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TECHNICAL SPECIFICATION

Recommendations for small renewable energy and hybrid systems for rural electrification –
Part 9-5: Integrated system – Selection of portable PV lanterns for rural electrification projects

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

Part 9-5: Integrated system – Selection of portable PV lanterns for rural electrification projects

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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 62257-9-5, 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 part of IEC 62257 is to be used in conjunction with the IEC 62257 series.

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

Enquiry draft	Report on voting
82/462A/DTS	82/477/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- withdrawn,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.

IMPORTANT – The "colour inside" logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

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. nominal voltage below 500 V, d.c. nominal voltage below 750 V and nominal 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 specify tests in order to help project developers and project implementers in the selection of relevant products (PV portable lanterns), able to match the techno-economic requirements of the project they have in charge, portable PV lantern. This technical specification and the others of the 62257 series are only guidance and so cannot be International Standards.

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

Part 9-5: Integrated system – Selection of portable PV lanterns for rural electrification projects

1 Scope

This Technical Specification applies to portable solar photovoltaic lanterns (portable PV lantern). This specification is independent of the technology used to provide the light.

The tests provided in this specification are able to help the project implementer to discriminate easily the most appropriate product within some different market offer and choose among them those which match the requirements expressed in the GS of the electrification project (see IEC/TS 62257-3).

The specification also provides provisions of regulations and installation conditions to be complied with in order to ensure the life and proper operation of the selected lantern as well as the safety of people living in proximity to the installation.

This technical specification does not replace any existing IEC standard.

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 62262, *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)*

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.

[IEV 723-08-30]

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

1 lux is the illuminance produced on a surface of 1 square metre by a luminous flux of 1 lumen uniformly distributed over that surface.

3.2
capacity (of a cell or a battery)
quantity of electricity (electric charge), usually expressed in amperes-hour (Ah), which a fully charged battery can deliver under specified conditions

3.3
light application
light produced by the lantern to allow a given activity

NOTE Examples of categories of applications of the light are given in 5.1.

3.4
life (of a lamp)
the total time for which a lamp has been operated before it becomes useless, or is considered to be so according to specified criteria

NOTE Lamp life is usually expressed in hours.

[IEV 845-07-61]

3.5
life test
test in which lamps are operated under specified conditions for a specified time or to the end of life and during which photometric and electrical measurements may be made at specified intervals

[IEV 845-07-62]

3.6
service life (of a battery)
the period of useful life of a battery under specified conditions

3.7
light output ratio (of a luminaire); luminaire efficiency (USA)
ratio of the total flux of the luminaire, measured under specified practical conditions with its own lamps and equipment, to the sum of the individual luminous fluxes of the same lamps when operated outside the luminaire with the same equipment, under specified conditions

[IEV 845-09-39]

3.8
light unit
assembly inside a casing of all parts such as lamps, optical apparatus, coloured glass, terminals, necessary to exhibit a light aspect

[821-02-38]

3.9
lighting performance
ability of a product to provide the right illuminance for a given application

3.10
illuminance meter
instrument for measuring illuminance

[IEV 845-05-16]

3.11
GS
general specification of the electrification project (see definition in IEC/TS 62257-3, 3.1)

3.12
IP degree
degree of protection provided by enclosures for electrical equipment against penetration by foreign bodies and dust/water.

3.13
IK code
degree of protection provided by enclosures for electrical equipment against external mechanical impacts

3.14
portable
capable to be carried by one person

NOTE The term “portable” implies often the additional ability to operate when carried.

[IEV 151-16-47]

3.15
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]

4 System limits

A PV portable lantern comprises:

- a casing (including in most cases a luminaire);
- a PV source (integrated, supported by or completely separate from the casing);
- one or several light sources: Compact Fluoescent Lamp (CFL), leds;
- a battery;
- a power manager (battery charge and discharge controller);
- one or several light control/selection switches;
- cables and connectors (when PV source is separate from the casing);
- status indication device (optional).

NOTE If the light is provided by means of CFL, the latter could be tested according to IEC 62257-12-1 if necessary.

5 Model pre-selection

5.1 Specification of a model

5.1.1 Service to be provided

The project implementer shall define within the GS the required minimum level of illuminance, the minimum daily duration of lighting service and the lifetime.

The project implementer shall define within the GS the required minimum level of illuminance measured as defined in Annex A, the minimum daily duration of lighting service and the minimum expected lifetime of the lamp and the ballast.

