INTERNATIONAL STANDARD

ISO 9848

Second edition
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Photography — Source document microfilms — Determination of ISO speed and ISO average gradient

Photographie — Microfilms de prises de vue — Détermination de la sensibilité ISO et du contraste moyen ISO

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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 2.

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

ISO 9848 was prepared by Technical Committee ISO/TC 42, *Photography*.

This second edition cancels and replaces the first edition (ISO 9848:1993), which has been technically revised.

Introduction

This International Standard describes the method for determining the ISO speed and ISO average gradient of camera negative microfilms exposed with an incandescent tungsten source at a distribution temperature of 2 650 K ± 100 K (to simulate “undervolted” photoflood).

The ISO speed and ISO average gradient determined by applying this International Standard are for film/process systems, not just the film alone. The sensitometric characteristics of microfilm are dependent on the process conditions (developer, time, temperature, agitation, etc.) and some films will provide satisfactory results only in specific processes. Therefore, process conditions are not specified in this International Standard. They should be specified when the sensitometric values are quoted in manufacturer's literature to enable proper interpretation.

Because of “reciprocity law failure”, it is desirable to specify the exposure time used when quoting ISO speed and ISO average gradient values to ensure proper interpretation. Source document microfilming cameras do not have a “standard” exposure time. The exposure time used in evaluating the sensitometric characteristics of the film should be the same as that for which the film is intended to be used. The alternative of using only one exposure time in this International Standard could be misleading if the film produces other results at its “end use” exposure time. If the film is used in a variety of applications, speed and contrast values at a range of exposure times may be helpful to the user. Typical light sources for microfilms include tungsten, xenon and fluorescent. Since xenon and fluorescent sources are not yet standardized they are not included in this International Standard, but will be incorporated in the document when standardized. Due to spectral output differences, ISO values determined by using tungsten sensitometric exposure cannot be used for applications where fluorescent or xenon illumination are used.

The effective density of film images depends on the geometry of the optical system in which they are used. Many source document microfilms are used as “masters” for producing copies by contact printing, thereby requiring diffuse density measurements. When film is viewed on a microfilm “reader”, projection densitometry is more appropriate. Since the more critical end use is the former, this International Standard specifies diffuse density.

Spectral conditions of the density measurement must also be specified. Printing density characteristics are dependent upon the spectral sensitivity of the print film chosen for use as well as the spectral energy distribution of the printing light source. These parameters are determined by “end use” system requirements. Since no standard printing conditions have been agreed to or defined in this document, the use of printing density is precluded and visual density measurements will, therefore, be used as a compromise.

The speed point density (1,20 above minimum density) was selected as a compromise of the proper image background densities. Since microfilms have medium to high average gradients, exposure latitude is rather narrow. Thus, the speed value should be considered “approximate” and used only as a guide for initial testing. For critical work, the final exposure should be determined by testing the film over a range of exposures and the optimum chosen. A measurement of contrast is provided by the average gradient which relates the line density to the background density. This measurement correlates with the visual appearance of the recorded image and should aid users in selecting the best film for their application. This International Standard is concerned primarily with the evaluation of a few characteristics of source document microfilms that are especially important in using the product. Therefore, the test method, sensitometric criteria and sampling procedures can prove inadequate for controlling quality in a film manufacturing operation. Since speed and contrast vary greatly depending on exposure time, illuminant quality and process conditions, it is important for the user to consult the film manufacturer regarding the film and sensitometric characteristics that fit their application.

Photography — Source document microfilms — Determination of ISO speed and ISO average gradient

1 Scope

This International Standard specifies a method for determining the ISO speed and ISO average gradient of black-and-white camera negative photographic films used for first generation microfilming of source documents at exposure times typically found with tungsten sources. These source documents include any handwritten or printed alphanumeric and line documents such as books, periodicals, business correspondence, and engineering drawings. The value-rating system described in this International Standard is only useful to the consumer if his exposure illumination is from an incandescent tungsten source as described in 5.3.3. It is not intended to include pictorial or continuous tone reproduction, computer output microfilm (COM), reversal processed or direct positive films or other films exposed by non-tungsten sources such as laser or cathode ray tube.

