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# International Standard



# 2240

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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

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## Photography — Colour reversal camera films — Determination of ISO speed

*Photographie — Films de prise de vues inversibles en couleur — Détermination de la sensibilité ISO*

Second edition — 1982-07-01

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See figure  
for revision

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Descriptors : photography, colour photography, photographic film, tests, sensitivity : photography.

## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

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.

International Standard ISO 2240 was developed by Technical Committee ISO/TC 42, *Photography*, and was circulated to the member bodies in February 1981.

It has been approved by the member bodies of the following countries :

Australia	Italy	Switzerland
Belgium	Japan	United Kingdom
Canada	Mexico	USA
Egypt, Arab Rep. of	Netherlands	USSR
France	South Africa, Rep. of	
Germany, F. R.	Spain	

The member body of the following country expressed disapproval of the document on technical grounds :

Czechoslovakia

This second edition cancels and replaces the first edition (i.e. ISO 2240-1972).

# Photography — Colour reversal camera films — Determination of ISO speed

## 0 Introduction

The ISO speeds will provide correct exposures with exposure meters conforming to ISO 2720, and, where applicable, automatic exposure controls for cameras conforming to ISO 2721; the resultant camera exposure will normally lead to colour transparencies or motion pictures of the best quality. For an average scene and average camera, the indicated camera exposure will be approximately midway between the least exposure and the greatest exposure required to produce transparencies and motion-picture films suitable for viewing at normal luminance levels.

For the purpose of this International Standard, the normal luminance of transparency illuminators is assumed to be that described in ISO 3664, with a ratio of direct-to-ambient luminance of about 40 : 1. The normal luminance of transparency projection screens is assumed to be about 137 cd/m<sup>2</sup>\*. (See ISO 2895.)

Screen luminance of typical 8 mm and Type S motion-picture film projection is assumed to range from approximately 40 to 62 cd/m<sup>2</sup>. Therefore, it may be desirable to increase exposure by 25 % above that obtained by using the speed derived by following the sensitometric procedure described in this International Standard. Many camera manufacturers design and calibrate their 8 mm and Type S motion-picture cameras with an adjustment which permits more exposure to compensate for the lower screen luminance of the usual projection conditions. (See ISO 2721.)

## 1 Scope and field of application

This International Standard specifies the method for determining the ISO speed of colour reversal camera films that are intended to be viewed on transparency illuminators or by projection as slides. It also applies to 8 and 16 mm motion-picture films used in non-professional applications.

This International Standard does not apply to professional motion-picture applications.

## 2 References

ISO 5/1, *Photography — Density measurements — Part 1 : Terms, symbols and notations for transmission and reflection density.*<sup>1)</sup>

ISO 5/2, *Photography — Density measurements — Part 2 : Geometrical conditions for transmission density.*<sup>1)</sup>

ISO 5/3, *Photography — Density measurements — Part 3 : Spectral conditions.*<sup>1)</sup>

ISO 5/4, *Photography — Density measurements — Part 4 : Geometrical conditions for reflection density.*<sup>1)</sup>

ISO 2239, *Photography — Light sources for use in sensitometric exposure — Simulation of the spectral distribution of daylight.*<sup>2)</sup>

ISO 2241, *Photography — Light sources for use in sensitometric exposure — Simulation of the spectral distribution of tungsten illumination.*<sup>3)</sup>

ISO 2242, *Photography — Light sources for use in sensitometric exposure — Simulation of the spectral distribution of photoflood illumination.*<sup>4)</sup>

ISO 2720, *Photography — General purpose photographic exposure meters (photoelectric type) — Guide to product specification.*

ISO 2721, *Photography — Cameras — Automatic control of exposure.*

ISO 2895, *Cinematography — Screen luminance for review room projection of motion-picture film intended for indoor theatres.*

ISO 3664, *Photography — Illumination conditions for viewing colour transparencies and their reproductions.*

\* 1 candela per square metre (cd/m<sup>2</sup>) = 0,292 foot lamberts (ftL).

- 1) At present at the stage of draft. (Revision of ISO 5-1974.)
- 2) At present at the stage of draft. (Revision of ISO 2239-1972.)
- 3) At present at the stage of draft. (Revision of ISO 2241-1972.)
- 4) At present at the stage of draft. (Revision of ISO 2242-1972.)

