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TECHNICAL SPECIFICATION

Recommendations for small renewable energy and hybrid systems for rural electrification –
Part 12-1: Selection of self-ballasted lamps (CFL) for rural electrification systems and recommendations for household lighting equipment

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FOREWORD

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 62257-12-1, which is a technical specification, has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

This part of IEC 62257 is based on IEC/PAS 62111 (1999); it cancels and replaces the relevant parts of IEC /PAS 62111.

This technical specification is to be used in conjunction with IEC 62257 series.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
82/464/DTS	82/478/RVC

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 62257 series, under the general title *Recommendations for small renewable energy and hybrid systems for rural electrification*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- transformed into an International Standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

The IEC 62257 series intends to provide to different players involved in rural electrification projects (such as project implementers, project contractors, project supervisors, installers, etc.) documents for the setting up of renewable energy and hybrid systems with a.c. voltage below 500 V, d.c. voltage below 750 V and power below 100 kVA.

These documents are recommendations:

- to choose the right system for the right place,
- to design the system,
- to operate and maintain the system.

These documents are focused only on rural electrification concentrating on but not specific to developing countries. They must not be considered as all inclusive to rural electrification. The documents try to promote the use of renewable energies in rural electrification; they do not deal with clean mechanisms developments at this time (CO_2 emission, carbon credit, etc.). Further developments in this field could be introduced in future steps.

This consistent set of documents is best considered as a whole with different parts corresponding to items for safety, sustainability of systems and at the lowest life cycle cost as possible. One of the main objectives is to provide the minimum sufficient requirements, relevant to the field of application that is: small renewable energy and hybrid off-grid systems.

The purpose of this part of IEC 62257 is to compile specifications and recommendations for lighting materials, involved in decentralized rural electrification.

This document is also linked to other parts of IEC 62257 series namely IEC 62257-1, IEC 62257-2 to IEC 62257-6 and IEC 62257-7 to IEC 62257-13.

RECOMMENDATIONS FOR SMALL RENEWABLE ENERGY AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –

Part 12-1: Selection of self-ballasted lamps (CFL) for rural electrification systems and recommendations for household lighting equipment

1 Scope

Decentralized Rural Electrification Systems (DRES) are designed to supply electric power to sites which are not connected to a large interconnected system, or a national grid.

As described in the IEC 62257-1, these systems include:

- an electrical power production subsystem;
- a secondary grid for sharing/distributing this power, when the system is a collective electrification system (microgrid);
- a subsystem for utilizing this electrical power as a demand subsystem including the in-house wiring and user's electrical appliances.

In many situations, lighting is the most expected application of the rural electrification process and the first application that the users may afford.

For a given lighting performance, the electrical characteristics of the lamps may vary, particularly the power factor and the harmonic content.

On large grids, the impact of these characteristics is generally not a major issue. In the context of the electrification systems considered in the IEC 62257 series, the main applications are lighting and TV. In these small systems, the power factor and the harmonic content of the supplied appliances have a high impact on the design and the sizing of the production and distribution subsystems as well as on the quality of the service provided.

Project implementers cannot afford an over-sizing of any part of the system. For this reason, they have to make sure that the selected appliances have characteristics which do not adversely affect the cost of the equipment necessary to provide the quality of service required by the General Specification of the project.

Some relevant products are available on the market (high power factor and low harmonic content). The purpose of this technical specification is to help project implementers to discriminate, in a potential sourcing panel, the models of lamps which could have the lowest impact on the whole system (generation and distribution subsystems).

This specification deals with integral compact fluorescent technology lamps:

- power less than 60 W;
- with an Edison screw E27 or bayonet B22 cap;
- with nominal voltage from 100 V to 250 V a.c.

IEC 60969 specifies the performance requirements together with the test methods and conditions required to show compliance of tubular fluorescent and other gas-discharge lamps with integrated means for controlling starting and stable operation (self-ballasted lamps) intended for domestic and similar general lighting purpose. This specification must be considered as the reference for the manufacturers.

This technical specification proposes comparative tests that could be particularly useful for project implementers to test in laboratories of developing countries the capability of products to be used for their project. The tests can be performed locally, as close as possible of the real site operating conditions. This technical specification does not cover other lamp technologies (e.g. d.c. lamps, leds, etc) however similar principles can be used for such comparative testing.

