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प्रदीपक ध्वनिमिति की पद्धति

भाग 2 सड़क और गली के प्रकाश के लिए प्रदीपक

Indian Standard

PHOTOMETRY OF LUMINAIRES — METHOD OF MEASUREMENT

PART 2 LUMINAIRES FOR ROAD AND STREET LIGHTING

(Incorporating Amendment No. 1)

UDC 628.971.6 : 535.24

B U R E A U O F I N D I A N S T A N D A R D S
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FOREWORD

This Indian Standard (Part 2) was adopted by the Bureau of Indian Standards after the draft finalized by the Illumination Engineering and Luminaires Sectional Committee had been approved by the Electrotechnical Division Council.

The object of this standard is to recommend the adoption of the test procedures that will give acceptable results in determining and reporting the photometric characteristics of luminaires intended for use of road and street lighting.

This standard (Part 2) is one of the series of Indian Standards which deals with the methods of photometry of luminaires. The series consist of the following parts:

Methods of photometry of luminaires:

Part 1 Luminaires intended for use of interior lighting;

Part 2 Luminaires for road and street lighting; and

Part 3 Luminaires for floodlighting.

In the formulation of this standard, assistance has been derived from CIE Publication No. 27 (TC-2.4) 1973 on Photometry of luminaires for street lighting.

This standard supersedes IS 7678 : 1975 'Method of photometric testing of incandescent type luminaires for general lighting services' which covers the method for photometric testing of filament type general lighting luminaires.

This edition 1.1 incorporates Amendment No. 1 (October 2000). Side bar indicates modification of the text as the result of incorporation of the amendment.

Indian Standard

PHOTOMETRY OF LUMINAIRES — METHOD OF MEASUREMENT

PART 2 LUMINAIRES FOR ROAD AND STREET LIGHTING

1 SCOPE

1.1 This standard applies to testing of luminaires designed primarily for road and street lighting, suitable for ac electricity supply and using the following lamp types:

a) High pressure mercury vapour;

b) Blended or self — ballasted mercury vapour;

c) Low pressure sodium vapour;

d) High pressure sodium vapour;

e) Tubular fluorescent;

f) Incandescent; and

g) Tungsten halogen.

2 DEFINITIONS

2.0 For the purpose of this standard the following definitions shall apply.

2.1 Luminaire Photometry per 1 000 Lamp Lumens

Photometric measurements of a luminaire converted into a total luminous flux of 1 000 lumens from all the lamps in the luminaire together, when these are operated under standard test conditions (*see* **5.3**).

2.2 Measuring Half-Plane (C-Plane)

That portion of any vertical plane through the photometric light centre of a luminaire, which is wholly to one side of the vertical axis.

2.3 Distribution of Luminous Intensity

By the luminous intensity distribution of a luminaire or light source is meant the luminous intensities of the luminaire or light source in all directions. The luminous intensity distribution may be represented by tables, diagrams or curves.

2.4 Test Distance

Photometric test distance is the distance from the photometric centre of the distribution photometer to the surface of the photocell, taking into account the distance to and from any mirror or mirrors that may be used.

2.5 Light Output Ratio

The light output ratio is defined as the ratio of the light output of the luminaire measured under specified practical conditions, to the sum of the individual light outputs of the lamps operating outside the luminaire under specified conditions.

The 'specified conditions' should be the standard conditions defined in **5.3**.

3 GENERAL REQUIREMENTS

3.1 Photometric Characteristics

The requirements described in these recommendations relate to the following characteristics. They can be divided into the measured characteristics, that is, those directly measured with laboratory instruments, and the derived characteristics which can be calculated from the measured ones and used in the application of the luminaires. The derived characteristics are more closely related to lighting application than to photometric measurements, but it is emphasized that these recommendations only deal with the measured photometric characteristics.

3.2 Distribution of Luminous Intensity

Distribution of luminous intensity in specified directions per 1 000 lamps lumens (*see* **2.1**). The directions in which the luminous intensity needs to be measured will depend on the later use of the measurements (*see* **2.3**).

3.3 Flashed Area

The flashed area is used in the calculation of glare in street lighting installations. It is the area of orthogonal projection of the light emitting surface of a luminaire on a plane perpendicular to a given direction of viewing within which the luminance exceeds 1 percent of the brightest part. For the purpose of the determination of the glare control mark the direction of viewing in specified as γ = 76°C in the plane C = 0°.