### 3 Definitions

For the purpose of this International Standard the following definitions apply :

**3.1 exposure ( $H$ )** : The time integral of illuminance on the film, measured in lux seconds, and designated by the symbol  $H$ .

Exposure is often expressed in  $\log_{10} H$  units.

**3.2 speed** : A quantitative measure of the response of the photographic material to radiant energy for the specified conditions of exposure, processing, and image measurement.

### 4 Sampling and storage

#### 4.1 Product sampling

In determining the ISO speed of a product, it is important that the samples evaluated are representative of those used by photographers. No fewer than 12 samples shall be obtained from the plant of the manufacturer or from an accredited distributor if they cannot be obtained directly from the manufacturer. In any case, the samples should be taken from film stored according to manufacturers' recommendations and available in the market. Each sample shall represent a different batch of product, if possible. No fewer than four independent evaluations shall be used, with at least three film samples in each.

#### 4.2 Storage of samples

After procurement from the manufacturer or distributor, all samples of a product shall be stored in the unopened package for 2 to 4 months under conditions recommended by the manufacturer. When no specific recommendation is made, storage shall be at  $23 \pm 5$  °C and a relative humidity of  $50 \pm 20$  %. At the end of this storage period, samples shall be tested. The basic objective in selecting and storing samples as described above is to ensure the film characteristics obtained are representative of those obtained by a photographer at the time of use.

### 5 Method of test

#### 5.1 Principle

Samples are exposed and processed in the manner specified below. Density measurements are obtained from the resultant images to produce a sensitometric curve from which values are taken and used to determine ISO speed.

#### 5.2 Safelights

To eliminate the possibility of safelight illumination affecting the sensitometric results, all films shall be handled in complete darkness during exposing and processing.

### 5.3 Exposure

#### 5.3.1 Sample condition

During exposure, the samples shall be at a temperature of  $23 \pm 5$  °C and a relative humidity of  $50 \pm 20$  %.

#### 5.3.2 Type of sensitometer

The sensitometer shall be a non-intermittent, illuminance-scale type.

#### 5.3.3 Radiant energy quality

The illuminant for the particular film type being exposed shall conform to the latest edition of the appropriate International Standard, i.e. ISO 2239, ISO 2241 or ISO 2242.

#### 5.3.3.1 Filters

ISO speed shall be specified for use without a filter in front of the camera lens. If film is used with a colour filter in front of the camera lens, an "equivalent" speed number can be used to determine the exposure of the film with the filter. ISO speed does not apply to the filtered condition.

#### 5.3.4 Modulation

The total range of spectral diffuse transmission density with respect to the film plane of each area of the light modulation throughout the wavelength interval from 400 to 700 nm shall not exceed 5 % of the average density obtained over the same interval or 0,03 density, whichever is greater. In the interval from 360 to 400 nm, 10 % of this same average density, or 0,06 density, whichever is greater, is acceptable.

If stepped increments are used, the exposure increment shall not be greater than  $0,15 \log_{10} H$ . The width and length of a single step shall be adequate to obtain a uniform density within the reading aperture specified for densitometry.

If continuous variable modulation is used, the change in exposure with distance along the test strip shall be uniform and not be greater than  $0,04 \log_{10} H$  per millimetre.

An area of the film shall be given sufficient exposure to produce the minimum density possible.

#### 5.3.5 Exposure time

The exposure time shall be between 5 and  $1/1\,000$  s, corresponding with the usage practice for the particular film tested. The maximum exposure shall be adequate to produce the minimum density possible. Since the speed of film is dependent on exposure time because of reciprocity law failure effects, the exposure time used for determining the ISO speed should be specified in use instructions.

**5.4 Processing**

**5.4.1 Conditioning of samples**

In the time interval between exposure and processing, the samples shall be kept at  $23 \pm 5$  °C and a relative humidity of  $50 \pm 20$  %. The processing shall be completed in not less than 5 days and not more than 10 days after exposure for general purpose films, and not less than 4 h and not more than 7 days for professional film.