Additionally some recommendations are suggested in Annex A in order to enhance the performances or effectiveness of the lighting sources using a luminaire.

This specification is not a type approval standard. It is a technical specification to be used as guidelines and does not replace any existing IEC standard on lamps.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60598-1, *Luminaires – Part 1: General requirements and tests*

IEC 60598-2-1, *Luminaires – Part 2: Particular requirements. Section One: Fixed general purpose luminaires*

3 Terms and definitions

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

3.1
illuminance (of an elementary surface) (symbol E)
the luminous flux received by an elementary surface divided by the area of this surface

NOTE In the SI system of units illuminance is expressed in lux (lx) or lumens per square metre (lm/m^2).

[IEV 723-08-30]

3.2
environmental conditions
characteristics such as elevation, temperature, humidity, that may influence performances

3.3
luminous efficacy (lm/W)
quotient of the luminous flux emitted by the power consumed by the source

[IEV 845-01-55]

3.4
power factor
under periodic conditions, ratio of the absolute value of the active power P to the apparent power S

3.5
compact fluorescent lamp (CFL)
tubular fluorescent lamp unit with a bended tube that incorporates, permanently enclosed, all elements that are necessary for starting and for stable operation, and which does not include any replaceable or interchangeable parts

3.6
real (or effective) power
the apparent power multiplied by the power factor

NOTE Real power, i.e. the actual power delivered to or consumed by the load, is expressed in watts.

3.7
rated voltage v (V)
voltage specified by the manufacturer and rated for the nominal functioning of the lamp

3.8
rated frequency
frequency marked on the lamp or declared as such by the manufacturer or responsible vendor

3.9
total harmonic distortion (THD)
ratio of the r.m.s. value of the harmonics (in this context harmonic currents I_n of the order n) to the r.m.s. value of the fundamental, viz.

$$THD = \sqrt{\sum_{n=2}^{40}\left(\frac{I_n}{I_1}\right)^2}$$

NOTE This definition has been chosen in accordance with the relevant standard IEC 61000-2-2.

3.10
lighting equipment
luminaire and lamp combination

3.11
luminaire
apparatus which distributes, filters or transforms the light transmitted from one or more lamps and which includes, except the lamps themselves, all the parts necessary for fixing and protecting the lamps and, where necessary, circuit auxiliaries together with the means for connecting them to the electric supply

[IEV 845-10-01]

3.12
GS
general specification of the project

3.13
colour
the colour characteristics of a lamp are defined by the colour appearance and the colour rendition (or rendering)

NOTE 1 The actual colour of the lamp is called colour appearance and is defined in terms of the spectral tristimulus values (colour co-ordinates) according to the recommendations of the IEC.

NOTE 2 The spectral characteristics of the light emitted by the lamp have an effect on the appearance of the objects it illuminates; this effect is called rendition.

3.14
colour temperature
temperature of a source whose radiation has the same chromaticity as that of a given stimulus

3.15
rated colour
the colour appearance as declared by the manufacturer or responsible vendor, or the colour corresponding to the colour designation marked on the lamp

4 Comparative tests for the selection of integral compact fluorescent lamps

The proposed comparative tests are designed to discriminate the most appropriate lamps taking into consideration the techno-economic context of the project.

It is assumed that the project developer has already defined in the General Specification of the project the illuminance level he wants to provide to the end user and consequently the nominal power of the CFL lamps he needs to purchase. To enhance the efficacy of lighting in the specified application a luminaire should be used. (See Annex A.)

The selection of the model of lamp to be implemented is achieved through three phases as indicated in Figure 1.

NOTE All the lamps should be tested simultaneously in order to ensure that they are tested in the same conditions (humidity, temperature, etc.).