Three lantern applications with different required illuminance could be considered:

Application 1 (A1): accurate activities such as reading, sewing, preparing meals, etc. (for example, illuminance > 200 lx could be considered as a basic performance needed for accurate activities on a table).

Application 2 (A2): common household activities such as taking meals, feeding animals, (indoor or outdoor), etc.; illuminance of 100 lx could be considered as a basic performance for this application.

Application 3 (A3): movements from one room to another with no other lighting; illuminance > 20 lx could be considered as a basic performance for this application

NOTE 1 For each of these activities, the required illuminance may differ from one user to another one.

NOTE 2 For a given distance between the lantern and the user, the lighting performance of the lantern may vary in relation to the installation mode of the lantern. The proposed tests are relative to different installation modes as explained in Annex A.

NOTE 3 Caution: Generally, manufacturers do not provide the illuminance but do provide the following information on the system:

- light output provided on a given duration (lm x h), for each level of application as indicated above and in relation to the installation mode of the lantern (laid on the ground or hung up);
- maximum service duration availability for a given application.

NOTE 4 Products must be tested for the same application. The position “standing” or “hung up” is dependant on the design of the product and should be as defined by the manufacturer.

5.1.2 Technical requirements

The project implementer shall also define the IP degree and IK code of the expected products.

Table 1 gives some values that could be considered as a minimum.

Table 1 – Suggested minimum values for IP and IK

Protection degree	Minimum suggested value
IP	33
IK	8

5.1.3 Operating conditions

The project implementer shall also define the operating conditions to which the portable PV lantern can be subjected. Examples of such conditions are given in Table 2.

Table 2 – Climatic conditions (example)

	Nominal operating range	Storage - Transport
Temperature	–10 to +50 °C	–40 to +80 °C
Humidity at 28 °C	5 % to 95 %	
Atmospheric pressure	860 hPa to 1 060 hPa	

NOTE In certain areas where low temperatures are usual (−40 °C for example) or high temperatures are excessive, it is recommended to keep the lamp protected from extreme temperature; technology of batteries has to be chosen in relation to the climatic condition. Control devices should be also considered.

5.2 Pre-selection process

5.2.1 Elements of the GS to be provided to potential suppliers

The project implementer shall check the locally available solar irradiation.

This information as well as the requirements defined in 5.1 shall be provided to potential suppliers in order to receive proposals for relevant products.

5.2.2 Answers to be provided by potential suppliers

A technical sheet shall be provided by the supplier in order to demonstrate the ability of its product to match the requirements defined in 5.1.

A user's manual shall also be provided including PV lantern operating guidelines such as:

- initial operations before first use;
- instructions to use the lantern properly;
- mounting the solar panel (when needed);
- charging instructions;
- maintenance and troubleshooting instructions.

5.3 Pre-selection criteria

The performances claimed by the manufacturer shall be compared to the performances required by the GS in order to make a pre-selection of available products.

The following general criteria can be used as an initial help for product pre-selection:

- lighting service characteristics as given by the manufacturer;
- overall dimensions and weights (for adaptability to the user);
- battery type and characteristics (for adaptability to the local conditions);
- lamp type and characteristics (for potential local replacement);
- PV module characteristics (to assess the easiness of installation and use);
- product architecture (PV module integrated or not in the lantern);
- additional features.

A short list of products potentially able to match the requirements of the GS shall be addressed.

6 Comparative tests

6.1 General

After the pre-selection process, samples of products of the short list shall be processed through comparative technical tests.

6.2 Performance requirements

For the three applications mentioned in 5.1.1, pre-selected models shall be compared through performances in accordance with the requirements of the GS, including as a minimum:

a) **illuminance** associated with a **daily** service duration (example: 100 lx during 3 continuous hours) = lighting service;

As the customer will not accept a delay of one month or two to get the full illuminance of the PV lantern (100 h stabilization), the lamp provided with the PV lantern must be able to provide the full illuminance ± 20 % as early as the first utilization.

Additionally, every time the customer switches on the PV lantern, the full illuminance must be provided within 2 min maximum.

NOTE The service duration corresponds to an average daily service expected from the lantern.

b) ability to provide the service **every night** after charge of the PV lantern under local sunny daylight conditions;

c) availability of the **service over the lifetime** expected in the GS.

6.3 Testing programme

The following recommended testing programme introduced in Table 3 allows assessment of operational performances of PV lanterns in a short time and with common technical means. They can be performed locally, as close as possible to the real site operating conditions.

