



Photography — Determination of ISO Speed of monochrome (black-and-white), continuous-tone photographic negative materials for still photography

Photographie — Détermination de la sensibilité ISO des émulsions photographiques négatives achromes (noir et blanc), à modelé continu pour photographie picturale

First edition — 1974-02-15

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[ISO 6:1974](https://standards.iteh.ai/catalog/standards/sist/8ffb4285-83c4-4849-b9af-75f1e3892646/iso-6-1974)

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UDC 771.534.51

Ref. No. ISO 6-1974 (E)

Descriptors : photography, photographic emulsions, black and white photography, photographic sensitometry, tests.

Price based on 4 pages

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 6 was drawn up by Technical Committee ISO/TC 42, *Photography*, and circulated to the Member Bodies in October 1972.

It has been approved by the Member Bodies of the following countries :

Austria	Germany	Romania
Belgium	Ireland	Switzerland
Canada	Italy	Thailand
Czechoslovakia	Japan	United Kingdom
Egypt, Arab Rep. of	Mexico	U.S.A.
France	New Zealand	U.S.S.R.

No Member Body expressed disapproval of the document.

This International Standard cancels and replaces ISO Recommendation R 6-1954.

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0 INTRODUCTION

This International Standard represents an extensive revision of ISO/R 6, *Method for determining photographic speed and exposure index*. The sensitometric method of this standard has been the subject of extensive study and evaluation for nearly ten years. Many of its essential features have been incorporated in the national standards of various countries.

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies a sensitometric method for determining and expressing the speed of photographic negative materials (monochrome, continuous-tone). It allows the determination of the ISO Speed of photographic roll films, film packs, miniature camera films, sheet films, and plates intended for the making of monochrome, continuous-tone negatives in pictorial still photography, exclusive of photography in the infrared.

This method does not apply to negatives produced in diffusion transfer systems, to process films and other graphic arts films and plates, to radiographic films, or to sensitized materials used in aerial photography.

2 REFERENCES

ISO 5, *Photography – Diffuse transmission density*.

ISO 2239, *Photography – Light sources for use in sensitometric exposure – Simulation of the spectral distribution of daylight*.

3 DEFINITIONS

3.1 speed (as used in this International Standard): A quantitative measure of the response of the photographic material to radiant energy for the specified conditions of exposure, processing, and measurement.

3.2 ISO Speed: Speed determined by the method described in this International Standard and expressed on one of the scales of the table. For convenience, ISO Speed may be identified by an abbreviated designation of the general form, "ISO 100" or "ISO 21^o", according to whether the arithmetic or logarithmic scale is used.

4 SENSITOMETRIC DERIVATION OF SPEED

The method for determining speed is illustrated by the figure, in which the curve of density against the logarithm of exposure (H) of a photographic material is plotted for the test conditions specified in 5.3. Two points are shown on the curve at **M** and **N**. Point **M** is located 0,1 above fog-plus-base density. Point **N** lies 1,3 log exposure units from point **M** in the direction of greater exposure. The developing time of the negative material is so chosen that point **N** lies at a density interval $\Delta D = 0,80$ above the density at point **M**. When this condition is satisfied, the exposure H_m , corresponding to point **M**, represents the sensitometric parameter from which speed is computed.

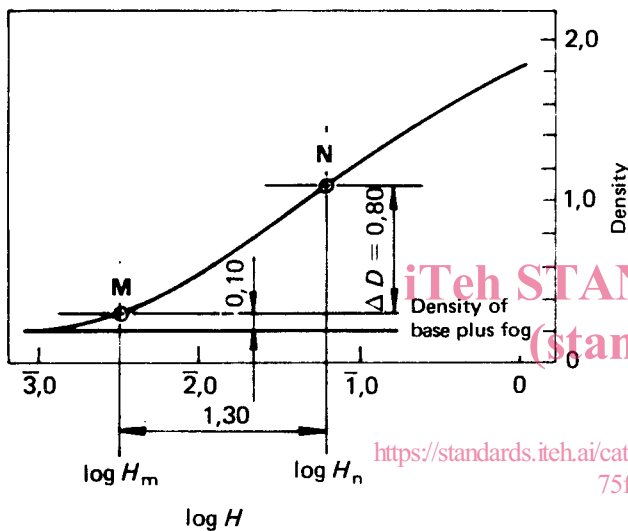


FIGURE – Curve of density against log H

5 DETERMINATION OF THE ISO SPEED OF A SPECIFIC SAMPLE

5.1 Determination of speed

Speed shall be computed by the use of the formula :

$$S = \frac{0,8}{H_m} \text{ ou } S^\circ = 1 + 10 \log_{10} \frac{0,8}{H_m}$$

where S or S° is the speed and H_m is the exposure (expressed in lux seconds) determined in accordance with the procedure described in clause 4.