3.4 Presentation of Distribution Intended for Luminance Calculations

Luminance calculations are practically always made by means of the computer. The light distribution must, therefore, be given in digital form (a light distribution table). The table gives a luminous intensity as a function of the horizontal angle C and the vertical angle Y (C Y-system, *see* Fig. 1).

The table should be given in the following form:

Y= \ C =	270°	285°	300°	310°	← (5° steps) →	50°	60°	75°	90°
0°	×	×	×	×		×	×	×	×
↗ (10° steps) ↘									
30°	×	×	×	×		×	×	×	×
↗ (5° steps) ↘									
45°	×	×	×	×		×	×	×	×
↗ (2·5° steps) ↘									
105°	×	×	×	×		×	×	×	×
↗ (15° steps) ↘									
180°	×	×	×	×		×	×	×	×

Y= \ C =	105°	120°	130°	← (5° steps) →	230°	240°	255°
0°	×	×	×		×	×	×
↗ (10° steps) ↘							
30°	×	×	×		×	×	×
↗ (5° steps) ↘							
45°	×	×	×		×	×	×
↙ (2·5° steps) ↖							
105°	×	×	×		×	×	×
↗ (15° steps) ↘							
180°	×	×	×		×	×	×

The reference half-plane (that is C = 0°) should generally be orientated parallel to the road as shown in Fig. 1.

In cases where that light distribution according to the construction of the luminaire can be considered symmetrical about the half-planes C = 270° and C = 90°, the table may contain only the luminous intensities for the half-planes from C = 270° to C = 90°. Each value in the table (except for C = 270° and C = 90°) will then be the mean value of the two readings in symmetrical directions.

3.5 Presentation of Distribution Intended for General Purposes

The presentation may be given in (one or more of) the following forms:

a) A polar curve in a vertical plane parallel to the road axis;

b) A polar curve in a vertical plane through the peak intensity, if different from (a);

c) A conical light distribution through the peak intensity. The value of the constant angle γ shall be stated; and

d) An isocandela diagram.

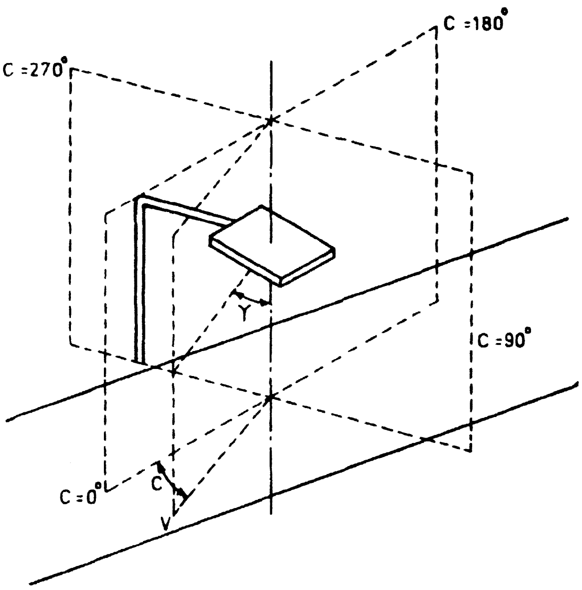

FIG. 1 COORDINATE SYSTEM FOR LUMINAIRE LIGHT DISTRIBUTION

4 SELECTION OF TEST APPARATUS, PROCEDURES AND METHODS

4.1 General

The accuracy of a street lighting design depends upon a knowledge of the characteristics of the road surface, the performance of the luminaires and of the associated lamps.

The accuracy of photometric measurement is in turn depended upon the apparatus used, and also on the testing procedure adopted.

4.2 Sources of Error

In General, two kinds of errors impair accuracy, namely, systematic errors, inherent in the test methods used, or caused by imperfections of instruments; and random errors, due to variations in test conditions outside the photometrist's control. It is the latter which affects repeatability. Examples of such sources of errors are given in Table 1.