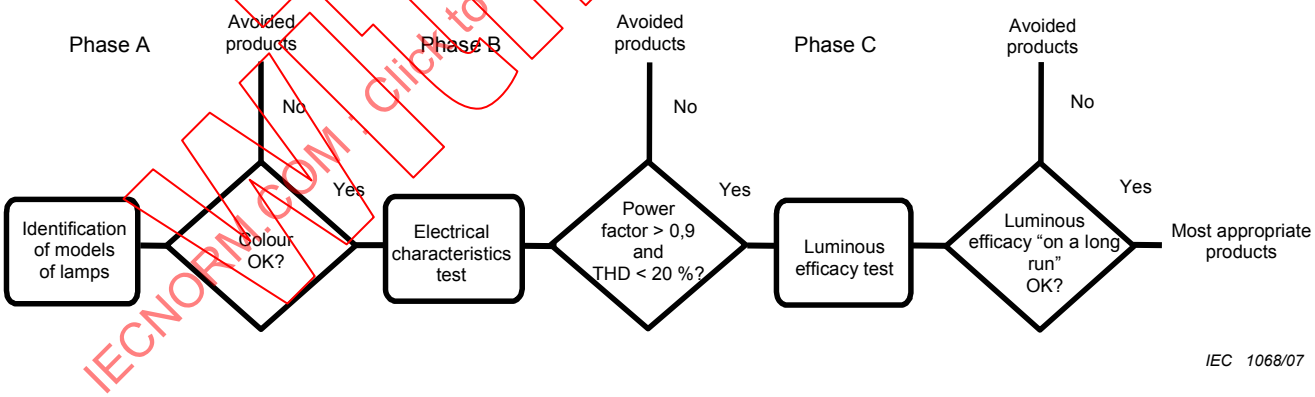


Figure 1 – Lamps selection test programme

4.1 Performance criteria

The models of lamps shall be selected in accordance with the following criteria:

- **colour temperature;**
- **electrical characteristics** that have a negative impact on the sizing of the electrification system: the power factor and the harmonic content;
- **luminous efficacy.**

The recommended tests are summarized in Table 1.

Table 1 – Tests list

Phase A	Phase B	Phase C
First discrimination of the products able to provide the required colour temperature	For products which have passed the previous test: selection of products in reference to electrical requirements	For products which have passed the previous tests: comparison and sorting of products in reference to luminous efficacy requirements
Subclause 4.2.2	Subclause 4.2.3	Subclause 4.2.4
NOTE These tests are not product certification tests.		

4.2 Comparative tests

4.2.1 Method of measuring lamp characteristics

All the samples of lamps shall be tested in the same environmental conditions (temperature, humidity, power supply).

The level of the quality of the supply to be provided by the electrification system is specified in the General Specification (GS) (refer to Table 6 of IEC/TS 62257-2).

The test lab shall use a level of quality for the test supply voltage which is equal to or better than that specified in the GS.

4.2.2 Phase A: identification of potentially acceptable models of lamps

The colour temperature of the lamps to be used in the project shall be required by the General Specification (GS). This is an important requirement to make the products acceptable by the final users.

NOTE It is obvious that the rated voltage and the rated frequency of the tested lamps must be in accordance with the nominal values required by the General Specification of the project.

4.2.2.1 Test sampling

Only one sample of each model to be tested is required.

4.2.2.2 Test operation

The rated colour temperature shall be checked on the marking of the different models or confirmed by the manufacturer or responsible vendor.

4.2.2.3 Test results

Pass criteria: only the models fitting with the colour temperature required by the GS shall be selected for the following tests.

4.2.3 Phase B: electrical test

4.2.3.1 General

This test aims to compare the models selected in the previous test through two main electrical characteristics of the lamps: the power factor and the total harmonic distortion (THD).

4.2.3.2 Test sampling

Five samples of each model of lamp are required.

4.2.3.3 Test operation

See the following Figure 2.

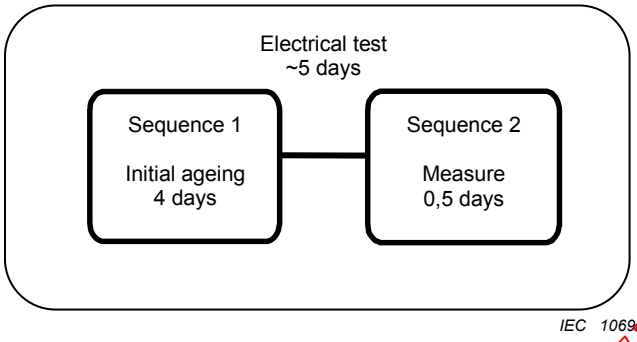


Figure 2 – Electrical characteristics test sequences

To perform the test, the laboratory shall be able to measure:

- time;
- real power;
- power factor;
- total harmonic distortion;
- illuminance.

