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Photography — General purpose photographic exposure meters (photoelectric type) — Guide to product specification

Photographie — Posemètres photographiques pour usage général (type photoélectrique) — Base de spécification

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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 2720 was drawn up by Technical Committee ISO/TC 42, *Photography*, and circulated to the Member Bodies in July 1972.

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

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

No Member Body expressed disapproval of the document.

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0 INTRODUCTION

This International Standard has been prepared in order to make information available for the development, manufacture and test of photoelectric exposure meters. It does not cover the automatic or semi-automatic control of exposure in cameras.

Photographic exposure is defined as the product of exposure time and image illuminance. Satisfactory exposure is achieved within the camera by control of the effective exposure time (shutter speed) and the relative aperture (*f*-number) and depends on the speed of the photo-sensitive material used and on the light incident upon it. In order to determine the exposure required, the luminance of, or illuminance falling upon, a given scene is measured by the exposure meter and a calculating mechanism is used to correlate the meter indication with the camera exposure settings for the photo-sensitive material used.

Exposure meters are calibrated by reference to a standard subject; reflected light meters by reference to an area of known uniform luminance which covers completely the whole field of view of the meter; incident light meters by reference to a point source of light of known luminous intensity located on the meter axis.

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies calibration levels and test conditions for general purpose photoelectric exposure meters which measure reflected light or incident light, or both, in determining photographic exposure for camera use.

It applies to meters containing a light sensitive element, an indicating electrical instrument calibrated in suitable units such as luminance, illuminance, or some factor of photographic exposure, a directional system and a calculator to correlate the meter indications with the camera exposure settings for the particular photographic film being used.

Quality of product is not covered.

2 REFERENCES

IEC Publication 68-2-6, *Basic environmental testing procedures — Test Fc : Vibration.*

IEC Publication 68-2-27, *Basic environmental testing procedures — Test Ea : Shock.*

3 GENERAL REQUIREMENTS

3.1 Meter and calculator markings

3.1.1 *Nomenclature*

The preferred exposure-parameter markings shown on the calculator or scale of the instrument shall be compatible with the symbols, abbreviations, and relationships given in clause 6.

3.1.2 *Relative aperture scale*

Numbered aperture markings shall be selected from the series of *f*-numbers given in table 2. The symbol used to indicate relative aperture shall be 1 : *A* or *f* : *A* or *f*/*A* or *f*-*A* where *A* is the *f*-number.

Intermediate scale divisions may be used and may be numbered.

3.1.3 *Effective exposure time scale (shutter speed)*

Effective exposure time scale markings shall be selected from the series of effective exposure times given in table 2.

Intermediate scale divisions may be used and may be numbered.

3.1.4 *Film speed markings*

Markings shall include the logarithmic and/or arithmetic film speeds (S° or S respectively) selected from the series of film speeds given in table 2. These film speeds may be designated as ISO if they are consistent with ISO proposals or International Standards.

3.1.5 *Exposure value scale*

Exposure values, when shown, shall be in numerical sequence determined from the equations given in clause 6 for any combination of relative aperture and effective exposure time. A change in meter reading of one exposure value unit, E_v, will require a change in exposure by a factor of 2. This unit is called a STEP.

3.1.6 *Light scale*

Because the light reading is used as a basis for setting the calculator, the light scale may be marked in light units or in any arbitrary units, or may not be marked at all, provided that transfer of the measured light value to the calculator can be made effectively.

3.2 Balance of movement

The moving coil system of the meter shall be statically balanced to permit accurate indication. Balance shall be tested with zero illuminance on the photo-sensitive element. A battery, if included, shall be switched off.

The pointer shall first be set to the zero mark on the scale when the meter is held so that the plane of movement of the pointer is horizontal. The device shall then be turned through 90° so that the plane of movement is vertical with the pointer : 1) horizontal, 2) vertical.

The deflection of the pointer from its initial position to that of maximum deflection after vibration to minimise friction, shall not exceed a prescribed percentage of the scale length.

3.3 Light sources for calibrating exposure meters

The light source used for calibrating meters shall operate at such a correlated colour temperature that it represents a reasonable compromise between the requirements of photography under tungsten and daylight lighting conditions, and shall closely match the relative spectral energy distribution of a black body at this temperature.

A possible correlated colour temperature for this purpose is 4 700 K. The chosen correlated colour temperature may be achieved by the use of a clear tungsten filament lamp operated at a specific correlated colour temperature used in conjunction with a suitable glass or liquid filter.

3.3.1 *Correlated colour temperature conversion filter*

Although other light sources and filters may be used, one reference lamp-filter combination to provide radiation at a correlated colour temperature of 4 700 K consists of a tungsten filament lamp operated at a correlated colour temperature of 2 855,6 K used in conjunction with a selectively absorbing liquid filter[1]) made up as described below.

