International Standard 7829

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

Photography — Black-and-white aerial camera films — Determination of ISO speed and average gradient

Photographie — Films noir et blanc pour photographie aérienne — Détermination de la sensibilité et du contraste moyen ISO «Aviation»

First edition — 1986-08-15

UDC 771.534.5 : 778.35 **Ref. No. ISO 7829-1986 (E)**

Descriptors : photography, aerial photography, black-and-white photography, photographic film, roll films, tests, determination, sensitivity (photography).

Price based on 9 pages

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.

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. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 7829 was prepared by Technical Committee ISO/TC 42, *Photography*.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

Printed in Switzerland

Photography — Black-and-white aerial camera films — Determination of ISO speed and average gradient

0 Introduction

ISO was requested to develop a method for measuring speed and average gradient of black-and-white negative camera film-process combinations used in aerial photography because of the incompatability of various existing standards; the aim being to create an International Standard that would incorporate the most important features of these standards.

Changes in aerial photography over the last 10 years, particularly those related to the increased use of mechanized processing, has made it necessary to eliminate the processing restrictions present in some of the existing standards in order to provide the user with realistic ISO speed and average gradient values.

Assigning speed values to aerial films presents problems. Aerial films are required to record or even amplify the small variations in luminance that exist when the earth is viewed from altitudes of several kilometres or as low as 20 to 30 m where the luminance range may be of the same order as that of ordinary ground photography. In the first case, the films are developed to a high average gradient or contrast; and in the second case, to a very low average gradient. In addition to the factor of elevation (slant range), the luminance range of the subject matter may be further modified by aerial haze, solar altitude, and contrast (ratio of sunlight to skylight). Modifying the processing of a given aerial film, or the selection of film emulsions having certain preferred gradation characteristics, are methods commonly used for obtaining optimum information.

Since there is no ideal, "gamma", "average gradient", or any other characteristics that can be ascribed to an aerial film for all applications, no single contrast or degree of development as a measure of film contrast is specified in this International Standard for determining film speed. Therefore, it is possible for a film to have several speed and average gradient values assigned to it depending on the processing conditions.

At the present time, there are a number of processing methods that can be used for aerial films. Some of them are difficult to define or may not be representative of all conditions under which aerial films will be processed. Most standards for determining the speed of aerial films specify a single process for determining speed, but the values obtained are of limited use and are seldom used due to lack of correlation with practical applications.

In recognition of these factors, this International Standard does not specify the processing conditions, but provides a method for measuring the speed of various film-process combinations; this means that a description of both the film and process used shall be given when quoting ISO speed values. Therefore, a single film product may have several speed values associated with it depending not only on the extent of development in a particular process, but also on the type of developer, machine, etc., used. The density at which the speed is calculated is 0,30 above base plus fog which is considered a compromise between minimizing the influence of contrast variations on speed and the minimum density to which aerial films are exposed.

A method for determining the ISO aerial average gradient is also described in this International Standard. Since ISO aerial speed is dependent on the extent of development, it is suggested the ISO average gradient values be provided whenever ISO speed is given, for example, ISO A640/$\bar{G}$ 1.6. It should however, be recognized that other characteristics such as fog, image quality, etc. may also be affected by the extent of development.

1 Scope and field of application

This International Standard specifies the method for determining the ISO aerial speed and ISO aerial average gradient of black-and-white negative camera film-process combinations used in aerial photography.

This International Standard does not apply to infrared aerial films.

2 References

ISO 5, *Photography — Density measurements*

- *Part 2 : Geometric conditions for transmission density.*
- *Part 3 : Spectral conditions.*

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

CIE Publication No. 15 (E-1.3.1.) 1971, *Colorimetry.*

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.

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

3.2 speed : A quantitative measure of the response of the photographic film-process combination to radiant energy for the specified conditions of exposure, processing, and image measurement.

3.3 average gradient : The slope of the straight line joining two points on a sensitometric curve.

4 Sampling and storage

In determining the ISO speed of a product, it is important that the samples evaluated yield the average results obtained by users. This will require evaluating several different batches periodically under the conditions specified in this International Standard. Prior to evaluation, the samples shall be stored according to the manufacturers' 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 photographer at the time of use.

5 Method of test

5.1 Principle

Samples are exposed and processed as specified below. Density measurements are obtained from the resultant image to produce a sensitometric curve from which values are taken and used to determine ISO aerial speed and ISO aerial average gradient values.

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 ± 2°C and a relative humidity of 50 ± 5 %. This is the recommended atmosphere and normal tolerances specified in ISO 554 for test results.