Table 1 Examples of Sources of Inaccuracy

Random Errors	Systematic Errors
Instability of lamp	Measurement of voltage
Temperature variation	Measurement of temperature
Draughts due to air conditions, etc	Non-linearity of photocell
	Stray light
Air movement due to relative movement of the lamp of luminaire	Spectral selectivity of luminaire*
	Variation in reflectance factor of mirror due to distortion from a plane surface, variation in silvering
Fatigue of photocell variation in frequency, of voltage source	Polarisation of light source
	Non standard value of phosphor density of test lamp
Variation in reflectance factor of mirror due to dust	Misalignment of lamp and optical components of luminaire, etc
	Too short measuring distance

* If the luminaire is spectrally selective, systematic errors could arise due to the spectral response curve of a mirror system and/or photocell departing from the CIE spectral luminous efficiency curve V (γ).

4.3 Acceptable Order of Accuracy of Photometric Measurement

It is recommended that the sum of any systematic error and random error, specified by the standard deviation, is not greater than:

— For measurement of luminous intensity:

± 5 percent or for the lower intensities ± 2 cd/1000 lm, whichever is the greater.

— For measurement of angle:

± 0.5°

4.4 Selection of Apparatus and Testing Procedures

Apparatus and testing procedures listed in Annex A are considered acceptable for photometry of street lighting luminaires within the scope of these recommendations and to the order of accuracy nominated in **4.3**.

4.5 Calibration Procedures

The distribution photometer may be calibrated either by the relative or by the absolute (or direct) method.

In the relative method the luminous flux of the lamp(s) used for the test is obtained from measurement of intensity distributions in terms of arbitrary units of the photometer scale reading. Intensity measurements on the luminaire being tested are then made in the same arbitrary units of scale reading. A description of this method is given in **8**.

In the absolute method both the lamp(s) and the photometer are calibrated in absolute units against standard light sources of which the luminous flux (in lumens) or the intensity (in candelas) are known.

5 LABORATORY REQUIREMENTS FOR TESTS

5.1 General

Photometric tests on luminaires should be carried out under the conditions and with the corrections, where applicable, as described in **5.5**.

5.2 Object of Tests

The object of the tests is to provide the users and manufacturers of luminaires with such information of the photometric characteristics of the luminaires under test that calculations of lighting installations may be carried out with sufficient accuracy and that a realistic comparison between different luminaires can be made. Provision is, therefore, made in these recommendations for: (a) appropriate standard test conditions (**5.3**); (b) acceptable variations produced by limitations of the laboratory and its apparatus, for example, temperature and orientation during test (**5.4**); and (c) correction factors where a service condition causes the luminaire to operate differently to the laboratory standard test conditions (**5.5**).

5.3 Standard Test Conditions

The standard test conditions should be taken as:

Luminaire orientation	:	The luminaire should be suspended in the position for which it is designed to operate in service.
Light source	:	Fundamentally the photometer should be calibrated with the lamp, operated under the same conditions for which the nominal luminous flux is measured. For most lamps this means freely suspended in either horizontal or vertical position. If lamp data are published for the lamp in both horizontal and vertical positions, the position during calibration should be the same as the operating position in the luminaire.
Air movement and ambient temperature	:	Still air at 25°C in the vicinity of the luminaire, or bare lamp(s) when calibrating the photometer.
Test ballasts	:	The same ballasts should be used for testing the luminaire and the bare lamps, and they should be representative for the manufacturer's normal production.

5.4 Practical Test Conditions

As it is virtually impossible to carry out photometry on a lamp or luminaire without some variation in ambient temperature and some movement of air within its vicinity, tests should be made to ensure that the laboratory conditions are satisfactory. Where the output of a lamp or luminaire is affected by changes in ambient temperature or air movement the recommendations of **5.4.1** and **5.4.2** should be observed. Usually these considerations only apply when testing tubular fluorescent lamps or luminaires incorporating them, but may be important for some other types of discharge lamps.

5.4.1 *Ambient Temperature Variation*

The mean ambient temperature t_m should be equal to 25 ± 2°C throughout the test on the lamp or luminaire.

The difference between mean ambient temperature t_m for the lamp during calibration and mean ambient temperature t_m for the luminaire during the test should not exceed 2°C.

5.4.2 *Limits of Error Due to Air Movement*

5.4.2.1 *General*

Movement of air may be caused by draughts, air conditioning, or motion of the luminaire on the photometer. It is recommended that the following tests be made to ensure that the laboratory conditions are satisfactory.

5.4.4.2 *Air movement due to draughts or air conditioning*

A bare lamp mounted on the photometer should be stabilized, as in **8.2**, in the proposed laboratory conditions, and the luminous intensity in a specified direction measured at a known ambient temperature. The air conditioning plant should then be switched off, any remaining draughts reduced as far as practicable, and the lamp re-stabilized and the luminous intensity again measured at the same ambient temperature.

