *Practice for Occupational and Educational Eye and Face Protection* [1]

ANSI/ASQC Z1.4-1981, *Sampling Procedures and Tables for Inspection by Attributes* [1]

ASTM D412-92, *Test Methods for Rubber Properties in Tension* [2]

ASTM D1415-94, *Test Method for Rubber Property – International Hardness* [2]

3 Definitions

3.1 Capable of withstanding an impact test: Capable of withstanding an impact test means able to withstand impact as determined by 100% testing or by testing of a statistically significant sample (for example, conforming to the requirements of ANSI/ASQC Z1.4-1981) of each production batch at the option of the manufacturer as an integral part of the manufacturing process. Capability of withstanding an impact test is determined by testing at any feasible stage of manufacture described in 5.1.1 and 5.1.2.

3.2 Density: Density (also called optical density) is the logarithm to the base 10 of the reciprocal of transmittance (Density = $\log 1/\tau$).

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[1] Available from American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

[2] Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428.

3.3 Geometric center: The geometric center is the point midway between the two vertical tangents and midway between the two horizontal tangents of the edges of a lens.

3.4 Lens fracture: A lens should be considered to have fractured when it cracks through its entire thickness and across a complete diameter into two or more separate pieces, or when any piece of lens material, visible to the naked eye, becomes detached from the ocular surface, or if the test ball passes through the lens.

3.5 Lens types

3.5.1 Polarizing lens: A polarizing lens is a lens whose luminous transmittance varies with the amount and orientation of the polarization in the incident light.

3.5.2 Photosensitive lens: A photosensitive lens is a lens whose luminous transmittance or color, or both, depends on the recent exposure history of the lens.

3.5.3 Gradient density lens: A gradient density lens is a lens whose luminous transmittance varies significantly across the lens.

3.5.4 Uniform density lens: A uniform density lens is a lens whose luminous transmittance does not vary significantly over the area of the lens.

3.6 Noncorrective impact-resistant lenses: Noncorrective impact-resistant lenses are glass lenses, plastic lenses, or laminated glass lenses made impact resistant by any method; however, all such lenses shall be capable of withstanding the impact test described in 5.1.

3.7 Production batch: A production batch is an identifiable group of lenses of essentially the same curvature, thickness, and material manufactured under essentially the same conditions, and during a substantially continuous production period.

3.8 Refractive properties

3.8.1 Refractive power: Refractive power of a lens is measured in diopters and is the reciprocal of the back focal length expressed in meters.

3.8.2 Astigmatic power: Astigmatic power is a measure of the maximum refractive power difference between any two meridians within a lens.

3.8.3 Prismatic power: Prismatic power of a lens, expressed in prism diopters, is the apparent displacement, in centimeters, of an object located 1 m from the lens in the meridian of maximum displacement.

3.9 Transmittance properties

3.9.1 Luminous transmittance: Luminous transmittance is a function of the spectral transmittance of the lens weighted by the corresponding ordinates of the photopic luminous efficiency distribution of the CIE (1931) standard colorimetric observer and by the spectral intensity of standard illuminant C.

The luminous transmittance (τ_V) of a lens is expressed mathematically as follows:

$$\tau_V = \frac{\int_{380}^{780} \tau(\lambda)V(\lambda)S_C(\lambda)d\lambda}{\int_{380}^{780} V(\lambda)S_C(\lambda)d\lambda} \qquad \ldots(1)$$

where:

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

$V(\lambda) =$ is the spectral ordinate of the photopic luminous efficiency distribution $[\bar{y}(\lambda)]$ of the CIE (1931) standard colorimetric observer;

$S_c(\lambda) =$ is the spectral intensity of standard illuminate C.

3.9.1.1 Luminous transmittance ratio of a polarizing lens: The luminous transmittance ratio of a polarizing lens is the ratio of the extremes of luminous transmittance of the lens when oriented parallel and crossed in a beam of essentially 100% linearly polarized light.

The luminous transmittance ratio $(R_{\tau V})$ of a polarizing lens is expressed mathematically as follows:

$$(R_{\tau V}) = \frac{\tau V_{\max}}{\tau V_{\min}} \qquad \ldots(2)$$

where:

$\tau V_{\max} =$ is the maximum luminous transmittance (parallel orientation) measured at the geometric center of the lens;

$\tau V_{\min} =$ is the minimum luminous transmittance (crossed orientation) measured at the geometric center of the lens.