5.2 Speed scale

Speed shall be calculated as described in 5.1 but shall be rounded to the nearest step of the scale, as shown in the table.

5.3 Testing technique

5.3.1 Conditioning of samples for testing

The test sample shall be in equilibrium with an atmosphere maintained at a temperature of $20 \pm 5^\circ\text{C}$ and a relative humidity of $60 \pm 10\%$.

5.3.2 Exposure

5.3.2.1 TYPE OF SENSITOMETER

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

5.3.2.2 EXPOSURE TIME

Exposure time shall be between 1/20 and 1/80 s.

5.3.2.3 MODULATION

The effective spectral transmission density with respect to the film plane of each area of the light modulator shall not vary more than 5 % throughout the wavelength range from 360 to 700 nm except in the interval from 360 to 400 nm, where 10 % is acceptable. For each area of the modulator, these tolerances apply to the permissible density range in the wavelength intervals specified.

The change in exposure with distance along the test strip for either continuous or stepped exposures shall not be greater than a factor of 2,5 per centimetre.

If stepped increments are used, the exposure increment shall not be greater than a factor of $\sqrt[3]{4}$ per step.

5.3.2.4 LIGHT SOURCE

The light source for the particular film type being tested shall conform to ISO 2239.

5.3.3 Processing

5.3.3.1 CONDITIONING OF SAMPLES

In the time interval between exposure and processing, the samples shall be kept at a temperature of $20 \pm 5^\circ\text{C}$ and a relative humidity of $60 \pm 10\%$. The processing shall be commenced not earlier than 1 h and not later than 2 h after exposure.

5.3.3.2 DEVELOPER AND EXTENT OF DEVELOPMENT

For the purpose of assigning an ISO Speed to a particular film, the following developer and conditions shall be used :

Air-free (distilled) water at 55°C	500,0 ml
Monomethyl para-aminophenol sulphate	0,5 g
Sodium sulphite (anhydrous)	40,0 g

Hydroquinone	1,0 g
Sodium carbonate (anhydrous)	1,5 g
Sodium bicarbonate	1,0 g
Potassium bromide	0,2 g
Air-free (distilled) water to make	1 000,0 ml

The pH of this solution shall be $9,4 \pm 0,2$ at 20°C .

NOTE — Chemicals conforming to applicable International Standards for photographic grade chemicals shall be used. A minimum of 3 ml of developer per square centimetre of film shall be used.

The time of development is to be chosen so that the value of ΔD (see figure) is within the following tolerances :

$$\Delta D = 0,80 \pm 0,05$$

It is recommended that several samples be developed for different time periods. If more than one developed sample fulfils the condition with respect to ΔD , that one shall be selected for which ΔD is nearest the specified value.

After mixing, the developer shall be held in air-tight containers for at least 6 h before use. For each test, the developer solution shall have been previously unused.

In addition to the ISO Speed, manufacturers and others may wish to determine a speed value for use in obtaining desired exposure levels when using developers giving development significantly different from the ISO developer. For determining these speed values, the exposure and evaluation methods of this International Standard shall be used. These speed values shall not be stated as the ISO Speed.

5.3.3.3 TEMPERATURE OF DEVELOPING SOLUTION

The temperature of the developing solution shall be $20 \pm 0,3^\circ\text{C}$.

5.3.3.4 AGITATION

The test sample may be developed in any suitable vessel, provided the agitation of the solution during development is equivalent in efficiency to that produced by the following method.

The developer is poured into a vacuum flask having an internal length of approximately 22 cm and an internal diameter of about 4 cm. The developer is added until three-quarters of the free space is filled. The negative material to be tested is fastened by means of rubber bands to a glass strip having a width of about 3,5 cm and a length of about 20 cm. The glass strip is fixed to an insert stopper and projects into the flask when the stopper is in place. The stopper carrying the glass strip and the test film is inserted in the flask and the development is carried out at the prescribed temperature. During development, the vessel is given an oscillatory

movement by tilting it in a vertical plane to an angle of about 45° above and below the horizontal. The rate is such that one complete cycle is made in about 1 s. At the same time, the vessel is revolved about its axis, the time for one revolution being about 5 s. To terminate development, the film is withdrawn and immediately immersed in the fixing bath.