The tested lamps will be powered with the voltage specified in the GS. The quality of supply will be that available in the test lab as it is not possible to reproduce the real voltage conditions and variations as that encountered in the field.

4.2.3.3.1 Sequence 1: Initial ageing

Lamps shall be initially aged for a period of 100 h of normal operation.

All the samples of all the tested models shall be tested simultaneously.

After 100 h, all lamps must remain alight. If not, the concerned models shall be avoided.

4.2.3.3.2 Sequence 2: Measurement of power factor and THD

Power factor and THD of the input current of each sample of each model shall be measured.

4.2.3.4 Test results

Pass criteria: all 5 samples of each model shall fit the following requirement:

Power factor > 0,9 **and** THD < 20 %

All the samples of the accepted models shall go through the next test.

4.2.4 Phase C: Luminous efficacy test

4.2.4.1 General

This test aims to assess the lighting performances of the lamps as close as possible to the field conditions. The objective is to simulate conditions of service life to determine the long term capability of the lamps to maintain luminous efficacy.

4.2.4.2 Test sampling

The 5 aged samples of each model accepted in the previous test are required.

4.2.4.3 Test operation

4.2.4.3.1 General

The test shall be performed according to the diagram shown in Figure 3.

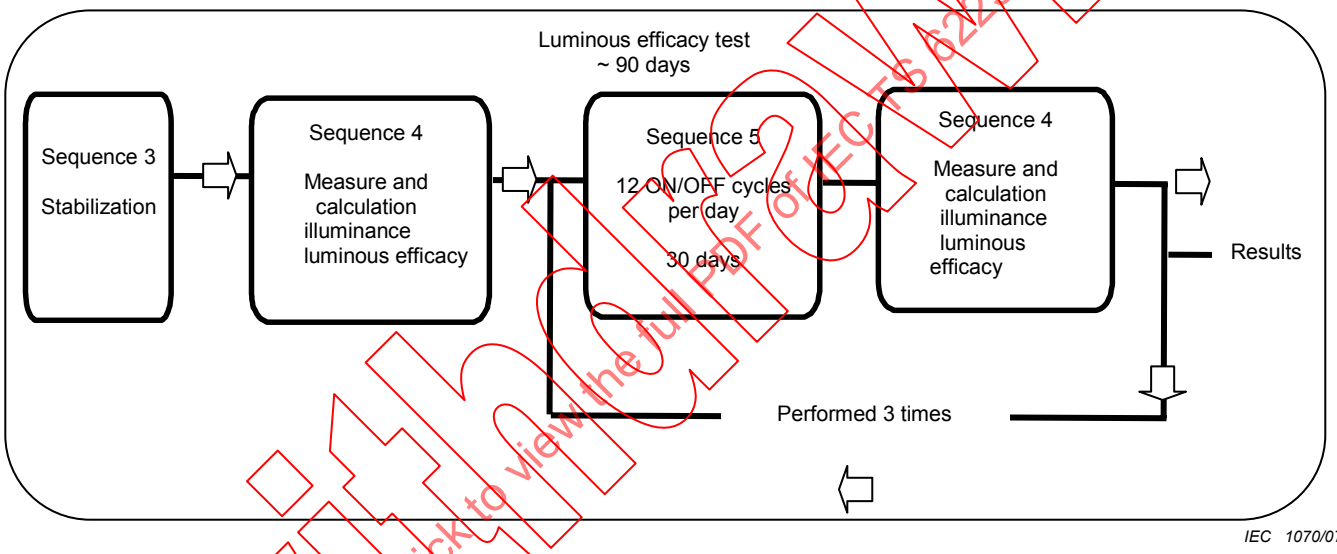


Figure 3 – Luminous efficacy test sequences

To perform the test, the laboratory shall be able to measure:

- time;
- real power;
- illuminance.

