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METROLOGICAL VERIFICATION REGULATION
OF THE PEOPLE'S REPUBLIC OF CHINA

JJG 245-2005

Illuminance meter

光照度计

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Verification regulation of illuminance meter

1 Scope

This Regulation applies to the initial verification, subsequent verification, in-use inspection of illuminance meters (hereinafter referred to as illuminance meters). The requirements related to measurement performance in type identification and prototype testing can be implemented with reference to Regulation.

2 Normative references

This Regulation cites the following documents:

"Illuminance Meter" OIML 1988 English version

"Performance Test Methods for Photometers and Luminometers" CIE 1987 English version

JJF 1059-1999 "Evaluation and Expression of Uncertainty in Measurement"

When using this Regulation, attention shall be paid to using the currently valid versions of the above cited documents.

3 Overview

An illuminance meter is a measuring instrument for measuring illuminance. It consists of a photometric probe (including a cosine corrector, a $V(\lambda)$ correction filter, a photoelectric receiver) and a display (digital or pointer type). When the photoelectric receiver receives the optical radiation passing through the cosine corrector and $V(\lambda)$ filter, the generated photoelectric signal is processed and the corresponding illumination value is displayed on the display.

4 Metering performance requirements

4.1 Relative indication error

The relative indication error of the illuminance meter shall not exceed the requirements of Table 1.

1 - The distance from the filament plane of the standard lamp to the test surface of the photometric probe, m.

During verification, the distance -- between the filament plane of the standard lamp and the photometric probe must be at least 15 times greater than the maximum linear dimension of the light-emitting surface or the test surface of the photometric probe (the diagonal length or diameter of the filament plane and the test surface of the photometric probe).

The standard illuminance meter shall calibrate at least five equally spaced points, within the full range of each gear. The level 1 and level 2 illuminance meters shall calibrate at least three equally spaced points. Each point shall be illuminated for 5 seconds and its display value shall be read. Each instrument is required to be verified for two rounds. The relative deviation of the two rounds of values: standard, level 1, level 2 illuminance meters shall not exceed 0.6%, 1%, 1.5%, respectively. The average value of each point is taken as the final result. The relative indication errors of illuminance meters at all levels shall comply with the requirements of 4.1.

Relative indication error = $[(\text{Displayed value} - \text{standard value}) / \text{Standard value}] \times 100\%$
(2)

For level 1 and level 2 illuminance meters, the comparison method can also be used for verification. See Appendix B for the method.

6.3.3 Cosine characteristic (directional response) error of illuminance meter

6.3.3.1 Install the photometric probe on the rotating platform with the dial of the photometric measuring device, so that the rotation axis of the platform passes through the center line of the test surface. Adjust the filament plane of the standard lamp and the test surface of the photometric probe, so that they are perpendicular to the horizontal measurement axis of the light track, with the center point located on this axis. Arrange a number of diaphragms between the standard lamp and the photometric probe. The distance from the standard lamp to the photometric probe shall be at least 15 times the maximum linearity of the luminous surface of the standard lamp or the test surface of the photometric probe.

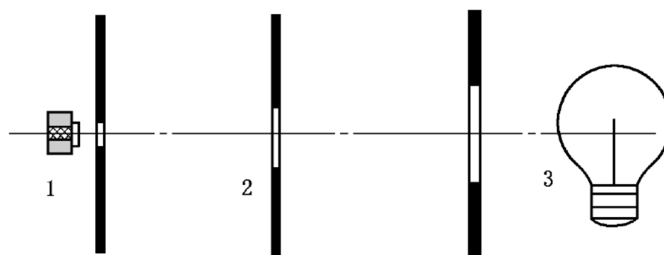


Figure 1 -- Schematic diagram of calibrating the illuminance meter on the photometric measuring device

Calculate the total directional error f_2 of the optical probe according to formula (4):

$$f_2 = \int_{\epsilon=0}^{1.484} |f_2(\epsilon)| \sin 2\epsilon d\epsilon \quad (4)$$

Where:

1.484 rad is equal to 85° .

The directional response error of illuminance meters at all levels shall comply with the requirements of 4.3.

The derivation relationship between formula (3) and formula (4) can be found in Appendix D.