A similar test should be carried out on the luminaire.

These tests should be repeated for a number of positions of the lamp or luminaire in the photometer.

5.4.2.3 *Satisfactory laboratory conditions*

Laboratory conditions may be considered satisfactory, if the sum of the differences between the readings measured under **5.4.2.2** and **5.4.2.3** does not exceed 2 percent.

5.5 Electric Power Supply

5.5.1 *Supply Voltage and Frequency*

The voltage and frequency at the supply terminals of the luminaire, except where tungsten filament lamps are used should be taken as the rated values marked on the luminaire. If not marked the rated voltage and frequency of the ballast should be used.

During photometric measurements the supply voltage and frequency should be maintained constant within ± 0.5 percent.

NOTE — It will be necessary to control the variation in voltage and frequency to a closer tolerance when selecting tests lamps in accordance with **7.2**.

In the case of luminaires incorporating tungsten filament lamps the voltage should be controlled to within ± 0.2 percent or better.

It should be noted that many matt black paints have a reflection factor as high as 4 percent when new and unmarked. For angles of incidence close to the plane of such surfaces the reflection factor is much higher. Where possible, therefore, screening should be arranged so that stray light from the luminaire reaches the photocell only after two or more reflections from blackened surfaces. Where only one surface can be provided it may be necessary to cover it with black velvet, black carpet, etc.

Possible paths of stray light which should not be overlooked are:

a) Luminaire — blackened surface (floor, screen, etc) — mirror — photocell.

b) Luminaire — blackened surface (floor, screen, etc) — luminaire — mirror — photocell.

c) Luminaire — mirror — luminaire — mirror — photocell.

6 REQUIREMENTS FOR TEST APPARATUS

6.1 General

The requirements in this clause are supplementary to the laboratory conditions described in **5**.

6.2 Requirements for Photocells

6.2.1 *Performance of Photocells*

The photocell and its measuring circuit should be stable in operation and not subjected to fatigue when exposed to the maximum level of illuminance encountered.

The combination of photocell and measuring circuit should possess essentially linear response to light up the maximum level of illuminance encountered.

The spectral sensitivity of the photocell should closely follow the CIE spectral luminous efficiency curve. It is recommended that the stability of the spectral response be checked periodically. A method of checking with colour filters is given in Annex B.

6.2.2 *Measurement of Photocell Output*

The output of the photocell should be measured to an accuracy of ± 1 percent. If automatic recording equipment is used for the measurement of photo current, it is important that the maximum inherent errors of the equipment are determined, for example, delayed response to change in photo current, and lack of response (a finite dead zone) to small changes.

6.2.3 *Additional Requirements for the Auxiliary Photocell Used in the Monitored Light Source Method*

The auxiliary photocell used in the monitored light source method should comply with the above requirements. In addition, it should be shielded so as to respond only to light from the centre position of the luminaire. The photocell may be mounted at any convenient distance, but should be rigidly fixed and rotate with the luminaire. The position chosen should not cause any disturbance of light reaching the main photocell when at normal measuring position.

6.3 Requirements for Distribution Photometers

6.3.1 *Selection of Performance*

The selection of a distribution photometer for use in an industrial laboratory involves the aspects of acceptable accuracy as discussed in **4** as also laboratory space available. The choice largely lies on one hand between:

a) mounting the luminaire on the normal service position, or

b) a test distance complying with the recommendation below (*see* **6.3.2**).

6.3.2 *Test Distance*

In general the test distance should not be less than fifteen times the maximum dimension of the light emitting part of the luminaires.

However, for luminaires with an approximately cosine distribution in planes passing through the long axis of the luminaire, the test distance may be determined as:

either : fifteen times the dimensions of the light emitting part normal to the lamp axis,

or : five times the dimension of the light emitting part parallel to the lamp axis.

The test distance to be used will be the larger distance of these two.

6.3.3 *Special Requirements for Mirrors*

Any mirror used in the construction of a distribution photometer should be rigidly supported and kept flat in all normal positions of rotation. The variation of the reflectance factor over its usable surface should not be more than ± 3 percent from the mean. This should be checked at regular intervals using the method described in **6.3.4** or a similar one. Errors introduced by mirrors may be caused by one or more of the following factors:

a) departures of the mirrored surface from a plane surface, for example, ripples in glass due to method of support, sagging etc.

b) variation in reflectance factor over the main reflecting surface of silver, aluminium, etc;

c) variation in transmission through the glass, when the reflecting surface is on the rear side.

d) light scattering due to scratches, dust, etc; and

e) spectral selectivity.