**5.4.2 Processing specifications**

No processing specifications are described in this International Standard in recognition of the wide range of chemicals and equipment used. ISO speed provided by film manufacturers generally applies to the film when it is processed in accordance with their recommendations to produce the photographic characteristics specified for the process. Process information shall be available from film manufacturers or others who quote ISO speed. This shall specify the chemicals, time, temperatures, agitation equipment and procedure used for each of the processing steps and any additional information required to obtain the sensitometric results described. The values

for speed obtained using various processing procedures may differ significantly. Although different speeds for a particular film may be achieved by varying the process, the user should be aware that other sensitometric and physical changes may also accompany the speed changes.

**5.5 Densitometry**

ISO standard diffuse visual transmission density of the processed images shall be measured using a densitometer complying with the geometric and spectral requirements specified in ISO 5. A minimum aperture of 3 mm diameter shall be used. Reading shall be at least 1 mm from the edges of the exposures.

**5.6 Evaluation**

**5.6.1 Sensitometric curve**

The ISO Standard diffuse visual transmission density values are plotted against the logarithm to the base 10 of the corresponding exposure ( $H$ ) expressed in lux seconds, to obtain a sensitometric curve similar to that illustrated in the figure.

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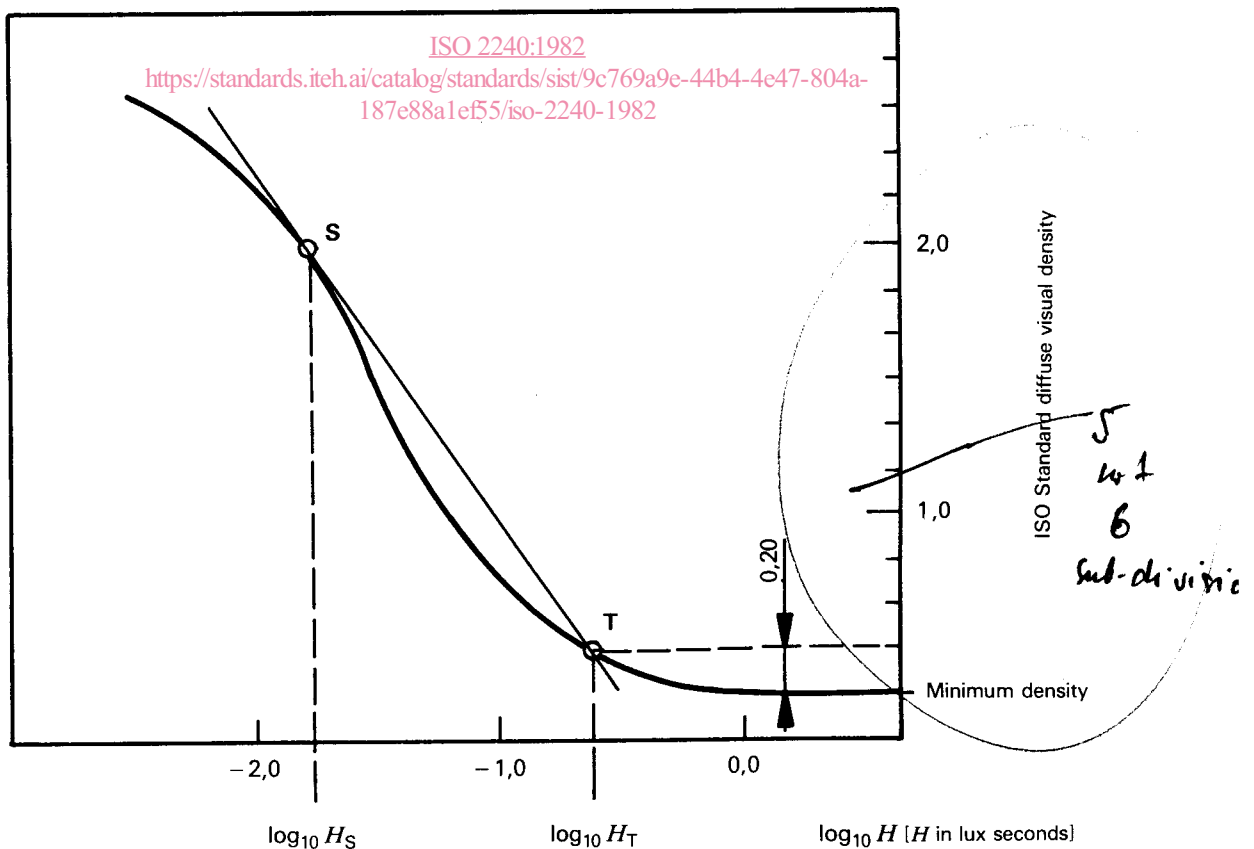


