INTERNATIONAL STANDARD

ISO 7589

Second edition
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Photography — Illuminants for sensitometry — Specifications for daylight, incandescent tungsten and printer

Photographie — Illuminants sensitométriques — Spécifications pour la lumière du jour, la lumière artificielle et la tireuse

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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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 7589 was prepared by Technical Committee ISO/TC 42, *Photography*.

This second edition cancels and replaces the first edition (ISO 7589:1984), which has been technically revised and enlarged to include a standard sensitometric illuminant for black-and-white papers.

Annexes A to D of this International Standard are for information only.

Introduction

Colour and black-and-white camera films are most commonly designed for use with three light sources, these being daylight, studio tungsten (type B) and photoflood (type A), while black-and-white papers are most commonly used with enlargers employing incandescent tungsten sources. This International Standard specifies three corresponding illuminants for film sensitometry and one for black-and-white paper sensitometry, since most meaningful results are obtained when exposing conditions match those of actual film or paper use. Two other important photographic light sources for film, the electronic flashtube and blue photoflash lamps, give light of a colour that approximates daylight so that the sensitometric daylight illuminant also serves for films used with them.

This International Standard constitutes a revision of the first edition, ISO 7589:1984. It differs from the first edition in that it includes a standard sensitometric illuminant for black-and-white papers (the first edition dealt with camera film illuminants only). No standard exists for the determination of the speeds of colour papers.

The illuminants described in this International Standard are used in ISO 3028, ISO 6728 and other International Standards which describe methods for determining the speed of various types of sensitized products.

Photography — Illuminants for sensitometry — Specifications for daylight, incandescent tungsten and printer

1 Scope

This International Standard specifies the spectral characteristics of illuminants for sensitometry appropriate for evaluating camera films used for pictorial photography in natural daylight, studio tungsten and photoflood, including colour and black-and-white films, both reversal and negative types, and for evaluating black-and-white papers used with incandescent tungsten printers. It also describes methods for evaluating the acceptability of illuminants for sensitometry and specifies tolerances.

It does not include illuminants for use with colour papers, since this would need to take account of the coloured mask of the negative material, for which no standard information is at present available.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 3028:1984, *Photography — Camera flash illuminants — Determination of ISO spectral distribution index (ISO/SDI)*

ISO 6728:1983, *Photography — Camera lenses — Determination of ISO colour contribution index (ISO/CCI)*

3 Terms and definitions

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

3.1
source
physical emitter of energy

3.2
illuminant
light impinging on a sensitized material and having a specific spectral power distribution not necessarily provided directly by a source and not necessarily realizable by a source

3.3
relative spectral power distribution
description of the spectral character of radiation by the relative spectral distribution of some radiometric quantity (radiant flux, radiant intensity)

3.4
distribution temperature
thermodynamic temperature of the full radiator for which the ordinates of the spectral distribution curve of its radiance are proportional, in the visible region, to those of the distribution curve of the radiation considered

3.5
photographic daylight
relative spectral power distribution of typical daylight having a correlated colour temperature of approximately 5 500 K

NOTE This describes the combination of skylight and sunlight when the sun is about 40° above the horizon with a clear atmosphere, and is designated as D_{55}.

3.6
spectral distribution index
SDI
three-number designation for camera films which describes the degree to which a light source is expected to change the overall colour of a photograph relative to that obtained with a specified illuminant, and two-number designation for black-and-white enlarging papers which describes the degree to which a light source affects the relative contributions from emulsion sensitivity and dye sensitivity

4 ISO sensitometric illuminants

4.1 General

This International Standard is concerned with the simulation of the spectral quality of radiation incident on the film (not the camera) or on the enlarger baseboard (not the enlarger lamp).

In order to realize this simulation, a given *photographic* illuminant (which is concerned with the light illuminating the subject matter or the light before passing through the optical system of a printer) has to be suitably modulated. For the purposes of this International Standard, the ISO standard camera lens specified in ISO 6728 has been taken as the best available modulator for which standard data are available.

The relative spectral power distributions of the four ISO sensitometric illuminants described in this International Standard are normally obtained by operating a lamp at a specified condition and modulating the flux with selectively absorbing filters of suitable spectral transmittance. It should be emphasized that this International Standard specifies the relative spectral distribution of power incident on the exposure plane at 10 nm intervals, i.e. the relative spectral power emitted by a source and its modulation by all elements in the sensitometer that affect the spectral quality, for example filters, mirrors and optical wedge.

4.2 ISO sensitometric daylight illuminant

This is suitable for the sensitometry of “daylight balanced” colour films and is also normally used for black-and-white camera films. These films are designed to be exposed in photographic daylight (see 3.5) or with flash. The spectral power distribution used to represent photographic daylight was taken from the data of Judd *et al*.[4] who give typical spectral irradiance data for five different conditions of daylight (skylight and sunlight plus skylight). Data corresponding to a correlated colour temperature of 5 500 K were selected as the most appropriate for photography and designated as D_{55}. This is the prevailing condition in temperate zones during the daylight hours recommended for colour photography.