Two solutions shall be compounded according to the following formulae, the complete filter consisting of a 10 ± 0,05 mm 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 pentahydrate ($CuSO_4 \cdot 5H_2O$)	2,377	g
Mannitol [$C_6H_8(OH)_6$]	2,377	g
Pyridine (C_5H_5N)	30,0	ml
Water, distilled, to make	1 000,0	ml

Solution B

Ammonium cobalt(II) sulphate hexahydrate [$(NH_4)_2SO_4 \cdot CoSO_4 \cdot 6H_2O$]	21,045	g
Copper(II) sulphate pentahydrate ($CuSO_4 \cdot 5H_2O$)	15,642	g
Sulphuric acid (ρ = 1,84 g/ml at 20 °C)	10,0	ml
Water, distilled, to make	1 000,0	ml

The luminous transmittance τ_v of this filter to 2 855,6 K radiation is 0,259.

This combination filter may be used as a reference standard for calibration and when setting up test equipment using the selectively absorbing glass filters mentioned in this International Standard.

3.3.2 *Reflected light meters*

For calibrating reflected light meters a combination of a selectively absorbing blue glass filter, together with a diffusing screen designed to provide the required effective colour temperature of the source luminance, may be used, in conjunction with a clear tungsten filament lamp. The luminance of this extended source at any angle within 60° from the meter axis shall not be less than 85 % of the maximum luminance. The source shall be large enough to cause a change in the light indication of the meter, not greater than 1/12 step when the meter is rotated 5° in any direction from its test position.

3.3.3 *Incident light meters*

For calibrating incident light meters a selectively absorbing blue glass filter may be used, in conjunction with a clear tungsten filament lamp. The effective size of the luminous source shall be small enough to perform as a point source, so that the inverse square law of illumination may be obeyed.

NOTE — The minimum distance between the light source and the meter must exceed ten times the maximum dimension of the luminous source or of the receiver whichever is the greater.

3.4 Spectral sensitivity

3.4.1 *Requirements*

The spectral sensitivity of the meter shall be continuous over the wavelength range 400 to 700 nm but shall not extend appreciably beyond this range.

The effect of different spectral sensitivities of different light sensitive elements used in exposure meters shall be assessed by comparing the transmittance of the correlated colour temperature conversion filter mentioned in 3.3.1, when measured by :

1) the CIE Standard Photometric Observer, i.e. the luminous transmittance τ_v, and

2) the exposure meter, i.e. the meter transmittance τ_m.

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.

3.4.2 *Test*

The meter shall be mounted on a photometer bench and its distance from a constant tungsten source giving light at a correlated colour temperature of 2 855,6 K adjusted to d_1 to give a convenient indication on the meter. The filter specified in 3.3.1 shall then be interposed between source and meter and their distance apart re-adjusted to d_2 to give the same meter indication as previously.

The meter transmittance τ_m is given by

$$\tau_m = \left(\frac{d_2}{d_1}\right)^2$$

The luminous transmittance τ_v has been determined for this filter from the density wavelength relationship of the filter in conjunction with the standard visibility curve and Planck's radiation law, and is 0,259 at 2 855,6 K.

The spectral behaviour of the meter is assessed by the value of the ratio τ_m/τ_v.

It is permissible and convenient to connect a separate current indicating instrument to the photo-sensitive element circuit in place of the meter indicating instrument, provided that no mechanical change of the meter occurs which could modify the light receptor response characteristic.

3.5 Calibration constant

The calibration constant K (for reflected light meters) and C (for incident light meters) may be assigned a value within the limits given in 6.3.

The value of K or C, or both, may be marked on the nameplate of the exposure meter or given in the instruction manual furnished with the meter by the manufacturer. The allowable range in the value of the constants is not intended to permit increased calibration error. Its purpose is to allow the manufacturer to use and declare an optimum value of the constant within the stipulated limits to take into account design variations and prescribed methods of use.

3.6 Meter sensitivity

Meter sensitivity shall be expressed as the effective exposure time scale marking in seconds which corresponds to the lowest effective light mark on the light scale for a relative aperture of $f/8$ when the calculator is set to a film speed represented by

$$S = 100 \quad \text{or} \quad S^{\circ} = 21$$

3.7 Response time

The response time of an exposure meter shall be measured at two levels of light incident upon the meter.

3.7.1 *Normal light level*

The exposure meter shall be exposed suddenly to a constant luminance or illuminance sufficient to give pointer deflection to a convenient mid or upper scale mark. The response time of the meter is the time taken for the pointer to reach and remain within one-third of a step of its final value.