The ISO speed and ISO average gradient values obtained by applying this International Standard are intended for practical use in comparing film/process combinations and for computing exposures.

2 Normative references

The following referenced documents are indispensable for the application 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 5-2, *Photography — Density measurements — Part 2: Geometric conditions for transmission density*

ISO 5-3, *Photography — Density measurements — Part 3: Spectral conditions*

ISO 554, *Standard atmospheres for conditioning and/or testing — Specifications*

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

3 Terms and definitions

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

3.1
speed
quantitative measure of the response of the photographic material to radiant energy for the specified conditions of exposure, processing, density measurement and analysis

3.2
exposure
H
time integral of illuminance measured on the plane of the film surface

NOTE 1 In the *International lighting vocabulary*[3], H is defined as the luminous exposure. In this International Standard, “luminous exposure” is simply referred to as “exposure”.

NOTE 2 Exposure is measured in lux seconds.

NOTE 3 Exposure is often expressed in $\log_{10}H$ units.

3.3
average gradient
$\overline{G}$
slope of a line drawn between two specified points on the sensitometric curve

3.4
minimum density
D_{min}
minimum density value obtainable from an unexposed sample of the same product processed simultaneously with the sample exposed for determining the sensitometric curve

4 Sampling and storage

In determining the ISO speed and ISO average gradient of a product, it is important that the samples evaluated yield the average results obtained by users. This requires evaluating several different batches periodically under the conditions specified in this International Standard. Prior to evaluation, the samples shall be stored according to the manufacturer's recommendations for a length of time to simulate the average age at which the product is normally used. Several independent evaluations shall be made to ensure the proper calibration of equipment and processes. The basic objective in selecting and storing samples as described above is to ensure the film characteristics are representative of those obtained by a user at the time of use.

5 Test method

5.1 Principle

Samples are exposed and processed as specified in 5.3 and 5.4, respectively. Density measurements are obtained from the resultant images to produce a sensitometric curve from which values are taken and used to determine ISO speed and ISO average gradient. See Figure 1.