6.3.4 Nonlinear error

6.3.4.1 On the photometric measuring device, install the standard lamp and the photometric probe of the illuminance meter in accordance with the requirements for calibrating the illuminance meter. The position of the fixed photometric probe remains unchanged; the standard lamp is moved so that the display value Y of the illuminance meter reaches 1/10 of the full scale; its corresponding standard illuminance value is X . Then move the standard lamp to make the display value of the illuminance meter reach $Y_{\max}$ (close to full scale). Find the corresponding standard illuminance value $X_{\max}$.

6.3.4.2 Calculate the nonlinear error f_3 of the photometer according to formula (5):

$$f_3 = \left(\frac{Y}{Y_{\max}} \times \frac{X_{\max}}{X} - 1 \right) \times 100\% \quad (5)$$

Where:

X - Standard illumination value;

Y - Display value when the standard illumination value X illuminates the photometer probe;

$X_{\max}$ - The standard illumination value corresponding to the maximum display value $Y_{\max}$;

$Y_{\max}$ - Maximum display value.

The nonlinear errors of illuminance meters at all levels shall comply with the requirements of 4.4.

6.3.5 Shift error

6.3.5.1 On the photometric measuring device, install the standard lamp and the

photometric probe of the illuminance meter in accordance with the requirements for calibrating the illuminance meter. Keep the position of the fixed photometric probe unchanged; move the standard lamp, so that the standard illumination value $X(A)$ reaches 90% of the full scale in the low-range gear A; its displayed value is $Y(A)$. Then change the illuminance meter to the relatively high range B; move the standard lamp so that the standard illuminance value $X(B)$ increases k times compared to $X(A)$. Read the illuminance meter's display value $Y(B)$.

6.3.5.2 Calculate the error f_4 caused by the change of measuring range according to formula (6):

$$f_4 = \left(\frac{Y(B)}{kY(A)} - 1 \right) \times 100\% \quad (6)$$

Where:

$Y(A)$ - The display value of the standard illumination value $X(A)$ (equivalent to 90% of the full scale) in the range A gear;

$Y(B)$ - The display value of $X(B)$ that is k times higher than $X(A)$ in the relatively high range B gear;

k - Shift multiple, $k = Y(\text{full-scale reading of range B gear}) / Y(\text{full-scale reading of range A gear})$.

The shifting error of illuminance meters at all levels shall comply with the requirements of 4.5.

6.4 Processing of verification results

Carry out verification one by one according to the provisions of 6.2 "Verification items". Record the various data obtained. Calculate the results. If all items meet the requirements of this Regulation, it will be judged as qualified (for ungraded illuminance meters, a verification conclusion can be issued that "the verified items meet the requirements of a certain level of illuminance meter"); otherwise, it will be unqualified. For qualified instruments, a calibration certificate will be issued; for unqualified instruments, a calibration result notification will be issued. Please refer to Appendix E for the format of the inner pages.

Newly produced illuminance meters shall be subject to initial verification. After repair, some necessary verification items can be added to the repaired illuminance meter according to the repair situation. During the initial verification, based on the verification data results and the description of the measurement performance indicators in the instrument's instruction manual, in accordance with the relevant provisions in Chapter 4 of this Regulation, the instrument will be graded and a calibration certificate will be

Appendix A

Recommended test methods for type identification and prototype testing

Type identification and prototype testing shall be carried out in accordance with JJF 1015-2002 "General norm for pattern evaluation and pattern approval of measuring instruments" and JJF 1016-2002 "The rules for drafting program of pattern evaluation of measuring instruments". The test items include appearance, relative indication error, $V(\lambda)$ Matching error, cosine characteristic error, nonlinear error, shift error, fatigue error, infrared response error, ultraviolet response error, temperature coefficient. This Appendix only gives the test methods other than 6.3 for type identification and prototype testing.

A.1 $V(\lambda)$ matching error of illuminance meter

The photometric probe of the illuminance meter must have a $V(\lambda)$ filter, so that its spectral responsivity matches the CIE photopic spectral efficiency of the International Commission on Illumination. The matching error f_1 is calculated as follows:

$$f_1 = \frac{\int_{380}^{780} |S^*(\lambda)_{\text{rel}} - V(\lambda)| d\lambda}{\int_{380}^{780} V(\lambda) d\lambda} \times 100\% \quad (\text{A. 1})$$

$$= 0.935 \, 84 (\text{nm}^{-1}) \int_{380}^{780} |S^*(\lambda)_{\text{rel}} - V(\lambda)| d\lambda \, \%$$

Where:

$S^*(\lambda)_{\text{rel}}$ - Standardized (normalized) relative spectral responsivity.

$$S^*(\lambda)_{\text{rel}} = \frac{\int_{380}^{780} P_A(\lambda) V(\lambda) d\lambda}{\int_{380}^{780} P_A(\lambda) S(\lambda)_{\text{rel}} d\lambda} \times S(\lambda)_{\text{rel}} \quad (\text{A. 2})$$

Where:

$P_A(\lambda)$ - Relative spectral power distribution of 2856 K light source;

$S(\lambda)_{\text{rel}}$ - The relative spectral responsivity using any reference point as the standard;

$V(\lambda)$ - CIE photopic spectrum light efficiency.