Table 3 – Testing programme

Initial aspect inspection	Lighting service test			Durability test	
				Storability test	Final aspect inspection
Test 1 **phase 1**	**Test 2**	**Test 3**	**Test 4**	**Test 5**	**Test 1** **phase 2**
Visual inspection of all preselected products	For products which have passed test 1: Test of ability to provide the required service at least one time	For products which have passed test 2: Test of ability to repeat the required service for several days	For products which have passed test 3: Test of ability to repeat the required service on the expected lifetime	For products which have passed test 4: Test of ability to provide the required service after a long out of service period	For products which have passed test 5: Final visual inspection
Subclause 6.3.2.2	Subclause 6.3.3	Subclause 6.3.4	Subclause 6.3.5	Subclause 6.3.6	Subclause 6.3.2.3

The proposed tests shall be performed in accordance with the sequence shown on Figure 1.

These tests are not product certification tests.

As these tests are comparative tests, all the samples of different lantern models shall be tested in the same conditions at the same time, with the same environmental conditions, and the same testing equipment. It is obvious that the tests will be preferably performed during a sunny season.

The test conditions shall be as close as practical to the utilization conditions (in accordance with the manufacturer's recommendations); it is particularly important to ensure the right tilt angle for modules (when not integrated).

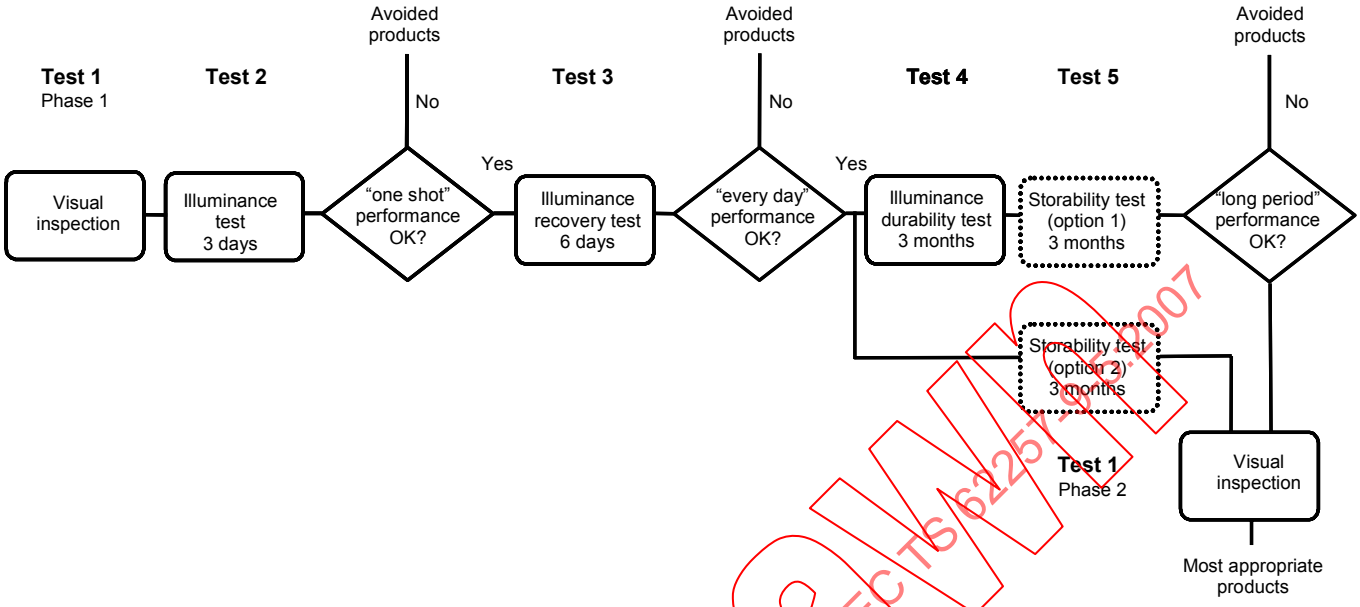


Figure 1 – Testing programme

Two options may be considered to perform test 5 as described in Table 4.

Table 4 – Storability test options

	Option 1: test 5 is performed in series with test 4	Option 2: test 5 is performed in parallel with test 4
Advantages	3 samples per model	Shorter whole test duration (~3 months)
		The storability test is more representative of the actual process of project implementation.
Disadvantages	Longer test duration: (~6 months): storability test is performed on samples already processed through tests 1 to 4	6 samples per model are necessary

6.3.1 Test equipment

To perform the test the equipment needed is:

- a time measurement device (clock/watch);
- a testing device as proposed in Annex A;
- an illuminance meter.

