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Standard method of assessing the spectral quality of daylight simulators for visual appraisal and measurement of colour

Méthode normalisée d'évaluation de la qualité spectrale des simulateurs de lumière du jour pour le jugement visuel et la mesure des couleurs

Reference number
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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11

Email: copyright@iso.org
Website: www.iso.org

CIE Central Bureau
Babenbergerstraße 9/9A • A-1010 Vienna

Phone: +43 1 714 3187
Fax: +41 22 749 09 47
Email: ciecb@cie.co.at
Website: www.cie.co.at

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Foreword

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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 document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by the International Commission on Illumination (CIE) in cooperation with Technical Committee ISO/TC 274, *Light and lighting*.

This first edition of ISO/CIE 23603 cancels and replaces ISO 23603:2005, which has been technically revised.

The main changes are as follows:

— prior reference numbers of the document (CIE S 012:2004, ISO 23603:2005) replaced by ISO/CIE 23603;

— normative references updated;

— terms and definitions updated;

— minor editorial changes.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

The purpose of the assessment method described in this document is to quantify the suitability of the spectral irradiance distribution of a practical daylight simulator of CIE daylight illuminant D55, D75 or CIE standard daylight illuminants D50 and D65 for the visual appraisal and measurement of colours of fluorescent or non-fluorescent specimens.

The basis for the assessment is the special metamerism index for change in illuminant, using pairs of virtual (rather than real) specimens specified by their reflecting and fluorescing properties. The pairs of specimens are metameric matches under the CIE daylight illuminant, when evaluated with the CIE 1964 standard colorimetric observer. The method described in this document quantifies the mismatch when the pairs of virtual specimens are illuminated by the daylight simulator under test and evaluated by the same standard colorimetric observer.

A visible range metamerism index is derived to quantify the suitability of the simulator for the visible wavelength range.

An ultraviolet range metamerism index is derived using a different set of virtual metameric pairs, each pair having a fluorescent and a non-fluorescent specimen which spectrally match for the CIE daylight illuminant and CIE standard colorimetric observer. The non-fluorescent specimen in each pair is specified by its spectral radiance factor. The fluorescent specimen in each pair is specified by its spectral reflected radiance factor, relative spectral distribution of radiance due to fluorescence and spectral external radiant efficiency of the fluorescent specimen. The ultraviolet range metamerism index quantifies the mismatch due to fluorescence that results from the use of the daylight simulator and the CIE 1964 standard colorimetric observer.

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Standard method of assessing the spectral quality of daylight simulators for visual appraisal and measurement of colour

1 Scope

This document specifies a method of assessing the spectral quality of the irradiance provided by a daylight simulator to be used for visual appraisal of colours or for colour measurements and a method of assigning a quality grade to the simulator. It specifies the maximum permissible deviation of the chromaticity of the simulator from the chromaticity of the CIE standard daylight illuminant or CIE daylight illuminant being simulated for a daylight simulator to be graded by this method.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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/CIE 11664-1, *Colorimetry — Part 1: CIE standard colorimetric observers*

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

ISO/CIE 11664-4, *Colorimetry — Part 4: CIE 1976 L*a*b* colour space*

ISO/CIE 11664-5, *Colorimetry — Part 5: CIE 1976 L*u*v* Colour Space and u′, v′ Uniform Chromaticity Scale Diagram*

CIE 051.2-1999, *A Method for Assessing the Quality of Daylight Simulators for Colorimetry*

CIE 250:2022, *Spectroradiometric measurement of optical radiation sources*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

CIE maintains a terminology database for use in standardization at the following address:

— CIE e-ILV: available at https://cie.co.at/e-ilv

3.1
daylight simulator
device for the visual appraisal or measurement of the colour of materials or surfaces that provides spectral irradiance approximating a CIE standard illuminant representing a phase of daylight

[SOURCE: CIE S 017:2020, Entry 17-23-025]

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3.2
quality grade
<illuminant simulator> class of quality of simulation of the spectral irradiance of a CIE illuminant by a simulator, expressed as a letter symbol A, B, C, D or E, with class A representing the highest quality

[SOURCE: CIE S 017:2020, Entry 17-23-024]

3.3
reflectance factor
R
quotient of the flux reflected in the directions delimited by a given cone with apex at a surface element, Φ_n, and the flux reflected in the same directions by a perfect reflecting diffuser identically irradiated or illuminated, Φ_d

$$R = \frac{\Phi_n}{\Phi_d}$$

Note 1 to entry: The definition holds for a surface element, for the part of the reflected radiation contained in a given cone with apex at the surface element, and for incident radiation of given spectral composition, polarization and geometric distribution.

Note 2 to entry: The reflectance factor is also defined spectrally and is called spectral reflectance factor, $R(\lambda)$.

Note 3 to entry: The ideal isotropic (Lambertian) diffuser with reflectance or transmittance equal to 1 is called a perfect diffuser.

Note 4 to entry: For regularly reflecting surfaces that are irradiated or illuminated by a beam of small solid angle, the reflectance factor can be much larger than 1 if the cone includes the mirror image of the source.

Note 5 to entry: If the solid angle of the cone approaches 2π sr, the reflectance factor approaches the reflectance for the same conditions of irradiation.

Note 6 to entry: If the solid angle of the cone approaches 0 sr, the reflectance factor approaches the radiance factor or luminance factor for the same conditions of irradiation.

Note 7 to entry: The reflectance factor has unit one.

[SOURCE: CIE S 017:2020, Entry 17-24-070, modified — Notes 8 and 9 to entry omitted.]

3.4
radiance factor
β_e
quotient of the radiance of a surface element in a specified direction, $L_{e,n}$ and the radiance of the perfect reflecting diffuser or perfect transmitting diffuser identically irradiated and viewed, $L_{e,d}$

$$\beta_e = \frac{L_{e,n}}{L_{e,d}}$$

Note 1 to entry: The definition holds for a surface element of a non-self-radiating medium, in a specified direction and under specified conditions of irradiation.

Note 2 to entry: Radiance factor is equivalent to reflectance factor or luminance factor when the cone angle is infinitely small, and is equivalent to reflectance when the cone angle is 2π sr. These quantities are also defined spectrally and called spectral radiance factor, $\beta(\lambda)$, and spectral reflectance factor, $R(\lambda)$.

Note 3 to entry: The ideal isotropic (Lambertian) diffuser with reflectance or transmittance equal to 1 is called a perfect diffuser.

Note 4 to entry: For photoluminescent media, the radiance factor contains two components, the reflected radiance factor, β_R, and the luminescent radiance factor, β_L. The sum of reflected radiance factor and luminescent radiance factor is the total radiance factor, β_T: $\beta_T = \beta_R + \beta_L$.

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