6.3.4 *Testing of Mirrors for Variation in Reflectance Factor*

By setting the photometer so that the effective position of the photocell is at nadir and moving a light source in a horizontal plane through the optical centre of the photometer, variation in the reflectance factor of the mirror over the area traversed can be measured. The light source should have an essentially uniform light distribution in directions near the vertical, and the apparent area should be approximately 0.003 m^2 (that is, a 100 W inside white incandescent lamp) with the photocell placed in its normal position.

The variation of the angle of incidence on the photocell and of the distance between the photocell and the light source, when moving this, must be taken into account.

NOTE — Variation observed by such a test will be due to one or more of the causes listed under (a) to (d) of **6.3.3** above.

6.3.5 *Special Requirements for Luminaires Mounted in Their Designed Operating Positions*

Movement of the luminaires should be smooth, free from rocking and in the case of luminaires using tubular fluorescent lamps, sufficiently slow so as not to upset the air temperature within the luminaire (*see* **5.4**).

NOTE — Mirror Goninometer method is recommended for accurate measurements. However in the absence of mirror goninometer other methods using convential goninometer may be used.

7 PREPARATION OF LAMPS AND LUMINAIRES FOR TESTS

7.1 General

The preparation of lamps and luminaires for testing should comply with the following recommendations.

7.2 Test Lamps

7.2.1 *Selection of Lamps for Test*

The lamps selected for test should comply with the relevant Indian standards. If such standards do not exist, the lamps should comply as close as possible with the nominal specifications of the lamp manufacturer. In the case of tubular fluorescent lamps, the variation from a uniform circular distribution in a plane at right angles to the axis should not exceed 3 percent.

Lamps for multiple lamp luminaires, if intended to be of the same type and wattage, should be matched for light output within a spread of 3 percent when operated on the same supply and ballast circuit. They may then be used in calibration and test without regard to the light output which might be obtained on the circuits of the luminaire ballasts.

The lamp should furthermore comply with the specifications given in **7.2.2** and **7.2.4**.

7.2.2 *Diffusing Quality of Lamps Bulb*

For lamps with a phosphor or diffuse coating of the bulb should correspond to the average of the production.

7.2.3 *Ageing of Lamps*

All lamps should be aged until the light output is shown by successive readings to be stable. Ageing should be carried out by cycle operation of the lamps close to their electrical design specifications for a recommended minimum period of 100 h in the case of tungsten filament and tubular fluorescent lamps and 200 h for other lamps. A suggested cycle consists of 15 min off period every 4 h. The position of lamps during ageing should be as follows:

a) Tubular fluorescent — horizontal

b) Low pressure sodium — horizontal

For the U bend type the plane through the limbs should be vertical unless otherwise specified.

NOTES

1 The lamp should be marked to ensure that in subsequent use it is operated in an identical position including its orientation about the long axis.

2 After ageing any lamp showing an abnormal distribution of metallic sodium should be discarded.

If the lamp is of a type which is intended to be used either horizontally or vertically the stability should be checked for both positions.

7.2.4 *Stability of Lamps*

Lamps should be regarded as stable when the variation in luminous flux during consecutive switch-ons is not greater than ± 1 percent, and when the variation between the mean values for any consecutive switch-ons is not greater than 2 percent.

7.2.5 *Tests for Lamp Stability*

Tests may be made either by measurement of total flux in an integrating sphere or by measurement of luminous intensity in one direction at 90° to the lamp axis in a distribution photometer.

The lamps should not be moved between measurements.

For tubular fluorescent lamps air temperature in the vicinity of the lamp should be stable throughout this test, and the air draughtfree (*see* **5.4.2**).

7.2.6 *Handling of Aged Lamps*

Aged lamps should be carefully handled. This is particularly important for low pressure sodium lamps both when hot and cold because a sudden movement can alter the distribution of sodium within the arc tube.