5.2 Safelights

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

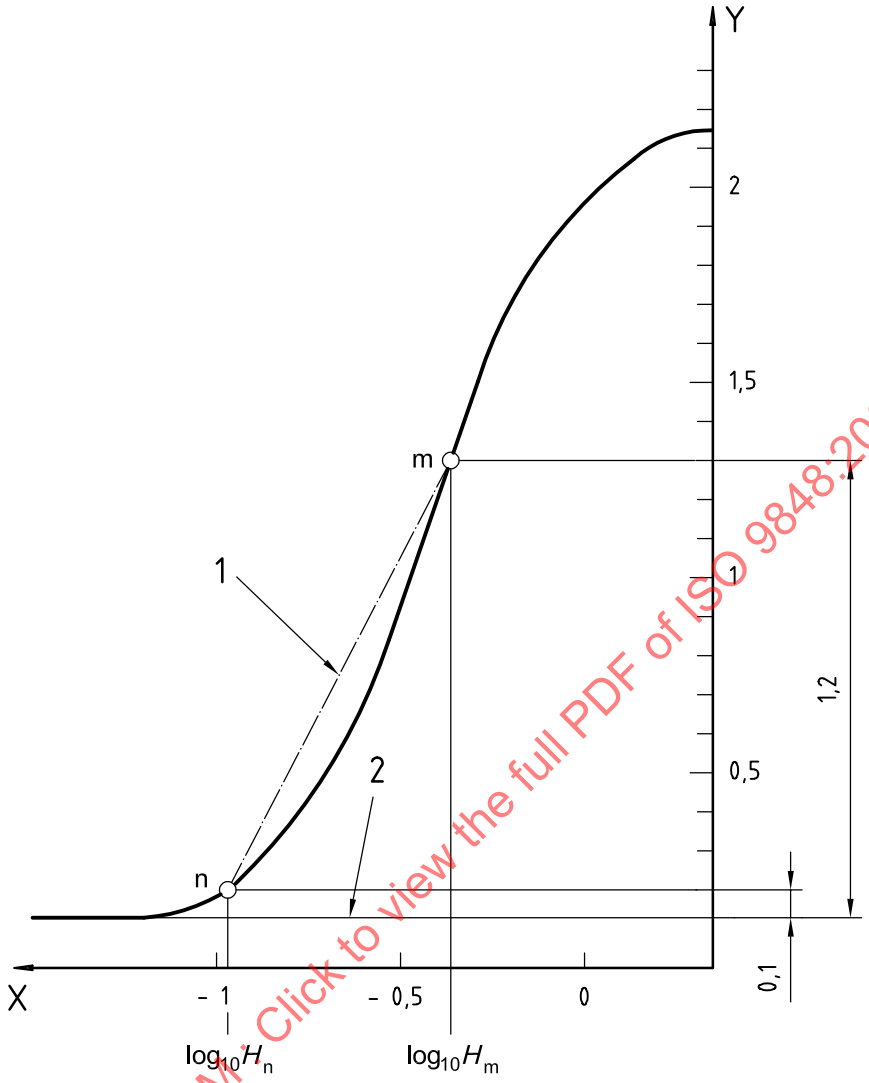
5.3 Exposure

5.3.1 Sampling conditions

During exposure, the samples shall be at a temperature of 23 °C ± 2 °C and a relative humidity of (50 ± 5) %. See ISO 554.

5.3.2 Type of sensitometer

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



Key

X $\log_{10}H$, lux seconds

Y ISO standard visual diffuse transmission density

1 average gradient

2 minimum density

Figure 1 — Sensitometric curve

5.3.3 Radiant energy quality

ISO speed shall be determined using an incandescent tungsten source at a distribution temperature of 2 650 K ± 100 K (to simulate “undervolted” photoflood) as modified by the spectral transmittance of the standard camera lens as described in ISO 6728. Speed and average gradient determined for other illuminants will be different.

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

5.3.4 Modulation

The total range of spectral diffuse transmission density of each area of the light modulator throughout the wavelength interval from 400 nm 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 nm to 400 nm, 10 % of this same average density, or 0,06 density, whichever is greater, is acceptable.

If a stepped increment modulator is used, the base 10 logarithm of the exposure increment shall not be greater than 0,15. The width and length of a single step shall be adequate to obtain a uniform density within the reading aperture specified for densitometry. If a continuous variable modulator is used, the change of exposure with distance along the test strip shall be uniform and shall not be greater than 0,02 $\log_{10}H$ per millimetre.

5.3.5 Exposure time

The exposure time shall correspond with the usage practice for the particular film tested. Since the speed of the film can be dependent on exposure time because of reciprocity law failure, the exposure time used for determining the ISO speed shall be specified.

5.4 Processing

5.4.1 Conditioning of samples

In the time interval between exposure and processing, the samples shall be kept at 23 °C ± 2 °C and a relative humidity of (50 ± 5) %. The processing shall be completed in not less than 3 h and not more than 4 h after exposure.

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. The ISO speed values provided by film manufacturers will generally apply 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 can differ significantly. Although different speeds for a particular film can be achieved by varying the process, the user should be aware that other sensitometric and physical changes can also accompany the speed changes.

5.5 Densitometry

ISO standard visual diffuse transmission density of the processed images shall be measured using a densitometer complying with the geometric conditions specified in ISO 5-2 and spectral conditions specified in ISO 5-3. Readings shall be taken at least 1 mm from the edge of the exposed areas.

5.6 Evaluation

5.6.1 Sensitometric curve

The ISO standard visual diffuse transmission density values are plotted against the base 10 logarithm of the corresponding exposure (H) expressed in lux seconds, to obtain a sensitometric curve similar to that illustrated in Figure 1.

5.6.2 Minimum density

The minimum density shall be determined from an unexposed film sample, which is processed simultaneously with the sample exposed for determining the sensitometric curve.