All the lanterns shall be tested with the same model of testing device.

6.3.2 Test 1: Visual inspection

6.3.2.1 General

The purpose of this test is to assess the evolution/degradation of the conditions of the different parts of the product during the test period, especially casings, lamps and modules.

It is intended to record as much information as possible concerning each sample to be tested (see a proposed data sheet in Annex B).

6.3.2.2 Phase 1: Initial visual inspection

6.3.2.2.1 General

The initial inspection is intended to record all necessary details of each sample of each pre-selected model and identify the sample for the duration of all tests. It will also determine that the sample has been supplied with all necessary items and components required for the test.

6.3.2.2.2 Phase 1 sampling

Three samples of each model are required for the whole comparative tests process.

Once each sample is uniquely identified, a test item number shall be assigned and used in all data sheets and records to avoid confusing sample results. It is recommended that the unit should be photographed in such a way that all major accessible components are recorded. This may necessitate multiple photographs of each sample.

6.3.2.2.3 Phase 1 operation

The following list (non-comprehensive) gives examples of items to be checked and recorded:

- all the necessary hardware;
- user documentation detailing usage and maintenance requirements;
- name of the manufacturer/supplier;
- type or model number;
- serial or batch number;
- connecting points for the incoming conductors;
- date of manufacture of unit/or manufacture date of battery;
- physical condition (e.g. presence of damage or other marks, etc.).

6.3.2.2.4 Phase 1 results

Pass criteria

For all samples

- there shall be no visual evidence of a major defect;
- and the sample is complete.

Fail criteria

For one or more samples

- there is evidence of a major defect;
- or the sample is determined to be not complete.

It is up to the project implementer to determine whether he will accept a certain model if one or more samples have failed this initial visual inspection. The implication of not accepting a sample is that the whole test schedule will need to be delayed while waiting for new sample(s) of the given failed models

6.3.2.3 Phase 2: Final visual inspection

6.3.2.3.1 General

The final inspection will be used to determine any physical degradation and the durability of the product over the period of testing.

6.3.2.3.2 Phase 2 sampling

All the tested samples at the end of test 5.

6.3.2.3.3 Phase 2 operation

The final inspection will utilize the records of the initial inspection to determine any evidence of degradation of the accessible components.

The list below contains examples of defects that may occur:

- corrosion of any part of the component, inside or outside;
- dust, water or fungus intrusion into the electrically active interior of the component;
- loss of mechanical integrity, to the extent that the operation of the sample is impaired;
- failure of any system component, including lamp;
- broken, cracked, bent, misaligned or torn external surface of any component;
- deterioration of wiring insulation.(e.g. for non-integrated PV modules);
- electrolyte leakage from the batteries;
- signs of overheating or corrosion.

This is not a complete list and the project implementer may discover other possible defects due to the individual model design.

6.3.2.3.4 Phase 2 results

Pass criteria

For all samples:

- they shall have passed all tests from 2 to 5;
- there shall be no additional deterioration of samples which cause the functionality of a sample to possibly be impaired.

Fail criteria

For one or more samples:

- there is evidence of a major defect;
- or additional deterioration which could affect the functionality of the sample has occurred.

6.3.3 Test 2: Ability to provide “on one shot” the required lighting service

6.3.3.1 General

The purpose of this test is to check the ability of the different lanterns **to perform one time**, for a given lighting application, the illuminance and the service duration required for this application in the GS of the electrification project.

6.3.3.2 Test 2 sampling

Three samples of each model of lantern are required.

6.3.3.3 Test 2 operation

Test 2 shall be performed according to the 3 days sequence A described in 6.4.1.

A model of a data record sheet is proposed in Annex C.

6.3.3.4 Test 2 results

Compare the initial and final recorded values of illuminance and service duration with the requirements of the GS.

Pass criteria: service duration is OK **and** the illuminance performance at the end of the test should be within ± 20 % of the performance required by the GS of the project.

The three samples shall match the requirements. If not, the model should be avoided.

All the samples of the accepted models shall go through test 3.

Fail criteria: the illuminance performance at the end of the required service duration does not meet the requirements for one or more samples. The concerned model should be avoided.

If none of the tested products matches the GS requirements, the project implementer has two options:

- change the GS requirements (if acceptable) and select the tested products which are able to match the new requirements;

or

- go back to the manufacturers for the selection of a new range of products to be tested.