4.2.4.3.2 Sequence 3: Stabilization of illuminance

Place each sample of the lamp in the test device proposed in Annex B.

Each sample shall be powered during 5 min before the measurement of the illuminance.

4.2.4.3.3 Sequence 4: Measurement and calculation

For each sample powered, measure:

- time (h);
- illuminance (lx);

- real power (W);
- luminous efficacy (lm/W).

Calculate the average illuminance of the 5 samples of a same model. The average value shall be considered as the initial illuminance performance of the model.

Calculate the average luminous efficacy of the 5 samples of a same model. The average value shall be considered as the initial luminous efficacy performance of the model.

After an initial Sequence 4, a loop of (Sequence 5 + Sequence 4) shall be performed 3 times (as illustrated in Figure 3).

4.2.4.3.4 Sequence 5: Service life cycles

For each sample, operate 12 times per day, during 30 days, the following cycle:

- switch ON the lamp during 1h 45 min;
- switch OFF the lamp during 15 min.

The test is realized at ambient temperature. To allow the comparison of the results all the samples of all the models shall be tested simultaneously.

After 30 days of ON/OFF cycles, each lamp is tested according to the requirements of Sequence 4.

4.2.4.4 Test results

At the end of the luminous efficacy test (after the last Sequence 4), the following results are available:

- initial average value of illuminance and luminous efficacy;
- first intermediate average value of illuminance and luminous efficacy (after 30 days);
- second intermediate average value of illuminance and luminous efficacy (after 60 days);
- final average value of illuminance and luminous efficacy (after 90 days).

Pass criteria

A model is accepted if 4 samples out of 5 have an illuminance > 80 % of the initial illuminance measured in Sequence 4.

NOTE 1 Accepted models are then sorted by luminous efficacy performance. The most appropriate product is the model which has the best luminous efficacy.

NOTE 2 Then the purchaser could select the model as a balance between performances and price.

NOTE 3 If desired intermediate recorded values could be used to draw a diagram showing the evolution of the illuminance and the luminous efficacy during the test.

Annex A
(informative)

Recommendations for luminaires

A.1 Environmental nominal reference

The luminaire characteristics and conditions of use shall be specified in the GS.

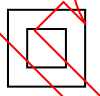
A.2 Performances and manufacture specifications

A.2.1 Safety

Lighting equipment must be shown to be safe both in use, when installed and when they reach the end of their life.

Lighting equipment must meet the safety requirements of IEC 60598-1 and IEC 60598-2-1. A written conformity of performance statement from the manufacturer must be supplied.

A.2.2 Electric classification

The luminaire should be class II. Symbol: 

A.2.3 Mounting

The mounting system of the lighting equipment shall take into account the domestic mounting surface specificity (friable walls for example).

The lighting equipment shall be suitable for mounting on a flammable surface.

Symbol: 

The mounting system of the lighting equipment should permit mounting of the light close to the visual task to be illuminated.

A.2.4 Internal luminaire wiring

The wiring of the luminaire should comply with IEC 60598-1. In particular, the wire section should be not less than 0,75 mm².

A.2.5 Switch

The luminaire may include a switch. In that case, the switch should withstand a current not less than twice the maximum nominal current of the lamp the luminaire can house.

A.2.6 Operating temperature

The lighting equipment should comply with IEC 60598-1.

The luminaire shall be designed to dissipate the heat produced by the largest acceptable power of the lamp. It is particularly important where ambient temperatures are high.

NOTE Luminous efficacy for many technologies of lamps (especially fluorescent) decrease with temperature rise.

A.2.7 Maintenance and ease of cleaning

Cleaning the lighting equipment should not require special training or dismantling of the equipment. In particular, optic parts exposed to dust should be easily cleanable with no risk of damage for the lamp. The material of these parts should not attract or retain dust.

A.2.8 Intrusion Protection Index

The lighting equipment shall be at least IP 2X for safety.