5.6.3 Determination of raw speed and raw average gradient

The method for determining raw speed and raw average gradient is illustrated in Figure 1. Raw speed is determined at point m, which is located on the curve at a density of 1,20 above minimum density. Raw average gradient is the slope of the line joining point m and point n, which is located on the curve at a density of 0,10 above the minimum density. The exposures required to produce the densities at m and n are designated H_m and H_n respectively.

6 Product classification

6.1 ISO speed

6.1.1 ISO speed scale

The ISO speed scale given in Table 1 was generated to include values of typical product samples whose raw speeds are derived from the following equation:

$$S = \frac{45}{H_m} \tag{1}$$

where

S is the raw arithmetic speed;

H_m is the exposure required to produce a density of 1,20 above minimum density.

6.1.2 ISO speed of a sample

ISO speed shall be obtained directly from $\log_{10} H_m$ by use of Table 1, which rounds the raw speed value. The ISO speed values shall be preceded by the capital letter “M”, to indicate the speed was determined by this International Standard and not by some other speed standard.

For use with cameras provided with automatic exposure control through variable shutter speed, i.e. AE cameras, the speed values obtained through the above formula should be divided by the factor 5 and rounded speed values then obtained from Table 1. See Annex A.

6.1.3 ISO speed of a product

The ISO speed of a product (as distinguished from that of a specific sample) shall be based on the arithmetic mean of the logarithms of exposures, $\log_{10} H_m$, determined from various batches of the product when selected, stored and tested as specified in this International Standard.

The ISO speed of a product (with proper rounding) is then determined from that mean by use of Table 1.

6.2 ISO average gradient

6.2.1 ISO average gradient scale

The ISO average gradient scale given in Table 2 was generated to include values of typical product samples whose raw average gradients were derived from the following formula:

$$\overline{G} = \frac{1{,}20 - 0{,}10}{\log_{10} H_m - \log_{10} H_n} = \frac{1{,}10}{\log_{10} H_m - \log_{10} H_n} \tag{2}$$

where

$\overline{G}$ is the raw average gradient of a sample;

H_m is the exposure required to produce a density of 1,20 above minimum density;

H_n is the exposure required to produce a density of 0,10 above minimum density.

Table 1 — ISO speed

$\text{Log}_{10}H_m$		**ISO speed**
from	to	Arithmetic
– 1,90	– 1,81	M 3 200
– 1,80	– 1,71	M 2 500
– 1,70	– 1,61	M 2 000
– 1,60	– 1,51	M 1 600
– 1,50	– 1,41	M 1 250
– 1,40	– 1,31	M 1 000
– 1,30	– 1,21	M 800
– 1,20	– 1,11	M 640
– 1,10	– 1,01	M 500
– 1,00	– 0,91	M 400
– 0,90	– 0,81	M 320
– 0,80	– 0,71	M 250
– 0,70	– 0,61	M 200
– 0,60	– 0,51	M 160
– 0,50	– 0,41	M 125
– 0,40	– 0,31	M 100
– 0,30	– 0,21	M 80
– 0,20	– 0,11	M 64
– 0,10	– 0,01	M 50
0,00	0,09	M 40
0,10	0,19	M 32
0,20	0,29	M 25
0,30	0,39	M 20
0,40	0,49	M 16
0,50	0,59	M 12
0,60	0,69	M 10
0,70	0,79	M 8
0,80	0,89	M 6

6.2.2 ISO average gradient of a sample

ISO average gradient of a sample (with proper rounding) shall be obtained directly from the value of ($\log_{10}H_m - \log_{10}H_n$) for the sample by use of Table 2. The ISO average gradient values shall be preceded by the capital letter "$\overline{G}$" (e.g. $\overline{G}$ 1,6).

6.2.3 ISO average gradient of a product

The average gradient of a product (as distinguished from that of a specific sample) shall be determined from the arithmetic mean of ($\log_{10}H_m - \log_{10}H_n$) values for various batches of the product when they are selected, stored and tested as specified in this International Standard.