INTERNATIONAL STANDARD

ISO 11475

Third edition
2017-05

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)

Reference number
ISO 11475:2017(E)

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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 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).

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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.

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].

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_∞
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
β
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, β, which contains two components, the reflected radiance factor, β_R, and the luminescent radiance factor, β_L, so that

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

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

3.4
intrinsic diffuse radiance factor
β_∞
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, β_∞, 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, β_R, is simply the intrinsic *reflectance factor*, R_∞ (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.

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.

5.3 Reference standards for calibration of the instrument and working standards.

5.3.1 Non-fluorescent reference standard for calibration, fulfilling the requirements for international reference standards of level 3 (IR3) as prescribed in ISO 2469.

5.3.2 Fluorescent reference standard for use in adjusting the UV content of the radiation incident upon the sample, having whiteness values and other relevant data as specified in Annex B and fulfilling the requirements for international reference standards of level 3 (IR3) as prescribed in ISO 2469.

Use new reference standards sufficiently frequently to ensure satisfactory calibration and UV adjustment.

5.4 Black cavity, having a reflectance factor which does not differ from its nominal value by more than 0,2 % at all wavelengths. The black cavity shall be stored upside down in a dust-free environment or with a protective cover.

The condition of the black cavity should be checked by reference to the instrument maker.

6 Calibration

6.1 Using the values assigned to the non-fluorescent reference standard (5.3.1), calibrate the instrument with the UV cut-off filters removed from the radiation beams. The setting of the UV adjustment filter is not important at this stage.

6.2 Using the appropriate measurement procedure, measure the diffuse radiance factors of the fluorescent reference standard (5.3.2), calculate the whiteness value (see 10.1) and compare the value obtained with that assigned to the fluorescent reference standard.

A measured whiteness value higher than the assigned value indicates that the relative UV content is too high and vice versa.

6.3 Using the UV adjustment filter or other adjustment device, adjust the UV content of the illumination until measurement gives the correct whiteness value.

NOTE If the UV content is too low, it may be necessary to replace the UV adjustment filter with a filter which raises rather than lowers the relative UV content.

6.4 Repeat the calibration as described in 6.1 using the non-fluorescent reference standard (5.3.1) with the UV adjustment filter in the position which gave the correct whiteness value. Repeat the measurement of the whiteness of the fluorescent reference standard (5.3.2) as described in 6.2. If the whiteness value obtained does not agree with the assigned value, adjust the position of the UV adjustment filter until measurement gives the correct whiteness value as described in 6.3.

6.5 Repeat 6.4 until the correct value for the whiteness of the fluorescent reference standard is obtained with the instrument correctly calibrated to the non-fluorescent reference standard. The relative UV content is now correctly adjusted with respect to whiteness so that the setting gives the CIE whiteness value equivalent to the CIE standard illuminant D65 and CIE 1964 (10°) observer. Record the setting of the UV adjustment.

NOTE 1 Variations in the green/red tint value can still arise and it cannot be assumed that the tristimulus values and other parameters will also be exactly applicable to the D65 illuminant.

NOTE 2 In some instruments, the procedure indicated in 6.2 to 6.5 is performed automatically.

6.6 Calibrate the fluorescent working standard (5.2.2) as the working standard.

This working standard shall only be used in the specific instrument in which it is calibrated and shall only be used to monitor changes in the lamps. It shall be recalibrated against a fluorescent reference standard of level 3 (5.3.2) if the lamps are changed.

6.7 Calibrate the opal glass or ceramic plates (5.2.1) as working standards as described in ISO 2469.

6.8 After adjustment of the UV content as in 6.1 to 6.5, insert the UV cut-off filter and calibrate the instrument in this position with the UV adjustment unchanged.

7 Sampling

Sampling is not included in this document. If the mean quality of a lot is to be determined, sampling shall be according to ISO 186. Otherwise, the method of sampling should be reported and care should be taken to ensure that the test pieces are representative of the sample available.

8 Preparation of test pieces

Avoiding watermarks, dirt and obvious defects, cut rectangular test pieces approximately 75 mm × 150 mm. Assemble at least 10 of the test pieces in a pad with their top sides uppermost; the number should be such that doubling the number of test pieces does not alter the reflectance factor. Protect the pad by placing an additional sheet on both top and bottom of the pad. Avoid contamination and unnecessary exposure to light or heat.