5.3.3.5 FIXING

The test samples shall be immersed in the following fixing bath immediately after development :

Distilled water at 55°C	600 ml
Sodium thiosulphate, crystalline	240 g
Sodium sulphite, anhydrous	15 g
Acetic acid, glacial	20 ml
Sodium tetraborate, pentahydrate	15 g
Aluminium potassium sulphate	15 g
Distilled water to make	1 000 ml

The pH of this solution is approximately $4,4$ at 20°C .

NOTE — Chemicals conforming to applicable International Standards for photographic grade chemicals shall be used.

The fixing solution shall be held at $20 \pm 5^\circ\text{C}$ and the fixing time shall be at least twice the clearing time, but no longer than 15 min. The samples shall be agitated vigorously during the first 30 s in the fixing bath.

5.3.3.6 WASHING

The sample shall be washed in running water at $20 \pm 5^\circ\text{C}$ for 15 to 25 min.

5.3.3.7 DRYING

Surface water shall be removed and the samples dried in evenly circulated air maintained at such atmospheric conditions that the drying time is not less than 15 min.

5.3.4 Density

The density used in obtaining the characteristic curve of the photographic material shall be ISO recommended simulated diffuse printing density, type P2-b, as defined in ISO 5.

5.3.5 Accuracy

The accuracy of the testing procedure (specified under 5.3) shall be such that the absolute error in the determination of H_m shall not be greater than 13 % ($0,05$ on the $\log_{10} H_m$ scale).

6 DETERMINATION OF THE ISO SPEED OF A PRODUCT

The speed of a product (as distinguished from that of a specific sample) shall be based on the numerical average of the exposure H_m , determined for at least twelve samples of the product, these samples being selected, stored, and tested as specified in the following sub-clauses. The speed of a product shall be calculated by using the average value of the exposure H_m in the formula given in 5.1. The average value shall then be rounded to the nearest step as shown in the table.

6.1 Sampling and processing

Not less than twelve samples shall be used for testing a product. The samples shall be obtained from the plant of the manufacturer, or from an accredited distributor if they cannot be obtained directly from the manufacturer. They shall be grouped in at least four sets of at least three samples each, the sets being taken at intervals of approximately 1 month. Each sample shall represent a different batch of product, if possible. Not less than four independent processing operations shall be used with at least three film samples in each.

6.2 Storage of samples

All samples which are to be used in making the tests shall be stored in the unopened package at $20 \pm 5^\circ\text{C}$ and a relative humidity of $60 \pm 10\%$ for a period of 3 months after procurement from the manufacturer or distributor.

6.3 Testing

At the end of the storage period specified above, each sample shall be tested and its speed determined according to the method described in clause 5. The average value of H_m for all samples tested shall be used to calculate the ISO Speed of the product.

TABLE – ISO Speed scales

For values of $\log_{10}H_m$		ISO Speed	
from	to	arithmetic	logarithmic
6,35 – 10	6,44 – 10	3 200	36°
6,45 – 10	6,54 – 10	2 500	35°
6,55 – 10	6,64 – 10	2 000	34°
6,65 – 10	6,74 – 10	1 600	33°
6,75 – 10	6,84 – 10	1 250	32°
6,85 – 10	6,94 – 10	1 000	31°
6,95 – 10	7,04 – 10	800	30°
7,05 – 10	7,14 – 10	630	29°
7,15 – 10	7,24 – 10	500	28°
7,25 – 10	7,34 – 10	400	27°
7,35 – 10	7,44 – 10	320	26°
7,45 – 10	7,54 – 10	250	25°
7,55 – 10	7,64 – 10	200	24°
7,65 – 10	7,74 – 10	160	23°
7,75 – 10	7,84 – 10	125	22°
7,85 – 10	7,94 – 10	100	21°
7,95 – 10	8,04 – 10	80	20°
8,05 – 10	8,14 – 10	63	19°
8,15 – 10	8,24 – 10	50	18°
8,25 – 10	8,34 – 10	40	17°
8,35 – 10	8,44 – 10	32	16°
8,45 – 10	8,54 – 10	25	15°
8,55 – 10	8,64 – 10	20	14°
8,65 – 10	8,74 – 10	16	13°
8,75 – 10	8,84 – 10	12	12°
8,85 – 10	8,94 – 10	10	11°
8,95 – 10	9,04 – 10	8	10°
9,05 – 10	9,14 – 10	6	9°

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