5.3.2 Type of sensitometer

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

5.3.3 Radiant energy quality

5.3.3.1 Relative spectral power distribution

The relative spectral power distribution of the illuminant shall be as specified in table 1. These values were derived by multiplying the relative spectral power distribution values for D_{60} by the transmittance values, τ, of an ISO standard aerial camera lens.

5.3.3.2 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

Table 1 — Relative spectral power distribution of ISO sensitometric aerial daylight

Wavelength, λ	Relative spectral power distribution of aerial photographic daylight	Relative lens transmittance	International standard sensitometric aerial photographic daylight illuminant	
(nm)	D_{60}*	τ	Relative** power	Tolerances
350	35	0	0	0 to +2
400	71	26	18	16 to 22
450	106	70	74	69 to 83
500	103	89	92	85 to 103
550	102	98	100	0
600	90	99	89	83 to 98
650	82	99	81	74 to 90
700	75	98	74	67 to 82
750	66	96	63	58 to 71

* This is the CIE Standard illuminant representing a phase of daylight with a correlated colour temperature of 6 003 K normalized to 102 at 550 nm.

** This relative power distribution may be approximated by the use of a 2 854 K tungsten source, an appropriate daylight conversion filter (for example Corning filter 5900 or equivalent) and a heat absorbing filter.

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 modulator throughout the wavelength interval from 400 to 750 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 0,20 $\log_{10}H$ units per step. The width and length of a single step shall be adequate to obtain a uniform density, devoid of edge effects, within the minimum 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, $\log_{10}H$ units 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 film is dependent on the exposure time because of reciprocity law failure effects, the exposure time used for determining ISO speed and average gradient shall be specified in the use instructions.

An area of the film shall not be exposed, to produce the minimum density possible.

5.4 Processing

5.4.1 Conditioning of samples

In the time interval between exposure and processing, the samples shall be kept at 23 ± 2 °C and a relative humidity of 50 ± 5 %. The processing shall be started between 1 h and 2 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. ISO aerial speed and average gradient values provided by film manufacturers 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 the film manufacturers or others who quote ISO speed and ISO average gradient values. This shall specify the chemicals, times, 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 and average gradient obtained using various processing procedures may differ significantly. Although different speeds and average gradients for a particular film may be achieved by varying the processes, the user should be aware that other sensitometric and physical changes may also accompany the speed and average gradient changes.

5.5 Densitometry

ISO standard visual diffuse transmission densities are obtained from the image using a densitometer complying with the geometric requirements specified in ISO 5/2 and the spectral requirements specified in ISO 5/3. A minimum aperture area of 7 mm^2 shall be used to minimize the effect of image non-uniformity. Readings shall be at least 1 mm from the edges of the exposures.

5.6 Evaluation

5.6.1 Sensitometric curve

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

5.6.2 Base plus fog density

The base plus fog density shall be determined from an unexposed area of the film.

6 Product classification

6.1 ISO aerial speed

The ISO aerial speed scale given in table 2 is derived from the formula

$$S = \frac{1,5}{H_m}$$

where

S is the ISO aerial speed;

H_m is the exposure, in lux seconds, required to produce a density of 0,30 above base plus fog density.

"ISO" aerial speed shall be obtained directly from $\log_{10} H_m$ by use of table 2 which shows the rounding method to be used.

6.1.2 ISO aerial speed of a product

The ISO aerial 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 from various batches of the product when selected, stored, and tested as specified above. The ISO aerial speed of a product with proper rounding is then determined from the average value of $\log_{10} H_m$ by use of table 2.