3.9.2 Mean transmittance: The mean transmittance, $\tau(\lambda_2, \lambda_1)$, of a lens over a spectral range λ_1 to λ_2 is expressed mathematically as follows:

$$\tau(\lambda_2, \lambda_1) = \frac{1}{\lambda_2 - \lambda_1} \int_{\lambda_1}^{\lambda_2} \tau(\lambda)d\lambda \qquad \ldots(3)$$

where:

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

Mean transmittance values are applicable only to the following ultraviolet spectral zones:

Erythemal zone: $\lambda_1 = 290\text{nm}, \lambda_2 = 315\text{nm}$;
Near ultraviolet zone: $\lambda_1 = 315\text{nm}, \lambda_2 = 380\text{nm}$.

3.9.3 Transmittance properties related to traffic signal recognition [3]

3.9.3.1 Chromaticity coordinates: The x and y chromaticity coordinates of traffic signals and average daylight (D65), as viewed through the lens, are expressed mathematically as follows:

$$x = \frac{X}{X+Y+Z}$$

$$y = \frac{Y}{X+Y+Z} \qquad \ldots (4)$$

The values of X, Y, and Z are determined as follows:

1) For traffic signals as viewed through the lens,

$$X_{sig} = \int_{380}^{780} \tau(\lambda) S_A(\lambda) \tau_{sig}(\lambda) \bar{x}(\lambda) d\lambda$$

$$Y_{sig} = \int_{380}^{780} \tau(\lambda) S_A(\lambda) \tau_{sig}(\lambda) \bar{y}(\lambda) d\lambda$$

$$Z_{sig} = \int_{380}^{780} \tau(\lambda) S_A(\lambda) \tau_{sig}(\lambda) \bar{z}(\lambda) d\lambda \qquad \ldots (5)$$

2) For average daylight (D65) as viewed through the lens,

$$X_{D65} = \int_{380}^{780} \tau(\lambda) S_{D65}(\lambda) \bar{x}(\lambda) d\lambda$$

$$Y_{D65} = \int_{380}^{780} \tau(\lambda) S_{D65}(\lambda) \bar{y}(\lambda) d\lambda$$

$$Z_{D65} = \int_{380}^{780} \tau(\lambda) S_{D65}(\lambda) \bar{z}(\lambda) d\lambda \qquad \ldots (6)$$

where:

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

$S_A(\lambda) =$ is the spectral intensity of standard illuminant A;

$S_{D65}(\lambda) =$ is the spectral intensity of standard illuminant D65;

$\tau_{sig}(\lambda) =$ is the spectral transmittance of the traffic signal filter (red, yellow, or green);

$\bar{x}(\lambda), \bar{y}(\lambda), \bar{z}(\lambda) =$ is the CIE (1931) standard observer (2°) spectral tristimulus values of the equal-energy spectrum;

$X, Y, Z =$ are the tristimulus values.

3.9.3.2 Traffic signal transmittance: Traffic signal transmittance is a function of the spectral transmittance of the lens weighted by the corresponding ordinates of the photopic luminous efficiency distribution of the CIE (1931) standard observer, the spectral intensity of standard illuminant A, and the spectral transmittance of the appropriate traffic signal filter (red, yellow, and green).

The traffic signal transmittance (τ_{sig}) of a lens is expressed mathematically as follows:

$$\tau_{sig} = \frac{\int_{380}^{780} \tau(\lambda) V(\lambda) S_A(\lambda) \tau_{sig}(\lambda) d\lambda}{\int_{380}^{780} V(\lambda) S_A(\lambda) \tau_{sig}(\lambda) d\lambda}$$

$$= \frac{Y_{sig}}{\int_{380}^{780} V(\lambda) S_A(\lambda) \tau_{sig}(\lambda) d\lambda} \qquad \ldots (7)$$

where:

$\tau(\lambda), S_A(\lambda), \tau_{sig}(\lambda), Y_{sig}$ are as defined in 3.9.3.1;

$V(\lambda) =$ is the spectral ordinate of the photopic luminous efficiency distribution $[\bar{y}(\lambda)]$ of the CIE (1931) standard observer.

Computational data for transmittance properties are given in table 1 (the appropriate reference data for table 1 are given in table 2).

3.9.4 Near infrared transmittance: Near infrared transmittance is a function of the spectral transmittance of the lens and spectral solar irradiation at sea level.

The near infrared transmittance $[\bar{y}(\lambda)]$ of a lens is expressed mathematically as follows:

$$\tau_{sir} = \frac{\int_{780}^{1400} \tau(\lambda) E(\lambda) d(\lambda)}{\int_{780}^{1400} E(\lambda) d(\lambda)} \qquad \ldots (8)$$

where:

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

$E(\lambda) =$ is the spectral solar irradiation at sea level (see table 3).

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[3] These properties are established to define the amount of chromatic distortion of attenuation, or both, of the red, yellow, and green traffic signals as viewed with a background of average daylight (D65). Chromatic distortion of average daylight (D65) is treated only in its relationship to traffic signal recognition.