7.2.7 *Mounting of Bare Lamps in Photometer*

It is most important that curing calibration of the distribution photometer the bare lamp or lamps are mounted in the position for which they are specially designed or for which the lamp photometric data are normally prepared. For example, most low pressure sodium lamps should be mounted horizontally, since except for the lowest wattage they will not operate satisfactorily in any other orientation. Tubular fluorescent lamps should be mounted horizontally as lamp data are usually only prepared for that condition.

Lamps of the type designed for universal mounting such as some types of high pressure mercury vapour lamps can be mounted in either position provided lamp photometric data are published for the position chosen, but preferably in the same position as the operating position in the luminaire. In such cases the orientation of the lamp during calibration should be included in the test report.

7.3 Test Ballast

7.3.1 *General*

The output of the luminaire is affected by the ballast used. In the case of tubular fluorescent lamps of the ballast position and method of attachment are also important, and they should be positioned as intended by the luminaire manufacturers.

Ballasts used for test on the luminaire should comply with the specification in **5.3**.

7.4 Preparation of Luminaires for Test

7.4.1 *Selection of Luminaire*

The luminaire selected for test should be representative of the manufacturer's regular product.

The optical parts should be clean, and all components rigidly located in their designed positions.

7.4.2 *Alignment of Lamp in Luminaire*

The photometric distribution of a luminaire is somewhat dependent upon the alignment of the lamp in relation to the position of a filament gap, arc tube support, etc.

It is recommended that the following conventions are adopted, where possible.

Tungsten filament lamps with a ring-type filament should be positioned so that the filament gap faces across the street. A plane-type filament should be aligned so that the filament lies in the C = 0° and C = 180° half-planes (*see* **3.5**).

Low pressure sodium lamps of the 'U' tube type should be mounted so that the plane through the two tubes is vertical, unless the manufacturer has specified otherwise. Low pressure sodium lamps of the linear type should be mounted so that the plane containing the profile of the grooves is vertical, unless the manufacturer has specified otherwise.

High pressure sodium or mercury vapour lamps when mounted vertically should be arranged so that the arc tube support rods are in a vertical plane perpendicular to the kerb lines. If there is only one support rod it should be located towards the house side. When such lamps are mounted horizontally the arc tube support rods should preferably be in a vertical plane. If there is only one rod it should be located towards the zenith.

A small variation from the above recommendations, which does not significantly change the light distribution, is permissible.

The alignment of the lamp should be recorded in the test report.

7.4.3 *Mounting of Luminaire in Photometer*

The luminaire should be mounted in the distribution photometer so that the photometer light centre of the luminaire (*see* **7.4.4**) corresponds with the optical centre of the photometer.

The luminaires should be levelled according to the manufacturer's instructions so that its alignment is mechanically true.

If instructions are not provided, then the plane containing the lower edge of the luminaire canopy (or the plane containing the reflector opening if this is lower) should be taken as one reference and the longitudinal axis, determined from the outer edges of the luminaire, when viewed in plan, should be taken as the second reference.

The mounting of the luminaire should also comply with.

7.4.4 *Photometric Light Centre*

The position of the photometric light centre of the luminaire should be determined in accordance with the following paragraphs:

a) At the lamp centre, if this is positioned below the plane of the lower edge of the luminaire canopy (or the plane of the reflector opening if this is lower).

b) At the intersection of the vertical axis passing through the lamp centre with the plane of the lower edge of the luminaire canopy (or the plane of the reflector opening if this is lower), if the lamp centre is positioned above the said plane.

c) For luminaires with more than one lamp the lamp centre is taken as being at the geometric centre of the individual lamp centres.

8 METHODS AND PROCEDURES FOR TEST APPARATUS

8.1 General

The stabilization of the lamps and luminaire, the calibration of the photometer and the procedures for testing should comply with the provisions in this section.

8.2 Stabilization of the Lamps, Luminaire and Photometer

The lamps, luminaire and measuring devices can be regarded having reached stability when the variation between three successive readings of luminous intensity of flux at intervals of not less than 15 min does not exceed 1 percent.

Experience may show that a bare incandescent lamps is sufficiently stable within 10 min, and most gaseous discharge lamps after 30 min operation. For metal halide lamps, however, the stabilization time may vary between 30 min and 6 h.

The stabilization period of luminaires may be much greater than that for the respective bare lamps, particularly in the case of tubular fluorescent lamps which may require periods in excess of 2 h.

Care should be taken to stabilize the measuring circuits and associated devices.