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

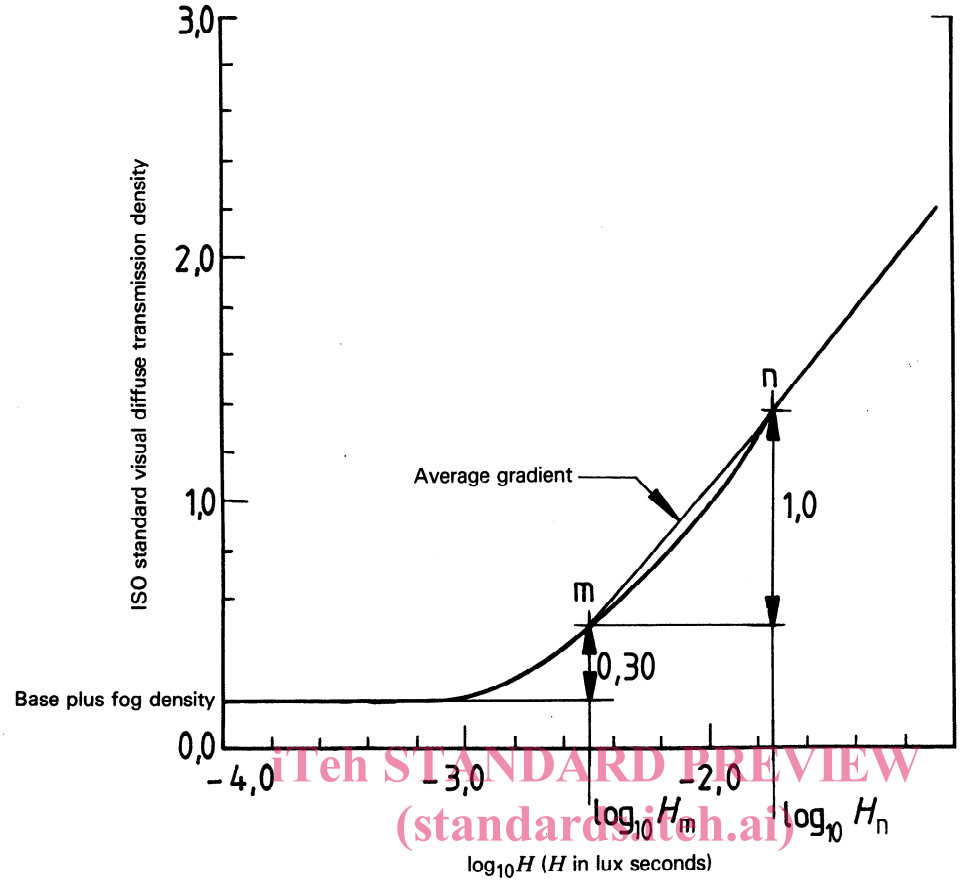

Figure 1 — Sensitometric curve

Table 2 — ISO aerial speed scale

$\log_{10} H_m$		ISO aerial speed
from	to	
−3,17	−3,08	A 2 000
−3,07	−2,98	A 1 600
−2,97	−2,88	A 1 250
−2,87	−2,78	A 1 000
−2,77	−2,68	A 800
−2,67	−2,58	A 640
−2,57	−2,48	A 500
−2,47	−2,38	A 400
−2,37	−2,28	A 320
−2,27	−2,18	A 250
−2,17	−2,08	A 200
−2,07	−1,98	A 160
−1,97	−1,88	A 125
−1,87	−1,78	A 100
−1,77	−1,68	A 80
−1,67	−1,58	A 64
−1,57	−1,48	A 50
−1,47	−1,38	A 40
−1,37	−1,28	A 32
−1,27	−1,18	A 25
−1,17	−1,08	A 20
−1,07	−0,98	A 16
−0,97	−0,88	A 12
−0,87	−0,78	A 10
−0,77	−0,68	A 8

6.2 ISO aerial average gradient

6.2.1 ISO aerial average gradient scale

The ISO aerial average gradient scale given in table 3 is derived from the following formula :

$$\bar{G} = \frac{D_n - D_m}{\log_{10} H_n - \log_{10} H_m}$$

where

$\bar{G}$ is the ISO aerial average gradient;

D_m is the density of the point on the curve which is 0,30 above base plus fog density;

H_m is the exposure required to produce D_m;

D_n is the density of the point on the curve which is 1,3 above base plus fog density;

H_n is the density required to produce D_n;

Since $D_n - D_m = 1{,}00$

$$\bar{G} = \frac{1}{\log_{10} H_n - \log_{10} H_m}$$

Table 3 — ISO aerial average gradient scale

$\log_{10}H_n - \log_{10}H_m$		ISO aerial average gradient $\bar{G}$
from	to	
1,80	1,54	0,6
1,53	1,34	0,7
1,33	1,18	0,8
1,17	1,06	0,9
1,05	0,95	1,0
0,94	0,87	1,1
0,86	0,80	1,2
0,79	0,68	1,4
0,67	0,60	1,6
0,59	0,53	1,8
0,52	0,48	2,0
0,47	0,43	2,2
0,42	0,38	2,5
0,37	0,34	2,8
0,33	0,30	3,2
0,29	0,27	3,6
0,26	0,24	4,0
0,23	0,21	4,5

"ISO" aerial average gradient shall be obtained directly from $\log_{10}H_n - \log_{10}H_m$ by use of table 3 which shows the rounding method to be used.