Mark the top test piece in one corner to identify the sample and its top side.

If the top side can be distinguished from the wire side, it shall be uppermost. If the distinction is not possible, as may be the case for papers manufactured on double-wire machines or those coated on both sides, ensure that the same side of the test piece is uppermost so that the CIE whiteness can be determined separately for each side of the paper or board.

Pulp sheets prepared in accordance with ISO 3688 may be measured in the same way, but whiteness is not normally considered to be a pulp property.

9 Procedure

9.1 Remove the UV cut-off filter from the light beam. Operate the reflectometer or spectrophotometer as described in ISO 2469.

9.2 Remove the protecting sheets from the pad of test pieces and measure the intrinsic diffuse radiance factors of the top test piece.

9.3 Move the measured test piece to the bottom of the pad. Repeat 9.2 until at least 10 measurements have been made. Repeat on the reverse side of the paper or board.

9.4 If an assessment of the fluorescence component is required, place the UV cut-off filter in the light beam. Operate the reflectometer or spectrophotometer as described in ISO 2469, and measure the intrinsic diffuse radiance factor of the top test piece without UV excitation, i.e. the intrinsic reflected radiance factor only.

9.5 Move the measured test piece to the bottom of the pad. Repeat 9.4 until at least 10 measurements have been made. Repeat on the reverse side of the paper or board.

NOTE Normally, the CIE whiteness and tint values will be automatically calculated (see 10.1) for each test piece at the time of measurement. In some instruments, it will be more convenient to measure the whiteness with and without fluorescence excitation on each test piece before proceeding to the next of the 10 pieces.

10 Calculation and expression of results

10.1 Calculate the whiteness, W_{10}, and tint, T_{W10}, values for each test piece, for the two sides separately, according to Formula (1) and Formula (2)[9]:

$$W_{10} = Y_{10} + 800\left(x_{n,10} - x_{10}\right) + 1\,700\left(y_{n,10} - y_{10}\right) \tag{1}$$

$$T_{W,10} = 900\left(x_{n,10} - x_{10}\right) - 650\left(y_{n,10} - y_{10}\right) \tag{2}$$

where

x_{10} and y_{10} are the chromaticity coordinates of the test piece, calculated as:

$$x_{10} = \frac{X_{10}}{X_{10} + Y_{10} + Z_{10}}$$

$$y_{10} = \frac{Y_{10}}{X_{10} + Y_{10} + Z_{10}}$$

X_{10}, Y_{10} and Z_{10} are the tristimulus values of the test piece for D65/10° conditions;

$x_{n.10}$ and $y_{n.10}$ are the chromaticity coordinates of the perfect reflecting diffuser for the illumination and observer specified ($x_{n.10}$ = 0,313 81 and $y_{n.10}$ = 0,330 98 for D65/10°).

10.2 For a sample to be considered white, the following limiting values for both whiteness and tint [Formula (3) and Formula (4)] shall be met[9]:

$$40 < W_{10} < \left(5Y_{10} - 280\right) \tag{3}$$

$$-4 < T_{w,10} < 2 \tag{4}$$

10.3 Where relevant, calculate the CIE whiteness without fluorescence excitation, $W_{0,10}$, i.e. with the UV cut-off filter in the light beam or other means used to eliminate the UV content of the illumination (5.1). Calculate the fluorescence component, F_{10}, of the CIE whiteness D65/10° as the difference between the two CIE whiteness values measured with and without fluorescence excitation, as given in Formula (5):

$$F_{10} = W_{10} - W_{0,10} \tag{5}$$

where

W_{10} is the CIE whiteness determined when the illumination has the desired UV content corresponding to the D65/10° illuminant;

$W_{0,10}$ is the CIE whiteness determined when the radiation which excites fluorescence has been eliminated.

NOTE A cut-off filter which eliminates only the UV component below 400 nm does not eliminate all the fluorescence effect.