6.3.4 Test 3: Ability to provide the lighting service every day

6.3.4.1 General

The purpose of this test is to check the ability of the different models which passed the test 2 to provide, for a given lighting application, the specified service at the same level for several days. The test aims to assess the ability of the system to recover its full capability in a short time.

Test 3 should start immediately after completion of test 2; delays greater than 2 days shall be avoided.

6.3.4.2 Test 3 sampling

All the test 2 accepted models will go to test 3 in the configuration as they are at the end of test 2, especially without any additional charge

6.3.4.3 Test 3 operation

Test 3 shall be performed according to the 6 days sequence B described in 6.4.2.

See proposed data sheet in Annex D.

6.3.4.4 Test 3 results

Compare the results of steps d, f, h, of the sequence B with the requirements of the GS.

Pass criteria: the illuminance performance recorded in step h is at least equal to the performance required by the GS of the project. At least two of the three samples shall match the requirements. If not, the model shall be avoided.

All the models which pass test 3 shall go to test 4.

Fail criteria: the final illuminance performance recorded in step h does not fit the requirements. The concerned samples should be avoided.

If none of the tested products match the GS requirements the project implementer has two options:

- select the least worst products by comparison of the illuminance curves and of the service durations;
- go back to the manufacturers for the selection of a new range of products to be tested.

6.3.5 Test 4: Ability to provide the lighting service every day for a long period

6.3.5.1 General

The purpose of this test is to check the ability of the different products which passed test 3 to provide, for a given lighting application, the specified service for a long period.

The objectives are:

- to assess the capability of the system to provide a sustainable service (6.4.3, sequence C);
- to evaluate the evolution of the initial performance (6.4.1, sequence A).

6.3.5.2 Test 4 sampling

The models selected after test 3 will go to test 4 in the configuration as they are at the end of test 3.

6.3.5.3 Test 4 operation

Test 4 includes an initial 3 days sequence A to reinitialize the samples, then a loop including a 1 month sequence C followed by a sequence A and performed 3 times as described in Figure 2.

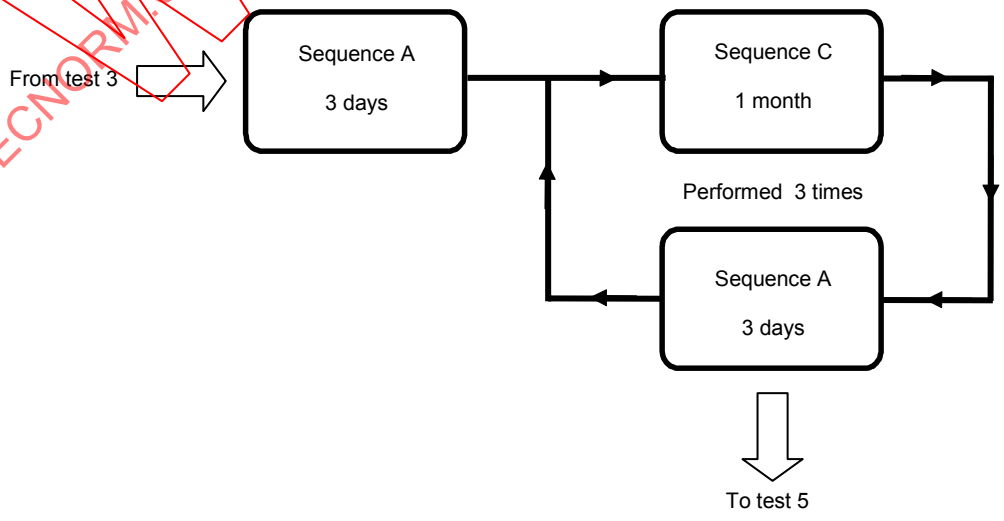


Figure 2 – Test 4 sequences

The initial sequence A is performed according to the operating procedure described in 6.4.1.

Sequence C is performed 3 times according to the operating procedure described in 6.4.3.

The sequence A included in the loop is performed 3 times according to the operating procedure described in 6.4.1 but the record of the illuminance is not optional and shall be performed.

Models of data record sheet are proposed in Annex C (sequence A) and Annex E (sequence C).

6.3.5.4 Test 4 results

Pass criteria: a model is accepted if

- the illuminance recorded at the end of test 4 (that means at the end of the last sequence A) for each sample shows a maximum reduction of 5 % or less with reference to the performance illuminance measured at the end of the first sequence A of test 4; and
- the lamp is still lit at the end of the daily duration required by the GS in 80 % of all the days of the sequences C.

