INTERNATIONAL STANDARD

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Ergonomics — Accessible design — Specification of age-related luminance contrast for coloured light

Ergonomie — Conception accessible — Spécification du contraste de luminance lié à l'âge pour la lumière colorée

Reference number
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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 24502 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 5, *Ergonomics of the physical environment*.

Introduction

Although the proportion of older people is increasing in many countries, the care for better visibility of signs and displays is not sufficiently taken for those older people. This prevents older people from actively being involved in social activities, as well as from living their life safely and comfortably. This International Standard provides a method of calculating age-related luminance contrast that can be used for assessing and designing signs and displays in our visual environment, so that they are clearly visible to older people. This method calculates age-related luminance contrast for people aged from 10 to 79 years based on age-related photopic spectral luminous efficiency of the eye.

This International Standard adopts the principles of accessible design given in ISO/IEC Guide 71 and amplified in ISO/TR 22411.

Ergonomics — Accessible design — Specification of age-related luminance contrast for coloured light

1 Scope

This International Standard specifies the age-related luminance contrast of any two lights of different colour seen by a person at any age, by taking into account the age-related change of spectral luminous efficiency of the eye.

This International Standard provides a basic method of calculation that can be applied to the design of lighting, visual signs and displays. It applies to light, self-luminous or reflected, in visual signs and displays seen under moderately bright conditions called photopic vision and whose spectral radiance is known or measurable. It does not apply to light seen under darker conditions called mesopic or scotopic vision.

This International Standard specifies the luminance contrast for people aged from 10 to 79 years who have had no medical treatment or surgery on their eyes that may affect their spectral luminous efficiency.

This International Standard does not apply to visual signs and displays seen by people with colour defects whose spectral luminous efficiency is different from those with normal colour vision, nor those seen by people with low vision.

2 Normative references

The following refererenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3864-1:—[1], *Graphical symbols — Safety colours and safety signs — Part 1: Design principles for safety signs and safety markings*

ISO 3864-4:—[2], *Graphical symbols — Safety colours and safety signs — Part 4: Colorimetric and photometric properties of safety sign materials*

ISO 9241-302:2008, *Ergonomics of human-system interaction — Part 302: Terminology for electronic visual displays*

ISO 9241-303:2008, *Ergonomics of human-system interaction — Part 303: Requirements for electronic visual displays*

ISO 23539/CIE S 010, *Photometry — The CIE system of physical photometry*

CIE 15, *Colorimetry*

CIE 17.4-1987, *International lighting vocabulary*

1) To be published. (Revision of ISO 3864-1:2002)

2) To be published.

3 Terms and definitions

3.1
luminous efficiency
ratio of radiant flux weighted according to $V(\lambda)$ to the corresponding radiant flux

[CIE 17.4-1987]

3.2
spectral luminous efficiency
〈of a monochromatic radiation of wavelength λ ($V(\lambda)$ for photopic vision; $V'(\lambda)$ for scotopic vision〉 ratio of the radiant flux at wavelength λ_m to that at wavelength λ, such that both radiations produce equally intense luminous sensations under specified photometric conditions and λ_m is chosen so that the maximum value of this ratio is equal to 1

NOTE 1 Adapted from CIE 17.4-1987.

NOTE 2 The values for spectral luminous efficiency in photopic vision are given in ISO 23539/CIE S 010.

3.3
radiant flux
power emitted, transformed or received in the form of radiation

NOTE The radiant flux is expressed in watts (W).

[CIE 17.4-1987]

3.4
age-related photopic spectral luminous efficiency
$V_a(\lambda)$
spectral luminous efficiency defined as a function of age, a

3.5
luminance contrast
ratio between the higher luminance, L_H, and lower luminance, L_L, that defines the feature to be detected

NOTE 1 If measured by contrast modulation (or Michelson contrast) it is defined as:

$$C_m = \frac{L_H - L_L}{L_H + L_L} \quad (1)$$

or, if measured by contrast ratio (CR), it is defined as:

$$CR = \frac{L_H}{L_L} \quad (2)$$

NOTE 2 Contrast ratio, CR, is often used for high luminances. When near the luminance-detection threshold, some use the following form (also known as Weber contrast):

$$C_w = \frac{L_H - L_L}{L_L} \quad (3)$$

NOTE 3 For some but not all displays, area-luminance targets can be used to approximate the luminances that define the feature to be detected because pixels are discrete and near-area luminance is sufficiently uniform.

[ISO 9241-302:2008]

NOTE 4 Equation (2) is used in this International Standard. Equations (1) and (3) may also be used to calculate age-related luminance contrast.

3.6
age-related luminance contrast
$C_a(\lambda)$
luminance contrast defined as a function of age, a

NOTE The formula is given in Equation (4).

3.7
photopic vision
vision by the normal eye when it is adapted to levels of luminance of at least several candelas per square metre

[CIE 17.4-1987]

3.8
CIE standard photometric observer
ideal observer having a relative spectral responsivity curve that conforms to the $V(\lambda)$ function for photopic vision or to the $V'(\lambda)$ function for scotopic vision, and that complies with the summation law implied in the definition of luminous flux

[CIE 17.4-1987]

4 Age-related luminance contrast

The equation for age-related luminance contrast, C_a, is derived from the luminance contrast equation in which the luminance term is accommodated to the value that takes into account the age-related change of spectral luminous efficiency. See Table 1. Equation (4) shall be applied when age-related luminance contrast is calculated for light P_1 and light P_2 with spectral radiance of $L_{e,\lambda,1}$ and $L_{e,\lambda,2}$, respectively.

$$C_a = \frac{\sum_{380}^{780} L_{e,\lambda,1} V_a(\lambda)\Delta\lambda}{\sum_{380}^{780} L_{e,\lambda,2} V_a(\lambda)\Delta\lambda} \quad (4)$$

$$\text{for } \sum_{380}^{780} L_{e,\lambda,1} V_a(\lambda)\Delta\lambda > \sum_{380}^{780} L_{e,\lambda,2} V_a(\lambda)\Delta\lambda$$

where

C_a is the age-related luminance contrast for age, a;

$L_{e,\lambda,1}$ is the spectral radiance of light P_1, expressed in $W \cdot m^{-2} \cdot sr^{-1} \cdot nm^{-1}$;

$L_{e,\lambda,2}$ is the spectral radiance of light P_2, expressed in $W \cdot m^{-2} \cdot sr^{-1} \cdot nm^{-1}$;

$V_a(\lambda)$ is the age-related photopic spectral luminous efficiency of age, a, in years (values given in Table 1 in decade steps);

$\Delta\lambda$ is the wavelength width (5 nm).

NOTE 1 Age, a, is expressed in years but specified in decade steps such as 10-19 or 20-29 years, as indicated in Table 1. For example, C_{20} and $V_{20}(\lambda)$ mean the age-related luminance contrast and age-related photopic spectral luminous efficiency function, respectively, averaged for people in their twenties.

NOTE 2 $L_{e,\lambda,1}$ and $L_{e,\lambda,2}$, as well as $V_a(\lambda)$, are tabulated in the range of 380 nm to 780 nm in 5 nm steps as shown in Table 1. $\Delta\lambda$ in Equation (4) is therefore 5 nm. For more accurate calculation, the 1 nm width is applied by using interpolation. There are a few methods for interpolation recommended by the CIE depending on the spectral composition (see CIE 15).