The $V(\lambda)$ matching error of illuminance meters at all levels shall meet the requirements of 4.2.

Appendix B

Verification of illuminance meter using comparison method

B.1 Illuminance meter calibration device

The illuminance meter's calibration device is shown in Figure A.1. It consists of two parts: an integrating sphere and a camera obscura. The integrating sphere part includes: 2856 K light source, integrating sphere, adjustable diaphragm; camera obscura includes: light track, movable turntable, photometric probe fixture, camera obscura, etc.

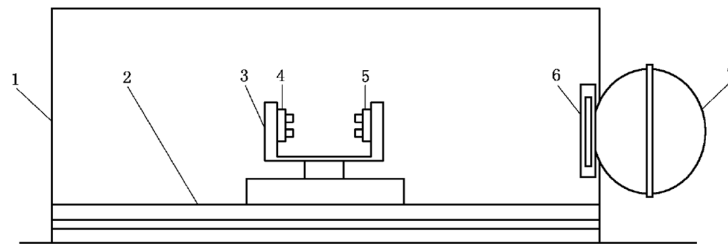


Figure B.1 -- Illuminance meter's calibration device

1 - Camera obscura; 2 - Slide rail; 3 - Mobile turntable; 4 - Standard illuminance meter's photometric probe fixture; 5 - Photometric probe fixture of the illuminance meter under test; 6 - Adjustable diaphragm; 7 - Integrating sphere (contains 2856 K light source)

B.2 Verification method

Install the qualified standard illuminance meter and the photometric probe of the tested illuminance meter, respectively, on the workbench fixture of the illuminance meter calibration device. Adjust the test surfaces of the two photometric probes, so that the distances between them and the adjustable aperture are equal. Point the photometric probe of the illuminance meter under inspection toward the integrating sphere. Move the position of the workbench. Change the distance between the test surface and the adjustable diaphragm. Or change the size of the adjustable diaphragm, so that the display value of the illuminance meter is a certain reading. Then rotate the workbench 180°, so that the photometric probe of the standard illuminance meter faces the integrating sphere. At this time, the value measured by the standard illuminance meter is the actual illuminance value of one of the above readings of the tested illuminance meter.

The illuminance meter must calibrate at least three equally spaced points within the full range of each gear. Each instrument is required to be verified for two rounds. The relative deviation of the two rounds of values: the level 1 and level 2 illuminance meters shall not exceed 1% and 1.5%, respectively. The average of each point is taken as the

Appendix C

Example of uncertainty assessment

This Appendix only provides an example analysis for the assessment of the uncertainty of the measurement results of the indication error, when using a level 1 standard lamp to verify one indication value of the level 1 and level 2 illuminance meters (the standard illuminance value is 100 lx). In actual work, the maximum value of the uncertainty of the measurement results can be given or the uncertainty can be evaluated point by point (range by range) according to customer requirements.

C.1 Measurement method

According to the relevant steps specified in this Regulation, install a 2856 K luminous intensity level 1 standard lamp and the illuminance meter to be verified on the photometric measurement device. Adjust their positions. Change the distance between the standard lamp and the photometric probe. Read the display value of the illuminance meter at the measurement point. Conduct two rounds of experiments. Take the average as the final result.

C.2 Mathematical model

C.2.1 Establish mathematical model:

$$\Delta E = \overline{E} - \frac{I(i)}{l^2} \quad (\text{C. 1})$$

Where:

ΔE - The indication error of the illuminance meter under verification;

$\overline{E}$ - The average value displayed by the illuminance meter under verification;

$I(i)$ - The luminous intensity of the standard lamp, $I(i) = 1180$ cd;

i - The current supplied to the standard lamp, $i = 6.7024$ A;

l - The distance from the filament plane of the standard lamp to the test surface of the photometric probe, $l = 3.435$ m.

C.2.2 Sensitivity coefficient:

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