All the samples of each model have to pass the two criteria.

If several models pass test 4, the project implementer may use the illuminance recorded during the sequences A and also the percentage of days where the lamp was still lit during sequences C in order to compare the model(s) and choose the best one(s).

Fail criteria: if one sample or more of a model does not match the requirements, the model should be avoided.

If none of the tested products match the GS requirements the project implementer has two options:

- change the GS requirements (if acceptable) and select the tested products which are able to match the new requirements;

or

- go back to the manufacturers for the selection of a new range of products to be tested.

6.3.6 Test 5: Storability test

6.3.6.1 General

The purpose of this test is to check the ability of a product to recover its lighting performance after a long out of service duration.

NOTE This test could be useful if the products are likely to be stored for a long period before being used (custom procedure for example). If it is not the case, this test should be considered as optional.

6.3.6.2 Test 5 sampling

Samples accepted by test 4 (option 1).

New samples (3) of each model accepted by test 3 (option 2).

6.3.6.3 Test 5 operation

Test 5 shall be performed according to the sequence D described in 6.4.4.

A model of the data record sheet is proposed in Annex F.

6.3.6.4 Test 5 results

Pass criteria: service duration is OK and the illuminance performance at the end of the test is at least equal to the performance required by the GS of the project.

At least two of the three samples shall match the requirements. If not, the model shall be avoided.

Fail criteria: if none or only one sample of a model matches the requirements, the model should be avoided.

NOTE If none of the models pass the test, the illuminance curves recorded during the last sequence A of test 4 may be used by the project implementer to choose the least worst model(s).

6.4 Tests sequences operating procedures

6.4.1 Sequence A (3 days)

Sequence A is performed as described in Table 5.

Table 5 – Sequence A operating procedure

Step	Start	Stop	Actions	Comments
			For each sample tested:	
a	$T_{A.1}$	$T_{A.2}$	**Switch off** any lighting application of the lantern. **Charge** the battery.	The expected result is a fully charged battery. Initial charge shall be performed with respect of the manufacturer's requirements. If no specific instructions are given for the initial charge, charge with the PV panel **during 3 consecutive days** under the local daylight conditions.
b	$T_{A.2}$	$T_{A.3}$	**Disconnect the PV module or cover the integrated module.** **Switch on** a given lighting application. **Use** the lantern continuously under this given application. and **Measure** the illuminance at the end of the duration required by the GS. **Switch off** the lighting application when the lighting service duration required in the GS is OK. *NOTE Optionally, the illuminance could be measured initially at T1 + 2 min and* *every 30 min in order to draw the illuminance curve of the products. These curves could be used to compare the products in case that they do not match the requirements of the GS.*	The discharge phase shall be performed the night following the day charge. (See Annex B for the measurement method and equipment.)

6.4.2 Sequence B (6 days)

Sequence B is performed as described in Table 6.

Table 6 – Sequence B operating procedure

Step	Start	Stop	Actions	Comments
For each sample tested:				
c	$T_{B.1}$	$T_{B.2}$	**Switch off** any lighting application. **Charge** the battery.	Charge during **1 day**, under the local daylight conditions.
d	$T_{B.2}$	$T_{B.3}$	**Disconnect the PV module or cover the integrated module.** **Switch on** the same given light application as tested in test 1. **Discharge** continuously under this given application. and **Measure** the illuminance each 30 min. **Measure** the illuminance at the end of the duration required by the GS. **Switch off** when the daily lighting service duration required in the GS is OK.	The discharge phase shall be performed the night following the day charge.
e	$T_{B.3 + 1\ day}$	$T_{B.4}$	**Switch off** any lighting application. **Charge** the battery.	Charge during **2 consecutive days**, under the local daylight conditions.
f	$T_{B.4}$	$T_{B.5}$	Same as step d	
g	$T_{B.5 + 1\ day}$	$T_{B.6}$	**Switch off** any light application. **Charge** the battery.	Charge during **3 consecutive days**, under the local daylight conditions.
h	$T_{B.6}$	$T_{B.7}$	Same as step d.	

6.4.3 Sequence C (1 month)

Sequence C is performed as described in Table 7.