Figure — Determination of ISO speed

**5.6.2 Minimum density**

The minimum density shall be determined from a film sample adequately exposed to produce the minimum density possible and processed simultaneously with the sample exposed for determining the sensitometric curve.

**5.6.3 Determination of  $H_m$  or  $\log_{10} H_m$**

The method for determining ISO speed is illustrated in the figure. Point **T** is located on the curve at a density of 0,20 above the minimum density. From point **T**, a straight line is drawn tangential to the curve. The tangent point is designated **S** if it has a density less than 2,0 above minimum density. If the tangent point has a density greater than 2,0 above minimum density, the point **S** is taken on the curve where the density is 2,0 above the minimum density. The exposure  $H_T$  and  $H_S$ , corresponds to points **T** and **S**, and are used as follows to compute the exposure,  $H_m$ , by use of the following formula :

$$\log_{10} H_m = \frac{\log_{10} H_S + \log_{10} H_T}{2}$$

or

$$H_m = \sqrt{H_S \times H_T}$$

The exposure,  $H_m$ , represents the exposure in lux seconds, used to determine ISO speed.

**6 Product classification**

**6.1 ISO speed scale**

The speed scales given in the table are derived from the following formulas :

$$S = \frac{10}{H_m}$$

$$S^\circ = 1 + 10 \log_{10} \left( \frac{10}{H_m} \right)$$

$$= 1 + 10 \log_{10} \{S\}$$

where

$S$  is the arithmetic speed;

$S^\circ$  is the logarithmic speed.

“ISO” speed shall be obtained directly from  $\log_{10} H_m$  by use of the table which shows the rounding method to be used.

**6.2 ISO speed of a product**

The ISO speed of a product (as distinguished from that of a specific sample) shall be based on the numerical average of the logarithms of exposures,  $\log_{10} H_m$ , determined for at least 12 samples of the product when selected, stored, and tested as

specified above. The ISO speed of a product with proper rounding is then determined from the average value of  $\log_{10} H_m$  by use of the table.

Since ISO speed is dependent on exposure and development conditions, these should be indicated when quoting ISO speed values.

**Table — ISO speed scales**

$\log_{10} H_m$		ISO Speed	
from	to	arithmetic	logarithmic
-2,55	-2,46	3 200	36°
-2,45	-2,36	2 500	35°
-2,35	-2,26	2 000	34°
-2,25	-2,16	1 600	33°
-2,15	-2,06	1 250	32°
-2,05	-1,96	1 000	31°
-1,95	-1,86	800	30°
-1,85	-1,76	640	29°
-1,75	-1,66	500	28°
-1,65	-1,56	400	27°
-1,55	-1,46	320	26°
-1,45	-1,36	250	25°
-1,35	-1,26	200	24°
-1,25	-1,16	160	23°
-1,15	-1,06	125	22°
-1,05	-0,96	100	21°
-0,95	-0,86	80	20°
-0,85	-0,76	64	19°
-0,75	-0,66	50	18°
-0,65	-0,56	40	17°
-0,55	-0,46	32	16°
-0,45	-0,36	25	15°
-0,35	-0,26	20	14°
-0,25	-0,16	16	13°
-0,15	-0,06	12	12°
-0,05	0,04	10	11°
0,05	0,14	8	10°
0,15	0,24	6	9°
0,25	0,34	5	8°
0,35	0,44	4	7°

**6.3 Accuracy**

The calibration of the equipment and processes involved in determining film speed shall be adequate to ensure the error in  $\log_{10} H_m$  is less than 0,05.

**7 Product marking and labelling**

Speed of a product determined by the method described in this International Standard and expressed on the scales of the table may be designated ISO speed and denoted in the form of ISO 100, ISO 21°, or ISO 100/21°.

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