8.3 Calibration of Distribution Photometer Relative Method

The principle underlying the relative method of calibration is

$$I_{C,\gamma\,(1\,000)} = R_{C,\gamma} \cdot \frac{1\,000}{\sum_{x=1}^{n} \phi_x}$$

where

ϕ_x = luminous flux of lamp No. x, in arbitrary units calculated from the readings of the photometer without converting these readings to absolute intensity units (candelas);

n = number of lamps in luminaire;

$I_{C,\gamma\,(1\,000)}$ = luminous intensity of the lamp in the direction C, per 1 000 lumens; and

$R_{C,\gamma}$ = reading of the photometer for the direction C,γ.

8.3.1 *Determination of* ϕ_x

ϕ_x is determined from a number of intensity readings and calculated by means of a suitable procedure, for example, direct calculation, Russel angles, zone factors, etc.

The necessary number of intensity readings will depend on the light distribution, but in general 18 to 20 readings in each of 12 to 20 vertical half-planes will be adequate.

For lamp types for which certain assumptions on the light distribution can be made, fewer readings may be sufficient. The accuracy of such a simplified procedure should, in these cases, be verified.

8.3.2 *Calibration of the Photometer*

The photometer can be calibrated according to the principle described in **8.3.1** measuring the lamp or lamps just prior to or immediately after the measurement of the luminaire.

A detailed description of how the calibration may be carried out is given in Annex C.

Precautions should be taken to ensure that the given direction can be reproduced in the photometer, for example, by marking the lamp and the direction should be so chosen that the variation of the luminous intensity with the angle is small.

The position of the lamp axis should be as recommended in **7.2.7**. Lamps should be carefully positioned in the photometer, using any convenient method, so that their axis is either vertical or horizontal, which is relevant. It is not advisable to simply insert the lamp into the lampholder and assume it is correctly aligned. Lamps fitted with bayonet caps may require a modified lampholder to provide a sufficiently rigid support.

Precautions should be taken to avoid the creation of cool spots with tubular fluorescent lamps. The light output of a tubular fluorescent lamp operated in some multi-lamp circuits is affected by the operating temperature of the other lamp (or lamps) in the same circuit. In such cases the other lamps not under test should remain energised, but should be freely suspended horizontally outside the luminaire, in still air at 25°C. It should not be necessary to remove the ballast from the luminaire for photometric measurement on the lamp.

The precautions under **7.2.7** relating to low pressure sodium lamps should be observed.

A check on lamp stability should be made at intervals during the test by comparing readings taken at the nadir. The drift in such readings should not exceed 2 percent.

NOTE — It may be necessary to sight from the photocell position to ensure that the view of the lamp is not obstructed by the supporting structure. Should this be unavoidable at some angles then the reading at these angles may be interpolated from measurements either side or alternatively taken as equal to the reading diametrically opposite.

However, most lamps if carefully handled, maintain a constant light distribution throughout the life, which means that the ratio:

$$\frac{I}{\phi^{\theta}} = \frac{R_{\theta}}{\phi}$$

where

R_θ = reading of the photometer in the given direction;

I_θ = the luminous intensity in the given direction; and

ϕ = luminous flux from the lamp.

will be constant.

If this ratio has been determined previously for the test lamp, it will in subsequent luminaire measurements, in which the same lamp is used, be sufficient to measure the photometer reading for the lamp in the given direction.

8.4 Procedure for Measurements on the Distribution Photometer — Lamps and Luminaire in Standard Test Condition

When the lamps and luminaire are located in the distribution photometer in accordance with **5.3** and laboratory temperature variation complies with **5.4.1** then measurements can be reported as relating to the standard laboratory test condition.

9 TEST REPORT

9.1 General

The following list is intended as a guide to the information which should be included in a test report covering photometric measurements on a luminaire.

The purpose of this information should be:

a) to correctly inform the user of the data as to the nature of the various controlled conditions under which the luminaire was measured; and

b) to give sufficient information so as to relate the photometric information to the particular luminaire tested. Without which the report may become quite meaningless.

9.2 Description of Luminaire

a) Manufacturer's name, type, catalogue number; and

b) Rated voltage and frequency.

9.3 Ballasts (and Auxiliary Starting Transformers)

a) Manufacturer's name, type catalogue number;

b) Type of circuit, for example, single or multi lamp, switch or quick start;

c) Rated voltage, wattage and frequency;

d) Method of mounting;

e) Marked operating temperature; and

f) Capacitive circuit, if used.