Table 7 – Sequence C operating procedure

Step	Start	Stop	Actions	Comments
For each sample tested				
i	$T_{C.1}$	$T_{C.2}$	**Switch off** any light application. **Charge** the battery.	Charge during **1 day**, under the local daylight conditions.
j	$T_{C.2}$	$T_{C.3}$	**Disconnect the PV module or cover the integrated module.** **Switch on** the same given light application as tested in test 2. **Discharge** continuously under this given application. **Verify** that the lamp is lit at the end of the daily duration required by the GS. If the above verification is OK, **switch off**. If the above verification is not OK, note that the lamp was already shut down, and **switch off.**	See data sheet.
k	$T_{C.3 + 1\ day}$	$T_{C.4}$	Same as step i.	
Perform this charge-discharge cycle 30 times (~1 month)				

6.4.4 Sequence D (3 months)

Sequence D is performed as described in Table 8.

Table 8 – Sequence D operating procedure

Step	Start	Stop	Actions	Comments
For each sample tested:				
l	$T_{D.1}$	$T_{D.2}$	**Switch off** any lighting application of the lantern. **Charge** the battery.	Charge with the PV panel **during 3 consecutive days** under the local daylight conditions.
m	$T_{D.2}$	$T_{D.3}$	**Disconnect the PV module or cover the integrated module.** **Switch on** a given lighting application. **Use** the lantern continuously under this given application. and **Measure** the illuminance at the end of the duration required by the GS. **Switch off** the lighting application when the lighting service duration required in the GS is OK.	The discharge phase shall be performed the night following the day charge.
n	$T_{D.3}$	$T_{D.4}$	Idem step l.	
o	$T_{D.4}$	$T_{D.5}$	**Store** the PV lantern in the conditions as close as possible of those that will be used during the supply chain of equipment for the electrification project.	Storage period: **~3 months.**
p	$T_{D.5 + 3\ months}$	$T_{D.6}$	Idem step l.	
q	$T_{D.6}$	$T_{D.7}$	Idem step m.	

7 Installation

When PV module is separate from the casing, for mechanical stability, a framework shall be provided by the manufacturer in order to install PV modules.

If the components of the envelope of the lighting system are not designed to withstand the effects of ultraviolet radiation with no deterioration, the manufacturer shall explicitly indicate that the system must be protected in a sheltered location during the day time.

8 Operation and maintenance

8.1 Operating conditions

When PV module is separate from the casing, place the panel outdoors and run the cable to the lantern outdoors, but make some form of protective shelter for the lantern.

Every day, charge the PV lantern.

The project developer should define in the GS what the expected lifetime of the product and the components should be to comply with his business plan. Provision should be made in the contract with the manufacturer to get warranty about the lifetime of the product.

8.2 First operation

For the first operation, the manufacturer's instructions shall be performed.

8.3 Maintenance

If present, the translucent part of the system transmitting the light and protecting the lamp (glass or synthetic material) must not be subject to any failure during the service life of the PV lantern, nor be subject to any change of aspect).

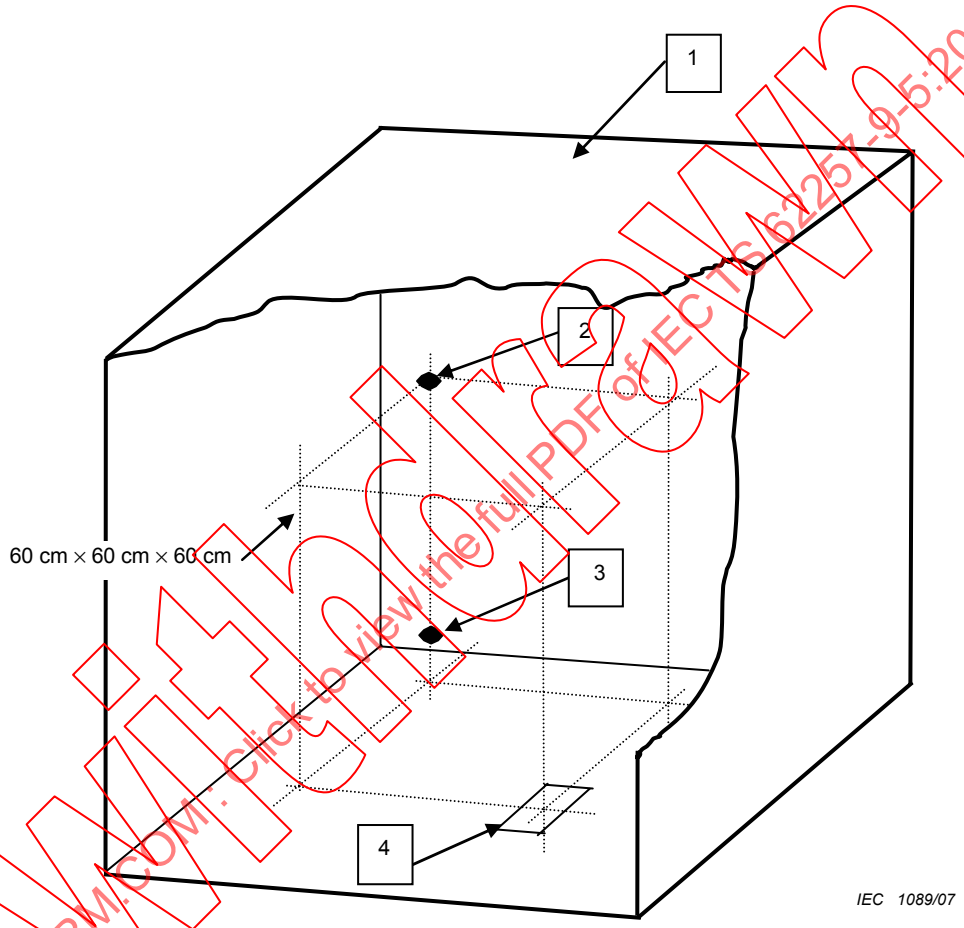
All components such as lamp, battery, ballast, etc. should be easy to replace without the need for a special tool.

