INTERNATIONAL STANDARD 2241

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Photography — Light sources for use in sensitometric exposure — Simulation of the spectral distribution of tungsten illumination

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FOREWORD

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Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

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It was approved in September 1971 by the Member Bodies of the following countries :

Belgium	Japan	Thailand
Czechoslovakia	New Zealand	United Kingdom
Egypt, Arab Rep. of	Romania	U.S.A.
France	South Africa, Rep. of	U.S.S.R.
Germany	Spain	
Italy	Switzerland	

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Photography – Light sources for use in sensitometric exposure – Simulation of the spectral distribution of tungsten illumination

0 INTRODUCTION

Colour films at present available for photography with artificial light are of two types. One type is balanced for exposure to incandescent tungsten sources operated at a colour temperature of 3 200 K; the other is balanced for incandescent tungsten sources operated at 3 400 K. The sensitometric illuminant described in this International Standard is intended for use with the former (3 200 K).

In this International Standard the specifications of the spectral energy distribution for the sensitometric illuminant are derived from the spectral energy distribution of a black body having a colour temperature of 3 200 K modified by the spectral transmittance values for a representative camera lens as given in Table 3. Although further study is required to establish with certainty the spectral transmittance which best characterizes a representative camera lens, the values given in Table 3 are considered reasonable and adequate for the intended purpose of this International Standard.

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies requirements for light sources appropriate for use in the sensitometric exposure of photographic materials, both monochrome and colour. The spectral quality of the exposing radiant energy closely matches the spectral energy distribution of average tungsten illumination modified by the spectral transmittance of a representative camera lens (see Table 3), exclusive of the infrared.

2 LIGHT SOURCE

2.1 General requirements

The light source shall be a lamp operated at a condition such that, with an absorbing filter if necessary, the energy incident on the exposure plane of the sensitometer will have, within the limits shown in Table 1, the spectral distribution shown for standard sensitometric tungsten (SST) (see Table 2).

2.2 Specific requirements

An illuminant meeting the requirements of this International Standard shall provide in each spectral interval the same portion of its total energy as is provided in the corresponding spectral interval by standard sensitometric tungsten (SST) (within the limits shown in Table 1).

An example of a suitable illuminant is given in the Annex.

TABLE 1 – **Requirements for relative spectral energy distribution**

Spectral interval	Relative energy of SST	Energy/Total energy		
		SST	Illuminant	
nm			Lower limits	Upper limits
360 to 400	46,9	0,016	0,011	0,021
410 to 450	154,3	0,053	0,048	0,058
460 to 500	280,5	0,096	0,091	0,101
510 to 550	418,0	0,144	0,139	0,149
560 to 600	553,0	0,190	0,185	0,195
610 to 650	676,7	0,233	0,228	0,238
660 to 700	781,1	0,268	0,263	0,273
Total	2 910,5	1,000		

The calculations of energy/total energy for each spectral interval of standard sensitometric tungsten are indicated in Table 2.

TABLE 2 – **Relative spectral energy distribution of standard sensitometric tungsten** [1)]

Wavelength nm	Relative energy	Interval sum	Energy/Total energy
360	2,1		
370	5,3		
380	9,0		
390	13,1		
400	17,4	46,9	47/2 910 = 0,016
410	21,7		
420	26,1		
430	30,8		
440	35,5		
450	40,2	154,3	154/2 910 = 0,053
460	45,3		
470	50,6		
480	56,1		
490	61,3		
500	67,2	280,5	280/2 910 = 0,096
510	72,6		
520	78,1		
530	83,6		
540	89,1		
550	94,6	418,0	418/2 910 = 0,144
560	100,0		
570	105,4		
580	110,7		
590	115,9		
600	121,0	553,0	553/2 910 = 0,190
610	126,0		
620	130,8		
630	135,5		
640	140,0		
650	144,4	676,7	677/2 910 = 0,233
660	148,6		
670	152,6		
680	156,4		
690	160,0		
700	163,5	781,1	781/2 910 = 0,268
Total	2 910,5	Total	1,000

1) 3 200 K calculated from Planck equation using C_2 = 1,438 79 and incorporating the transmittance of a representative camera lens (see Table 3).

TABLE 3 — **Spectral transmittance of representative camera lens and of liquid filter**

Wavelength	Spectral transmittance	
nm	Camera lens	Liquid filter
360	0,20	0,690
370	0,41	0,747
380	0,58	0,793
390	0,71	0,824
400	0,80	0,846
410	0,86	0,859
420	0,90	0,865
430	0,93	0,864
440	0,95	0,856
450	0,96	0,841
460	0,97	0,825
470	0,98	0,811
480	0,99	0,797
490	0,99	0,781
500	1,00	0,760
510	1,00	0,738
520	1,00	0,720
530	1,00	0,710
540	1,00	0,703
550	1,00	0,695
560	1,00	0,685
570	1,00	0,672
580	1,00	0,659
590	1,00	0,646
600	1,00	0,635
610	1,00	0,628
620	1,00	0,622
630	1,00	0,616
640	1,00	0,610
650	1,00	0,606
660	1,00	0,601
670	1,00	0,595
680	1,00	0,588
690	1,00	0,579
700	1,00	0,570

ANNEX

EXAMPLE OF A SUITABLE ILLUMINANT

A.1 LIGHT SOURCE

Although other light sources and filters may be used, one light source which meets the specific requirements of 2.2 consists of an incandescent tungsten filament lamp operated at a colour temperature of 2 850 K together with a selectively absorbing filter[1)] having spectral transmittance values which conform to those in Table 3 and made up as described in section A.2.

A.2 FILTER

Two solutions shall be compounded according to the following formulae, the complete filter consisting of a 1 ± 0,005 cm layer of each solution contained in a double cell made by using three pieces of borosilicate crown glass (refractive index, $n = 1{,}51$) each 2,5 ± 0,05 mm thick. The working temperature of the filter shall be 20 ± 5 °C.

Solution A

Copper(II) sulphate ($CuSO_4.5H_2O$)	0,551	g
Mannitol [$C_6H_8(OH)_6$]	0,551	g
Pyridine (C_5H_5N)	30,0	ml
Water (distilled) to make	1 000,0	ml

Solution B

Ammonium cobalt(II) sulphate hexahydrate [$(NH_4)_2SO_4.CoSO_4.6H_2O$]	4,492	g
Copper(II) sulphate ($CuSO_4.5H_2O$)	3,831	g
Sulphuric acid ($\rho = 1{,}84$ g/ml)	10,0	ml
Water (distilled) to make	1 000,0	ml

The luminous transmittance of this filter to 2 850 K radition is 0,671.

1) Detailed consideration of the make-up of colour-correcting filters is given in NBS Miscellaneous Publication No. 114, duplicate copies of which may be purchased upon application from Photoduplication Section, Library of Congress, Washington, D.C. 20540, U.S.A.