The ISO sensitometric daylight illuminant is defined as the product of the spectral power distribution of photographic daylight (D_{55}) and the spectral transmittance of the International Standard camera lens, $\overline{\tau}(\lambda)$. The aim values, S_{λ}, for the relative spectral power distribution for this illuminant are given in Table 1. An illuminant complying with these values within the tolerances specified in 5.4 may be designated “ISO sensitometric daylight illuminant”.

4.3 ISO sensitometric studio tungsten illuminant

This is suitable for the sensitometry of type B colour films which are normally exposed with lamps described as 3 200 K lamps. However, the effect of lamp age, reflectors, diffusers and general studio conditions is to reduce the average effective distribution temperature to about 3 050 K. The spectral power distribution used to represent studio tungsten was obtained by spectroradiometric measurements in several professional photographic studios. The aim values, S_λ, for the relative spectral power distribution for this source after modulation by the ISO standard lens are given in Table 2. An illuminant complying with these values within the tolerances specified in 5.4 may be designated “ISO sensitometric studio tungsten illuminant”.

4.4 ISO sensitometric photoflood illuminant

This illuminant is suitable for the sensitometry of type A colour films. The spectral power distribution used to represent photoflood lamps is that of a black body at 3 400 K. The aim values, S_λ, for the relative spectral power distribution of this source after modulation by the ISO standard lens are given in Table 3. An illuminant complying with these values within the tolerances specified in 5.4 may be designated “ISO sensitometric photoflood illuminant”.

4.5 ISO sensitometric printer illuminant

This illuminant is suitable for the sensitometry of black-and-white continuous-tone papers. The spectral power distribution used to represent typical printers is that of a studio tungsten source modified by the ISO standard lens as specified in ISO 6728 and a typical diffusing screen. The aim values, S_λ, for the relative spectral power distribution of this illuminant are given in Table 4. An illuminant complying with these values within the tolerances specified in 6.4 may be designated “ISO sensitometric printer illuminant.”

5 Camera films: Spectral distribution index (ISO/SDI)

5.1 General

The spectral distribution index for camera films is a three-number designation which describes how well a film illuminant matches a specified spectral power distribution in terms of the total photographic responses of the three component emulsions of average colour films. In this International Standard, three different distributions are involved. ISO 3028 gives a more complete description of SDI.

NOTE Other colour imaging systems may exhibit weighted spectral sensitivities similar to those listed in Table 1, 2 or 3. In such a case, the relevant table can be used to calculate SDI values which will estimate illuminant performance.

5.2 Weighted spectral sensitivity values

Weighted spectral sensitivity values for use in evaluating candidate illuminants for acceptability are given in Tables 1, 2 and 3. These values have been weighted so that the aim relative spectral power values for the ISO illuminant in the same table will yield an ISO/SDI of 0/0/0.

5.3 Calculation of the ISO/SDI

The relative spectral power values of a candidate illuminant need to be determined at 10 nm intervals. These values, S_λ, are multiplied by the appropriate blue, green and red weighted spectral sensitivity values $W(\lambda)$. For example, to determine if the illuminant is satisfactory for sensitometric daylight, the weighted spectral sensitivity values in Table 1 would be used. The total photographic responses, R_B, R_G and R_R are obtained by summation $R = \Sigma W(\lambda) S_\lambda$. Logarithms to the base 10 of the total response values are determined to two decimal places. The smallest element of this three-number designation is made equal to zero by subtracting it from all three $\log_{10}$ values. The decimal is eliminated by multiplying by 100. The resultant three numbers are the ISO/SDI for the candidate illuminant. The above calculations are illustrated in Table A.1 for a candidate ISO sensitometric daylight illuminant.

5.4 Tolerances for ISO/SDI

To meet the requirements of this International Standard, the red index shall not differ from the green index by more than ± 3, and the blue index shall not differ from the green index by more than ± 4. These tolerances are depicted in parentheses in Figure 1.

To determine whether an illuminant meets these tolerances, it is recommended that the blue, green and red SDI values be plotted on a trilinear diagram on similar axes to those indicated in Figure 1. This portrays the colour balance of the photographic image obtained with a candidate illuminant compared to that obtained with the illuminant used as a standard.

Calculations for a typical sensitometer set-up that meets the acceptance criterion are illustrated in Table A.1, which shows how to calculate the spectral distribution index. The resultant ISO/SDI 4/2/0 is plotted in Figure 1.