10.4 Calculate the mean values and report the mean CIE whiteness (D65/10°) separately for both sides to the nearest integer, and the tint value to one decimal. If either W_{10} or T_{W10} falls outside the limits given in 10.2, report that the sample is "not white according to CIE". If $W_{0,10}$ falls outside the limits given in 10.2, it is not necessary to report this fact. Report the fluorescence component as the CIE whiteness difference to the nearest integer.

11 Precision

Round robin testing of paper samples of different whiteness values have shown a between-laboratory standard deviation of the order of ±1,1 to 1,4 CIE whiteness unit. See Annex C for further details.

12 Test report

The test report shall include the following information:

a) the date and place of testing;

b) the precise identification of the sample;

c) a reference to this document, i.e. ISO 11475;

d) the CIE whiteness value, the tint value and, if required, the fluorescence component of the whiteness for the two sides separately;

e) the type of apparatus used;

f) the type of instrument source used;

g) any departure from this document or any other circumstances that may have affected the results.

Annex A
(normative)

Spectral characteristics of reflectometers for determining tristimulus values

A.1 Filter reflectometers

The required spectral characteristics of the reflectometer are arrived at by a combination of lamps, integrating sphere, glass optics, filters and photoelectric cells. The filters shall be such that they, together with the optical characteristics of the instrument, give overall responses equivalent to the CIE tristimulus values X_{10}, Y_{10}, Z_{10} of the CIE 1964 (10°) standard colorimetric system of the test piece evaluated for the CIE standard illuminant D65.

A.2 Abridged spectrophotometers

A.2.1 General

The desired tristimulus values are obtained by summing the products of the spectral reflectance factors and the weighting functions given in ASTM E308 for the CIE standard illuminant D65 and the CIE 1964 (10°) observer.

"Check sum" and "White point" data are given at the bottom of each column in Table A.1 to Table A.4. The "check sum" is the algebraic sum of the entries. It provides, as a convenience, a check value to ensure that the tables have been copied correctly should copying be required. These check sums may not be identical to the "White point" data located below them because of roundoff. Each value in a column has been rounded to three decimal digits. It is these "White point" data, and no others, that shall be used as X_n Y_n Z_n when converting tristimulus values calculated by use of these tables to CIELAB or CIELUV coordinates or for any other purpose requiring the ratio of the tristimulus value of the specimen to that of the "White point".

Apply the following instructions, given in ASTM E308-08, 7.3.2.2, when the values are not available at the top or at the bottom of the range:

Wavelength range outside the range 360 nm to 780 nm. When data for $R(\lambda)$ are not available for the full wavelength range, add the weights at the wavelengths for which data are not available to the weights at the shortest or longest wavelength for which spectral data are available.

That is:

a) add the weights for all wavelengths (360 nm, ...,) for which measured data are not available to the next higher weight for which such data are available;

b) add the weights for all wavelengths (..., 780 nm) for which measured data are not available to the next lower weight for which such data are available.

A.2.2 Procedure for using data without bandpass correction

Use Table A.1 and Table A.2 when the spectral data have not been corrected for bandpass dependence and for which the bandpass is approximately equal to the measurement interval; Table A.1 is to be used when the data have been obtained at 10 nm measurement intervals while Table A.2 is to be used when the data has been obtained at 20 nm measurement intervals. These tables apply a correction for spectral bandpass dependence built into the calculation of the tristimulus values.

A.2.3 Procedure for using data with bandpass correction

Use Table A.3 and Table A.4 when the spectral data have been already corrected for bandpass dependence (e.g. by the instrument manufacturer) and for which the bandpass is approximately equal to the measurement interval; Table A.3 is to be used when the data have been obtained at 10 nm measurement intervals while Table A.4 is to be used when the data have been obtained at 20 nm measurement intervals.

NOTE 1 Table A.3 and Table A.4 were added to this document to allow for calculation using instrumentation that does not require bandpass correction, i.e. has already been built into the instrument and applied to the reported raw data.

NOTE 2 Raw reflectance data will differ for instruments with built-in bandpass correction from those without. However, after the appropriate weighting table is used, the resulting colorimetric values will be nearly identical.