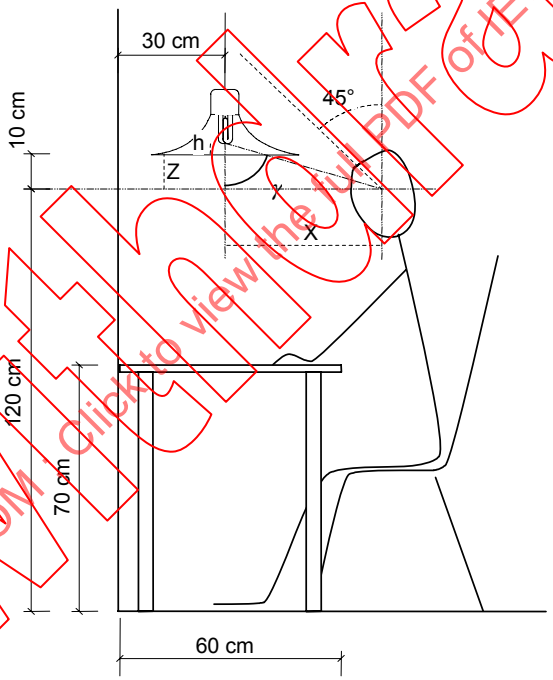
In order to maintain the efficiency of lighting, higher IP degrees could be chosen for the optical part depending on identified risks such as insects (IP4X) and dust (IP5X).

A.2.9 Glare control

The luminaire should be designed to prevent direct glare for the user.

In practice, glare becomes negligible above 45° from the direction of the user's vision.

NOTE The glare control is characterized with angle γ, that is measured from the lower visible part of the luminous source (see figure hereinafter).



A.2.9.1 Marking of the luminaire

The following data should be marked on the luminaire itself, at a place that is visible during maintenance:

– brand;
– reference;
– operating voltage;
– maximum allowed power;
– symbols

– IP degree;

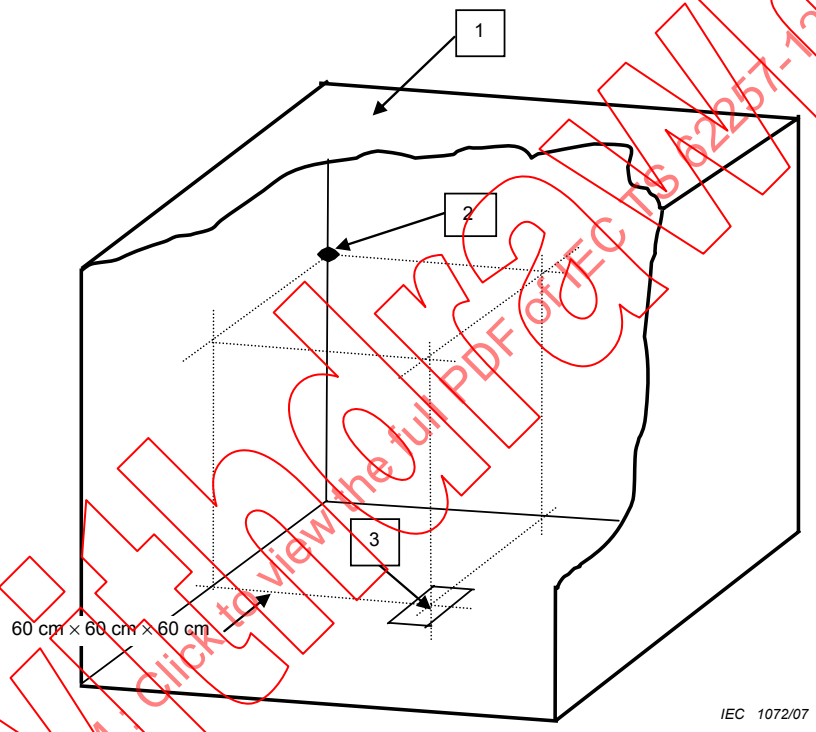
– A pictogram to specify the type of lamp to be used (for example CFL only) and to prohibit the use of another type but expected (for example incandescence bulb).

Annex B
(normative)

Device for illuminance measurement

The test shall be performed in a “completely” closed dark box, painted black inside. Different configurations shall be used, depending on the operating position decided to test the lamp.

Figure B.1 is an illustration of such a box.



Key

1 testing box: darkness inside, closed during the illuminance measurement
2 position of the lamp
3 position of the illuminance meter

Figure B.1 – Outlines for a testing device for lamps