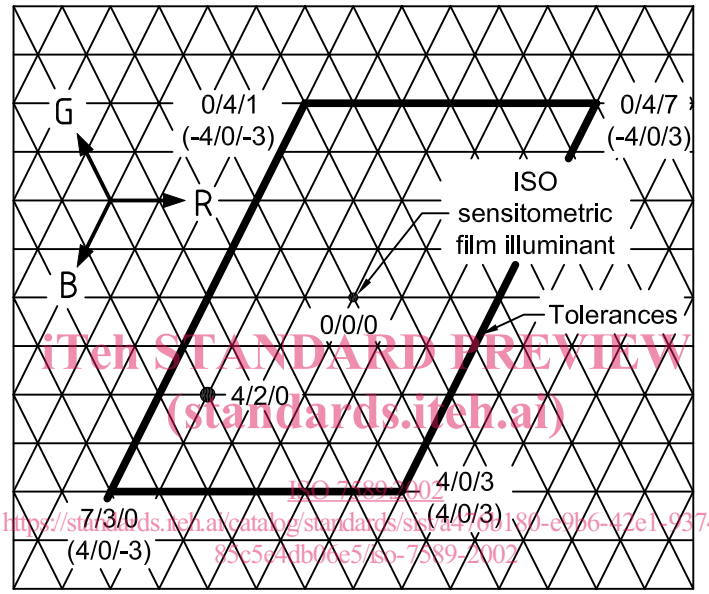

Figure 1 — Trilinear graph for film illuminants

6 Black-and-white papers: Spectral distribution index (ISO/SDI)

6.1 General

The spectral distribution index for black-and-white printing papers is a two-number designation which describes how well a paper illuminant matches the specified spectral power distribution in terms of the total photographic responses of the two sensitivity contributions, emulsion and sensitizing dye, of an average black-and-white enlarging paper.

6.2 Weighted spectral sensitivity values

Weighted spectral sensitivity values for use in evaluating candidate illuminants for acceptability are given in Table 4. These values have been weighted so that the aim relative spectral power values for the ISO sensitometric printer illuminant in the same table will yield an ISO/SDI of 0/0.

6.3 Calculation of the ISO/SDI

The relative spectral power values of a candidate illuminant need to be determined at 10 nm intervals. These values, S_λ, are multiplied by the appropriate emulsion (blue) and dye (blue-green) weighted spectral sensitivity values, $W(\lambda)$ given in Table 4. The total photographic responses R_B and R_G are obtained by summation $R = \Sigma W(\lambda) S_\lambda$. Logarithms to the base 10 of the total response values are determined to two decimal places. The "emulsion" element of this two-number designation is made equal to zero by subtracting it from both $\log_{10}$ values.

The decimal is eliminated by multiplying by 100. The resultant two numbers are the ISO/SDI for the candidate illuminant. The above calculations are illustrated in Table A.2 for a candidate ISO sensitometric printer illuminant.

6.4 Tolerances for ISO/SDI

To meet the requirements of this International Standard, the dye (blue-green) index shall not differ from the emulsion (blue) index by more than ± 4.

Calculations for a typical sensitometer set-up that meets the acceptance criterion are illustrated in Table A.2, which shows how to calculate the spectral distribution index for black-and-white enlarging papers, the resultant ISO/SDI being 0/−2.

Table 1 — Relative spectral power distribution, S_λ, of ISO sensitometric daylight illuminant

Wavelength, λ	Photographic daylight[a] relative power	Relative spectral transmittance of the ISO standard lens	ISO sensitometric daylight illuminant (daylight transmitted by lens)	Weighted spectral sensitivities for calculating ISO/SDI of daylight illuminant		
				Blue	Green	Red
nm	D_{55}	$\bar{\tau}$ (λ)	$S_\lambda = D_{55}\ \bar{\tau}$ (λ)	$W_B(\lambda)$	$W_G(\lambda)$	$W_R(\lambda)$
350	28	0,00	0			
360	31	0,07	2,17	1		
370	34	0,23	7,82	2		
380	33	0,42	13,86	5		
390	38	0,60	22,80	9		
400	61	0,74	45,14	14		
410	69	0,83	57,27	17		
420	72	0,88	63,36	19		
430	68	0,91	61,88	19		
440	86	0,94	80,84	17		
450	98	0,95	93,10	15		
460	100	0,97	97,00	13		
470	100	0,98	98,00	9	1	
480	103	0,98	100,94	5	1	
490	98	0,99	97,02	2	1	
500	101	0,99	99,99	1	2	
510	101	1,00	101,00	1	3	
520	100	1,00	100,00		5	
530	104	1,00	104,00		8	
540	102	1,00	102,00		15	
550	103	1,00	103,00		24	1
560	100	1,00	100,00		12	1
570	97	1,00	97,00		13	1
580	98	1,00	98,00		10	2
590	91	0,99	90,09		3	3
600	94	0,99	93,06		1	5
610	95	0,99	94,05			7
620	94	0,98	92,12			9
630	90	0,98	88,20			14
640	92	0,97	89,24			21
650	89	0,97	86,33			26
660	90	0,96	86,40			18
670	94	0,95	89,30			4
680	90	0,94	84,60			1
690	80	0,94	75,20			

[a] Data for D_{55} daylight from CIE Publication 15.2 — 1986.