Table A.1 — Weighting functions (D65/10°) for instruments without bandpass correction and measuring at 10 nm intervals (Source: **ASTM E308–08**)

Wavelength nm	$W_{10,X}$	$W_{10,Y}$	$W_{10,Z}$
360	0,000	0,000	0,000
370	0,000	0,000	−0,001
380	0,001	0,000	0,004
390	0,005	0,000	0,020
400	0,097	0,010	0,436
410	0,616	0,064	2,808
420	1,660	0,171	7,868
430	2,377	0,283	11,703
440	3,512	0,549	17,958
450	3,789	0,888	20,358
460	3,103	1,277	17,861
470	1,937	1,817	13,085
480	0,747	2,545	7,510
490	0,110	3,164	3,743
500	0,007	4,309	2,003
510	0,314	5,631	1,004
520	1,027	6,896	0,529
530	2,174	8,136	0,271
540	3,380	8,684	0,116
550	4,735	8,903	0,030
560	6,081	8,614	−0,003
570	7,310	7,950	0,001
580	8,393	7,164	0,000
590	8,603	5,945	0,000
600	8,771	5,110	0,000
610	7,996	4,067	0,000
620	6,476	2,990	0,000
630	4,635	2,020	0,000
640	3,074	1,275	0,000
650	1,814	0,724	0,000
660	1,031	0,407	0,000

Table A.1 *(continued)*

Wavelength nm	$W_{10,X}$	$W_{10,Y}$	$W_{10,Z}$
670	0,557	0,218	0,000
680	0,261	0,102	0,000
690	0,114	0,044	0,000
700	0,057	0,022	0,000
710	0,028	0,011	0,000
720	0,011	0,004	0,000
730	0,006	0,002	0,000
740	0,003	0,001	0,000
750	0,001	0,000	0,000
760	0,000	0,000	0,000
770	0,000	0,000	0,000
780	0,000	0,000	0,000
Check sum	**94,813**	**99,997**	**107,304**
White point	**94,811**	**100,000**	**107,304**

Table A.2 — Weighting functions (D65/10°) for instruments without bandpass correction and measuring at 20 nm intervals (Source: ASTM E308–08)

Wavelength nm	$W_{10,X}$	$W_{10,Y}$	$W_{10,Z}$
360	0,000	0,000	0,000
380	0,003	−0,001	0,025
400	0,056	0,013	0,199
420	2,951	0,280	13,768
440	7,227	1,042	36,808
460	6,578	2,534	37,827
480	1,278	4,872	14,226
500	−0,259	8,438	3,254
520	1,951	14,030	1,025
540	6,751	17,715	0,184
560	12,223	17,407	−0,013
580	16,779	14,210	0,004
600	17,793	10,121	−0,001
620	13,135	5,971	0,000
640	5,859	2,399	0,000
660	1,901	0,741	0,000
680	0,469	0,184	0,000
700	0,088	0,034	0,000
720	0,023	0,009	0,000
740	0,005	0,002	0,000
760	0,001	0,000	0,000
780	0,000	0,000	0,000
Check sum	**94,812**	**100,001**	**107,306**
White point	**94,811**	**100,000**	**107,304**

Table A.3 — Weighting functions (D65/10°) for instruments with bandpass correction and measuring at 10 nm intervals (Source: **ASTM E308–08**)

Wavelength nm	$W_{10,X}$	$W_{10,Y}$	$W_{10,Z}$
360	0,000	0,000	0,000
370	0,000	0,000	0,000
380	0,000	0,000	−0,002
390	0,008	0,001	0,033
400	0,137	0,014	0,612
410	0,676	0,069	3,110
420	1,603	0,168	7,627
430	2,451	0,300	12,095
440	3,418	0,554	17,537
450	3,699	0,890	19,888
460	3,064	1,290	17,695
470	1,933	1,838	13,000
480	0,802	2,520	7,699
490	0,156	3,226	3,938
500	0,039	4,320	2,046
510	0,347	5,621	1,049
520	1,070	6,907	0,544
530	2,170	8,059	0,278
540	3,397	8,668	0,122
550	4,732	8,855	0,035
560	6,070	8,581	0,001
570	7,311	7,951	0,000
580	8,291	7,106	0,000
590	8,634	6,004	0,000
600	8,672	5,079	0,000
610	7,930	4,065	0,000
620	6,446	2,999	0,000
630	4,669	2,042	0,000
640	3,095	1,290	0,000
650	1,859	0,746	0,000
660	1,056	0,417	0,000
670	0,570	0,223	0,000
680	0,274	0,107	0,000
690	0,121	0,047	0,000
700	0,058	0,023	0,000
710	0,028	0,011	0,000
720	0,012	0,005	0,000
730	0,006	0,002	0,000
740	0,003	0,001	0,000
750	0,001	0,001	0,000
760	0,001	0,000	0,000
770	0,000	0,000	0,000