The only regular maintenance required is to clean the solar panel from time to time using a soft damp cloth. The panel will require most cleaning if it is mounted permanently at a small (or zero) tilt angle. The lantern can also be cleaned if necessary with a soft damp cloth. Never use abrasive materials or solvents to clean either the lantern or the solar panel, as they might damage the plastic parts and protective seals.

Annex A
(normative)

Device for illuminance measurement

The test shall be performed in a “completely” dark box, painted mat black inside. Different configurations shall be used, depending on the position decided to use the lantern : hung up or standing. Figure A.1 is an illustration of a testing box and testing positions. The most important requirement is to use the same testing equipment for the all samples.



Key

1 Testing box: darkness inside
2 Position of the lamp of a tested hung lantern, according to the manufacturer’s recommendations
3 Testing position of a “standing” lantern
4 Position of the illuminance meter

NOTE The 60 cm x 60 cm x 60 cm dimensions could be taken as a reference of operating conditions (to respect an acceptable minimum distance of the lantern and a user for reading application).

Figure A.1 – Outlines for an illuminance testing device for PV lanterns

Annex B
(informative)

Data record sheet for visual inspection

PV lantern comparative tests		
Test 1: Visual inspection		
Model tested: *Brand name, manufacturer's name*	**Sample tested:** *Code used for identification of each sample*	
Items to be checked	**Records**	
	Phase 1 **Initial inspection** *(6.3.2.2)*	**Phase 2** **Final inspection** *(6.3.2.3)*
	Date: **Inspector:**	**Date:** **Inspector:**
See suggestions in 6.3.2.2.3	*OK, not OK*	*Evolution, degradation, major defects, See suggestions in 6.3.2.2.3*

Annex C
(normative)

Sequence A data record sheet for illuminance tests 2 and 4

PV lantern comparative tests		
Test 2: Ability to provide "on one shot" the required lighting service		*(to be ticked off if relevant)*
Test 4: Ability to provide the required lighting service on a long period		*(to be ticked off if relevant)*
Sequence A		
Model tested: *Brand name, manufacturer's name*	**Sample tested:** *Code used for identification of each sample*	**Application tested:** *A1, A2, or A3 (5.1.1.)*
Position of the lantern: *Hung up or standing*		
Requirements of the GS for the tested application	**Illuminance (lux)**	*Value given by GS*
	RSD = required service duration (hours)	*Value given by GS*
Recorded data		
Time		**Illuminance**
T0	*Starting time of the light application*	
Planned measurement time	**Real measurement time**	
***T0*+2 min**	***T0* +...**	*Measured value with the illuminance meter*
T1= T0+30 min	*T1* =	*Measured value with the illuminance meter:* *Optional for test 2 and initial sequence A for test 4;* *Compulsory for final sequence A for test 4*
T2= T1+30 min	*T2* =	*Idem above*
T3= *T2*+30 min	*T3* =	*Idem above*
T4= *T3*+30 min	*T4* =	*Idem above*
T5= *T4*+30 min	*T5* =	*Idem above*
...	...	*Idem above*
***T0* + RSD**	***T0* + ...**	*Measured value with the illuminance meter*