3.7.2 *Low light level*

The exposure meter shall be exposed for 2 min to a luminance or illuminance sufficient to give pointer deflection to a mark 2 steps above the lowest scale mark. The exposure shall then be terminated suddenly. The response time is the time taken for the pointer to coincide with the lowest scale mark.

3.8 Effect of temperature change

3.8.1 *Requirements*

The criteria for the effect of temperature change shall be as follows :

The change in indicated exposure at any temperature between 0 and + 40 °C from that at 20 °C, measured at any convenient mid-scale mark, and the change in indicated exposure after the meter has been subjected to temperatures of − 35 °C and + 50 °C, from that at 20 °C.

3.8.2 *Test*

The exposure meter shall be placed in air maintained constant within ± 2 °C at each prescribed temperature for at least 2 h before any readings are taken. It shall then be exposed to a tungsten light source having an effective correlated colour temperature between 2 650 K and 2 900 K, giving a luminance corresponding to a convenient mid-scale mark on the meter.

3.9 Fatigue of the photo-electric element

3.9.1 *Requirement*

The criterion for fatigue of the photo-electric element shall be determined by the test described in 3.9.2.

3.9.2 *Test*

The meter shall be kept unexposed to light for a period of not less than 1 h, and shall then be suddenly exposed to light of a luminance sufficient to give a deflection to a convenient mid-scale mark of the angular full scale deflection. The ratio of the luminance required after a protracted period to that required initially to maintain the same meter deflection, is the measure of fatigue.

The initial indication shall be that obtained after 5 s exposure; the protracted period shall be 3 min or any further period not exceeding 1 h provided that the fatigue measured is not thereby reduced.

Any incandescent lamp may be used for this test.

3.10 Shock resistance

3.10.1 *Requirement*

The change in indicated exposure to a constant light source, before and after the test described in 3.10.2, shall be the criterion for the assessment of shock resistance.

3.10.2 *Test*

The exposure meter shall be subjected to one impact of half-sine wave-form of peak acceleration equal to 75 times the acceleration due to gravity (g) and duration 3,5 ms, in accordance with IEC Publication 68-2-27, on each of its six sides (a total of six impacts).

3.11 Effect of vibration

3.11.1 *Requirement*

The change in indicated exposure to a constant light source, before and after the test described in 3.11.2, shall be the criterion for the assessment of the effect of vibration.

3.11.2 *Test*

The exposure meter shall be subjected to vibration in accordance with IEC Publication 68-2-6, applied in the following manner.

The exposure meter shall be vibrated successively in three mutually perpendicular directions, one of which is parallel with the pivot axis of the meter. The frequency shall be changed at a uniform rate from 30 to 100 to 30 Hz in 5 min. The vibration shall be applied for 20 min, in each of the three directions. The total peak-to-peak amplitude shall be adjusted to give a maximum acceleration of 3 g.

3.12 Effect of humidity

3.12.1 *Requirement*

The change in indicated exposure to a constant light source, before and after the test described in 3.12.2, shall be the criterion for the assessment of the effect of humidity.

3.12.2 *Test*

The exposure meter shall be maintained in total darkness for 40 h at an ambient temperature of 35 ± 2 °C and relative humidity of 90 ± 5 %.

3.13 Battery life

If a separate battery is used to supply power to the exposure meter indicator and no means is provided to show when the battery is failing, the instructions supplied with or on the exposure meter shall give some guidance on the expected battery life. If the battery life is liable to be shortened by leaving the exposure meter exposed to light when not in use, a warning to this effect shall be given.

4 REQUIREMENTS FOR REFLECTED LIGHT EXPOSURE METERS

4.1 Calibration

The instrument-calculator combination shall be calibrated in accordance with the appropriate formula in clause 6.

4.1.1 *Calibration accuracy*

The criterion of overall accuracy of the meter shall be the deviation, from the stated value, of the constant K.

4.1.2 *Calibration test procedure*

The calibration accuracy of the instrument shall be measured by means of exposure to an extended source of known luminance. The equipment and test conditions shall be as given in the following sub-clauses.

4.1.2.1 AMBIENT CONDITIONS

The ambient temperature shall lie within the range 20 to 30 °C and the relative humidity within the range 45 to 85 %.

4.1.2.2 ZERO ADJUSTMENT

Prior to checking calibration the instrument shall be set to zero with no illuminance on the cell. A battery, if fitted, shall be switched off.

4.1.2.3 TESTING POSITION

The meter shall be held in front of an extended luminance source. Inter-reflections between the luminance source and the meter shall be eliminated by covering all reflecting surfaces of the meter with a matt black material. Care must be taken to ensure that no change occurs to the meter which could modify the light receptor response characteristics.

