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# Paper and board — Determination of CIE whiteness, D65/10° (outdoor daylight)

*Papier et carton — Détermination du degré de blanc CIE, D65/10° (lumière du jour extérieure)*

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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.

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 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*.

This third edition cancels and replaces the second edition (ISO 11475:2004), which has been technically revised. The major change is to allow for calculations to use ASTM E308 for instruments that have bandpass correction and still maintain the non-bandpass-correction procedure. This third edition also includes Precision Data.


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# Paper and board — Determination of CIE whiteness, D65/10° (outdoor daylight)

## 1 Scope

This document specifies the procedure to be used for determining the whiteness of papers and boards. The values obtained correspond to the visual appearance of white papers and boards with or without fluorescent whitening agents when they are viewed under the CIE D65 daylight standard illuminant. It is based on reflectance data obtained over the full visible spectral range (VIS) in contrast to the measurement of ISO brightness which is limited to the blue region of VIS.

In addition, it specifies a method for adjustment of the UV content to correspond to the CIE D65 daylight illuminant[10][11], insofar as results obtained when fluorescent whitening agents are present are dependent upon the UV content of the radiation falling upon the sample. It is specific for white fluorescent paper samples where the emission due to the fluorescent whitening agent (FWA) occurs in the blue region of the visible spectrum.

This method is not applicable to coloured papers containing fluorescent dyes.

This document should be read in conjunction with ISO 2469.

NOTE 1 This document is based on the CIE whiteness formula, published in CIE 15.3-2004[9].

NOTE 2 A related International Standard, ISO 11476, specifying the procedure for obtaining values corresponding to the appearance of these products under indoor illumination, has also been published.

## 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 186, *Paper and board — Sampling to determine average quality*

ISO 2469:2014, *Paper, board and pulps — Measurement of diffuse radiance factor (diffuse reflectance factor)*

ISO 4094, *Paper, board and pulps — International calibration of testing apparatus — Nomination and acceptance of standardizing and authorized laboratories*

## 3 Terms and definitions

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

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

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

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

NOTE The symbols used here are selected to maintain consistency, wherever possible, with Reference [8].

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**3.1**
**reflectance factor**
$R$
ratio of the radiation reflected by a body to that reflected by the perfect reflecting diffuser under the same conditions

Note 1 to entry: The ratio is expressed as a percentage.

**3.2**
**intrinsic reflectance factor**
$R_\infty$
*reflectance factor* (3.1) of a layer or pad of the material thick enough to be opaque, i.e. such that increasing the thickness of the pad by doubling the number of sheets results in no change in the measured reflectance factor

**3.3**
**diffuse radiance factor**
$\beta$
ratio of the diffusely reflected radiance of a body in a given direction to that of the perfect reflecting diffuser under specified conditions of irradiation

Note 1 to entry: For fluorescent (luminescent) materials, the specified conditions of irradiation in this document are for CIE Standard Illuminant D65 and the diffuse radiance factor is strictly the total radiance factor, $\beta$, which contains two components, the reflected radiance factor, $\beta_R$, and the luminescent radiance factor, $\beta_L$, so that

$$\beta = \beta_R + \beta_L$$

Note 2 to entry: For non-fluorescent materials, the diffuse radiance factor, $\beta$, is simply the *reflectance factor*, $R$ (3.1).

**3.4**
**intrinsic diffuse radiance factor**
$\beta_\infty$
*diffuse radiance factor* (3.3) of a layer or pad of the material thick enough to be opaque, i.e. such that increasing the thickness of the pad by doubling the number of sheets results in no change in the measured diffuse radiance factor

Note 1 to entry: For fluorescent (luminescent) materials, the intrinsic diffuse radiance factor is, strictly speaking, the total intrinsic radiance factor, $\beta_\infty$, which contains two components: the intrinsic reflected radiance factor, $\beta_{\infty,R}$, and the intrinsic luminescent radiance factor, $\beta_{\infty,L}$, so that

$$\beta_\infty = \beta_{\infty,R} + \beta_{\infty,L}$$

Note 2 to entry: For non-fluorescent materials, the intrinsic diffuse radiance factor, $\beta_R$, is simply the intrinsic *reflectance factor*, $R_\infty$ (3.2).

**3.5**
**CIE whiteness value**
$W_{10}$
measure of whiteness derived from the CIE tristimulus values

Note 1 to entry: CIE whiteness is dimensionless and is expressed as whiteness units.

**3.6**
**green tint value**
**red tint value**
$T_{W10}$
measure of the deviation from whiteness of the test material towards the green or red region

Note 1 to entry: The tint value is dimensionless and is expressed as tint units.

Note 2 to entry: A positive value of $T_{W10}$ indicates a greenish tint and a negative value indicates a reddish tint.


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**3.7**
**fluorescence component**
$F_{10}$
measure of the extent to which the whiteness of the material is affected by excitation of the added fluorescent whitening agent (FWA)

Note 1 to entry: The suffix 10 in the terms given in 3.5 to 3.7 is used to indicate that the value refers to the CIE 1964 (10°) observer.

## 4 Principle

The diffuse radiance factor of the material is determined under standardized conditions after the instrument has been adjusted so that a reference standard has the same CIE whiteness value as it would have under CIE standard illuminant D65, and the CIE whiteness value and the tint value are calculated. The fluorescence component of the whiteness is calculated from the difference between this whiteness value and the whiteness value obtained when the fluorescence emission from the material is eliminated, for instance, by the introduction of a sharp cut-off UV-absorbing filter into the light beams.

## 5 Apparatus and equipment

**5.1 Reflectometer or spectrophotometer**, having the geometric, spectral and photometric characteristics described in ISO 2469:2014, Annex A, calibrated in accordance with the provisions of ISO 2469:2014, Annex B, and equipped with a light source having an adequate UV content and a means of adjusting the relative UV content so that the measured CIE whiteness value agrees with that corresponding to the CIE standard illuminant D65.

For the measurement of reflectance factors with the fluorescence effect eliminated, the instrument shall be equipped with a sharp cut-off, UV-absorbing filter having a transmittance not exceeding 5,0 % at and below a wavelength of 410 nm and not exceeding 50 % at a wavelength of 420 nm. The cut-off filter shall have characteristics such that a reliable reflectance value is obtained at 420 nm. The reflectance value obtained at 420 nm shall then be considered for computational purposes to be the value which applies at all lower wavelengths at which it is not possible to make any measurement.

For the measurement of fluorescent papers, photometric linearity up to a scale reading of at least 200 % is necessary in the wavelength region corresponding to the fluorescent emission.

**5.1.1 In the case of a filter reflectometer**, pairs of filters giving the photoelectric detectors of the reflectometer responses equivalent to the CIE tristimulus values $X_{10}$, $Y_{10}$, $Z_{10}$ of the test piece, evaluated for the CIE standard illuminant D65 and CIE 1964 (10°) observer[4].

**5.1.2 In the case of an abridged spectrophotometer**, a means of calculating the weighted means according to the requirements of the CIE standard illuminant D65 and CIE 1964 (10°) observer using the weighting functions given in Annex A and Reference [7], where Table A.1 and Table A.2 are used for instruments without bandpass correction and Table A.3 and Table A.4 are used for instruments with bandpass correction.

**5.2 Working standards**.

**5.2.1 Two plates of flat opal glass or ceramic material**, cleaned as described in ISO 2469.

**5.2.2 A stable plastic or other tablet** incorporating a fluorescent whitening agent.

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