Table A.3 *(continued)*

Wavelength nm	$W_{10.X}$	$W_{10.Y}$	$W_{10.Z}$
780	0,000	0,000	0,000
Check sum	**94,809**	**100,000**	**107,307**
White point	**94,811**	**100,000**	**107,304**

Table A.4 — Weighting functions (D65/10°) for instruments with bandpass correction and measuring at 20 nm interval (Source: **ASTM E308–08**)

Wavelength nm	$W_{10.X}$	$W_{10.Y}$	$W_{10.Z}$
360	−0,001	0,000	−0,007
380	−0,043	−0,004	−0,200
400	0,378	0,035	1,667
420	3,138	0,320	14,979
440	6,701	1,104	34,461
460	6,054	2,605	35,120
480	1,739	4,961	15,986
500	0,071	8,687	4,038
520	2,183	13,844	1,031
540	6,801	17,327	0,229
560	12,171	17,153	0,002
580	16,465	14,150	−0,003
600	17,230	10,118	0,000
620	12,872	6,012	0,000
640	6,248	2,593	0,000
660	2,126	0,832	0,000
680	0,544	0,210	0,000
700	0,105	0,041	0,000
720	0,023	0,009	0,000
740	0,005	0,002	0,000
760	0,001	0,000	0,000
780	0,000	0,000	0,000
Check sum	**94,811**	**99,999**	**107,303**
White point	**94,811**	**100,000**	**107,304**

Annex B
(normative)

UV calibration service

B.1 General

In this document, reference is made to special reference standards which are required to enable the relative UV content in the illumination falling on the test piece to be adjusted to conform to the D65 illuminant.

To enable this to be done, the following procedure is established.

B.2 Standardizing laboratories

A laboratory (or laboratories) equipped to make primary spectrofluorimetric measurements using the two-monochromator method is appointed as a "standardizing laboratory" in accordance with the provisions of ISO 4094. Such a laboratory issues fluorescent "international reference standards of level 2" (IR2) to the authorized laboratories. Such reference standards shall be assigned spectral total radiance factor data for the CIE standard illuminant D65. Standardizing laboratories shall meet the general requirements for quality and competence of its IR2 calibration results, in accordance with the provisions of ISO 4094.

B.3 Authorized laboratories

B.3.1 Laboratories having the necessary technical competence and maintaining reference instruments having the characteristics specified in ISO 2469 are appointed as "authorized laboratories" in accordance with the provisions of ISO 4094.

NOTE It is anticipated that these authorized laboratories will automatically be the same as those authorized in accordance with the requirements of ISO 2469, but the standardizing laboratories will not necessarily be the same as those appointed according to ISO 2469 since different equipment is required.

B.3.2 An authorized laboratory shall make any necessary adjustment to correct for differences in the basic photometric level between the instrument at the standardizing laboratory and the level specified for the authorized laboratory in ISO 2469, before calculating the CIE whiteness value of the IR2 and using this value to adjust the UV content of the reference instrument. The calculations shall be carried out using 10 nm data and the weighting functions given in Annex A, which are taken from ASTM E308-08.

B.3.3 An authorized laboratory shall take steps to ensure that directional effects in the IR2 which may affect the measurements at the standardizing laboratory are recognized and taken into account when determining the value to be used when transferring this calibration to an instrument providing a diffuse illumination.

B.3.4 Authorized laboratories shall make interlaboratory comparisons at least every second year. Agreement to within ±1 whiteness unit should be achieved.

NOTE A list of standardizing and authorized laboratories is available at the ISO/TC 6 secretariat.