6.2.2 ISO aerial average gradient of a product

The aerial average gradient of a product (as distinguished from that of a specific sample) shall be based on the numerical average of $\log_{10}H_n - \log_{10}H_m$ determined for various batches of the product when selected, stored, and tested as specified above. The ISO aerial average gradient with proper rounding is then determined from the average value of $\log_{10}H_n - \log_{10}H_m$ by use of table 3. Since ISO aerial average gradient is dependent on exposure and development conditions, these should be indicated when quoting ISO aerial average gradient values.

6.3 Accuracy

The calibration of the equipment and processes involved in determining ISO aerial speed shall be adequate to ensure the error in $\log_{10}H_m$ is less than 0,05 and for ISO aerial average gradient less than ± 5 % of the value.

7 Product marking and labelling

7.1 ISO aerial speed

Aerial speed of a product determined by the method described in this International Standard, and expressed on the scale of table 2, should be designated ISO aerial speed and denoted in the form "ISO A100".

7.2 ISO aerial average gradient

Aerial average gradient of a product determined by the method described in this International Standard, and expressed on the scale of table 3, should be designated ISO aerial average gradient and denoted in the form "ISO $\bar{G}$ 1,2".

7.3 General

Since it is possible to quote several ISO aerial speed and ISO aerial average gradient values for a single film ISO aerial speed and average gradient values should be quoted together and denoted in the form "ISO A 100/$\bar{G}$ 1,2". The processing specifications and exposing time used for obtaining the values shall be specified.

Annex A

Processing with standard chemicals

(This annex does not form part of the standard.)

Some national standards currently in use determine speed when film is processed in a specific manner. Since the characteristics obtained from a film is a function of processing, the use of a single specified process in this International Standard to evaluate various films is considered to be of limited value. In fact, in many cases, the results may be misleading when required to indicate the characteristics obtained under processing conditions actually used in practice. The process described below is suggested for those people or organizations who wish to continue this practice. Only photographic grade chemicals meeting the requirements of the appropriate International Standard should be used.

A.1 Development

A.1.1 Developer and extent of development

The test sample shall be developed for 8 min in the following solution, which is often referred to as D-19.

Air-free distilled water	500 ml
Monomethyl para-aminophenol sulfate	2,0 g
Sodium sulfite, anhydrous	90,0 g
Hydroquinone	8,0 g
Sodium carbonate, monohydrated	52,5 g
Potassium bromide	5,0 g
Air-free distilled water to make	1 000 ml

The pH of this solution shall be 10,1 ± 0,1 at 20 °C.

A.1.2 Temperature of developing solution

The temperature of the developing solution shall be 20 ± 0,3 °C.

A.1.3 Apparatus

A.1.3.1 Vacuum flask, having an internal length of approximately 22 cm and an internal diameter of about 4 cm.

A.1.3.2 Glass strip approximately 20 cm × 3,5 cm.

A.1.4 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.

A.1.5 Method of test

Pour the developer (A.1.1) into the vacuum flask (A.1.3.1) until three-quarters of the free space is filled. Fasten the negative material to be tested by means of rubber bands to the glass strip (A.1.3.2). Fix the glass strip to an inert stopper so that it projects into the flask when the stopper is in place. Insert the stopper carrying the glass strip and the test film in the flask and develop at the prescribed temperature. During development, the vessel shall be given an oscillatory movement by tilting it in a vertical plane to an angle of about 45° above and below the horizontal, one complete cycle lasting approximately 1 s. At the same time, the vessel shall be revolved about its axis, the time for one revolution being about 5 s. To terminate development, withdraw the film and immediately immerse in the fixing bath.

A.2 Fixing

The test sample shall be immersed in the following fixer immediately after development :

Distilled water	600 ml
Sodium thiosulfate, crystalline	240 g
Sodium sulfite, anhydrous	15 g
Acetic acid, glacial	20 ml
Sodium tetraborate, pentahydrate	15 g
Aluminium potassium sulfate	15 g
Distilled water to make	1 000 ml

The pH of this solution shall be approximately 4,4 at 20 °C.

The fixer shall be maintained at 20 ± 5 °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 fixer.

A.3 Washing

The sample shall be washed in water at 20 ± 5 °C not less than 20 min nor more than 40 min.

A.4 Drying

Surface water shall be removed and the samples dried in evenly circulated air having a temperature of 20 ± 5 °C and a relative humidity of 50 ± 10 %.

A.5 Classification

The values for speed and average gradient determined following the methods described in this International Standard and using the above processing conditions shall be designated ISO aerial speed and ISO aerial average gradient. It is recommended that values for both measurements be given simultaneously in order to provide a more comprehensive description of the film characteristics. Processing conditions shall also be specified.