9.4 Test Lamps

a) Manufacturer's name, type, relevant dimensions;

b) Rated lumen output and orientation of the lamp for which this output was given;

c) Colour;

d) Rated watts;

e) Diffusing quality of lamps (*see* **7.2.2**);

f) If universal mounting operating position during calibration of distribution photometer (*see* **7.2.2**); and

g) Alignment of lamp in luminaire (*see* **7.4.2**).

9.5 Test Procedure

a) Description of photometric procedure and equipment used. This should include the method of calibration of the photometer and alignment of lamp within the luminaire (*see* **4.5** and **7.4.2**).

b) Test distance.

9.6 Test Results

a) Polar curve is one or more vertical half-planes (*see* **3.5**),

b) Conical light distribution,

c) Isocandela diagram, and

d) Light output ratio.

ANNEX A

(*Clause* 4.4)

SELECTION OF TESTING APPARATUS AND TESTING PROCEDURE

Procedure No.	Orientation of Luminaire (5.3 and 5.4.3)	Apparatus and Procedure (6.3.1)	Comments (*see* 6.2.1 and 6.3.5)
1	Standard	Distribution photometer without mirror	*see* 6.2.1 to 6.3.3 6.3.4 to 6.3.5
2	Standard	Distribution photometer with mirror(s)	

ANNEX B

(*Clause* 6.2.1)

METHOD OF CHECKING STABILITY OF SPECIAL RESPONSE OF A PHOTO-ELECTRIC CELL USING COLOUR FILTERS

B-1 It is recommended that the stability of the spectral response of a photocell and associated filter be checked periodically. This may be done simply by using the cell to make periodic measurements of the luminous transmittances of three stable colour filters.

Measurements should be made at a normal illuminance level. High illuminance of the photocell should always be avoided. It is recommended that, in the case of selenium photovoltaic cells, the illuminance should not exceed a level at which the cell begins to show non-linearity. In practice this is commonly in the region of 200 lux for a cell operating with zero external resistance.

Periodic measurements should be made under identical test conditions to minimise errors due to extraneous effects. The light source should be an incandescent lamp operated at the same colour temperature on each occasion, usually 2856 K (CIE Illuminant A).

NOTES

1 Filters with characteristics similar to the following are satisfactory for this measurement:

Blue filter	:	Corning Type CS 1-62, Glass type 5900 or Schott Type BG 28/1 mm
Green filter	:	Corning Type CS 4-64, Glass Type 4010 or Schott Type VG 6/1 mm
Red filter	:	Corning Type CS H, R, 2-61, Glass Type 2412 or Schott Type RC 1/3 mm

2 The red filters may be sensitive to high temperatures and should not be mounted close to the light source.

ANNEX C

(*Clause* 8.3.2)

DESCRIPTION OF A PROCEDURE FOR CALIBRATION OF THE PHOTOMETER BY MEANS OF ZONE FACTORS

C-1 The lamp is mounted in the photometer and connected as specified in **5.3** and **7.2.7**. A number of readings of the luminous intensity (in scale units) is taken as specified in the table.

The luminous flux of the lamp (in scale units) is then calculated by means of the given zone factors. Finally the value of one scale units in cd per 1 000 lumen is calculated (Formula 1).

$$\text{One scale unit} = \frac{1\,000}{\phi}\ \text{cd/1 000 lm}$$

If there is more than one lamp, the lamp flux from each lamp (ϕ_1, ϕ_2, ϕ_3, etc) is measured and calculated separately as described above. The luminous flux from all lamps together is:

$$\phi = \phi_1 + \phi_2 + \phi_3 + \text{etc}$$

And the value of one scale unit in cd per 1 000 lumen is calculated from Formula 1.

C = Luminous intensity in scale units 0° 30° 60° 90° 130° 150° 180° 210° 240° 270° 300° 330°	Mean of Zone	Zone Factor	Zonal Flux in ac Units
y =			
5°		0.095	
15°		0.284	
25°		0.463	
35°		0.628	
45°		0.774	
55°		0.897	
65°		0.993	
75°		1.058	
85°		1.091	
95°		1.091	
105°		1.058	
115°		0.993	
125°		0.897	
135°		0.774	
145°		0.628	
155°		0.463	
165°		0.284	
175°		0.095	
		ϕ (scale unit) =	

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