4.1.2.4 BEARING FRICTION

The meter or its support shall be vibrated at the moment of reading the instrument to eliminate friction errors.

4.1.2.5 LIGHT SOURCE

The light source shall meet the requirements of 3.3.

4.2 Acceptance (Directional characteristics of response to light)

The directional characteristics of an exposure meter shall be defined in terms of specific and oblique acceptance angles, or alternatively in terms of average acceptance angle.

4.2.1 *Specific acceptance angle*

4.2.1.1 REQUIREMENTS

The specific acceptance angle of an exposure meter is defined as the angle in the stated directions from the optical axis of the light receptor at which the point source must be placed to reduce the scale reading of the meter an amount corresponding to 1 step from the original light reading when the same point source was on the optical axis. Specific acceptance angles shall be defined by the direction of measurement with respect to the optical axis, left, right, up or down. The specific acceptance angle shall be denoted "up" when the light source is above the optical axis of the meter, etc.

4.2.1.2 TEST

The meter and standard lamp may be mounted in alignment on a conventional photometer bench. The lamp position shall be adjusted to give a convenient low-scale reading and its distance d from the meter aperture noted. It shall then be moved closer to a distance $d/\sqrt{2}$ from the meter. The meter shall then be rotated about an axis through the centre of its light receptor until the original scale indication is obtained. This angular displacement is the specific acceptance angle in the corresponding direction. Methods or apparatus which produce equivalent results are acceptable.

4.2.2 *Oblique acceptance angle*

The oblique acceptance angle is the angle in the stated directions from the optical axis of the light receptor at which the point source must be placed to reduce the response of the meter to an amount corresponding to 4 steps from the original light reading when the same point source was on the optical axis. It shall be measured in a manner similar to that described in 4.2.1.2, but the distance between lamp and meter shall be reduced to $d/4$.

4.2.3 *Average acceptance angle*

4.2.3.1 REQUIREMENTS

The average acceptance angle is the angle subtended at the centre of the meter light receptor when the meter is so mounted that the axis of maximum sensitivity is coincident with the axis of a circular surface source of uniform luminance, preferably not less than 20 cm diameter, from which the meter light receptor receives luminous flux corresponding to one-third of a step less than that from an infinite source of the same luminance as the circular source.

4.2.3.2 TEST

The circular surface source shall be trans-illuminated uniformly by a lamp mounted on its axis. The meter shall be placed coaxially in contact with the source and its reading and the distance d of the lamp from the source noted. Inter-reflections between the luminance source and the meter shall be eliminated by covering all reflecting surfaces of the meter with a matt black material. The lamp shall then be moved to a distance 0,89 d from the surface source and the meter moved axially away from the source until the original scale deflection is obtained. The average acceptance angle is the angle subtended at the entrance aperture of the meter by the circular surface source.

5 REQUIREMENTS FOR INCIDENT LIGHT EXPOSURE METERS

The requirements for an incident light meter shall be analogous to those given for a reflected light meter but a light receptor shall be provided having known directional characteristics different from those used for reflected light meters.

5.1 Calibration

The instrument-calculator combination shall be calibrated in accordance with the appropriate formula given in clause 6.

5.1.1 *Calibration accuracy*

The criterion of overall accuracy of the meter shall be the deviation, from the stated value, of the constant C.

5.1.2 *Calibration test procedure*

The calibration accuracy of the instrument for measuring incident light shall be measured by means of exposure to a point source of known luminous intensity. The equipment and test conditions shall be as given in the following sub-clauses.

5.1.2.1 AMBIENT CONDITIONS

The ambient temperature shall lie within the range 20 to 30 °C and the relative humidity within the range 45 to 85 %.

5.1.2.2. ZERO ADJUSTMENT

Prior to checking calibration, the instrument shall be set to zero with no illuminance on the cell. A battery, if fitted, shall be switched off.

5.1.2.3 TESTING POSITION

The meter shall be held with the normal to its light receptor directed towards the source of illuminance.

5.1.2.4 BEARING FRICTION

The meter or its support shall be vibrated at the moment of reading the instrument to eliminate friction errors.

5.1.2.5 LIGHT SOURCE

The light source shall meet the requirements of 3.3.

5.2 Acceptance (Directional characteristics of response to light)

5.2.1 *Requirements*

Light receptors for incident light measurement may be in any form which allows satisfactory determination of exposure. Satisfactory forms include :

1) a hemispherical receptor (the cardioid type receptor), the polar curve of response to incident light of which approximates to a cardioid.

2) a flat plate receptor (the cosine type receptor), the polar curve of response to incident light of which approximates to a circle.