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Edition 2.0 2015-10

TECHNICAL SPECIFICATION

Recommendations for renewable energy and hybrid systems for rural electrification –
Part 12-1: Selection of lamps and lighting appliances for off-grid electricity systems

IEC TS 62257-12-1:2015-10(en)

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RECOMMENDATIONS FOR RENEWABLE ENERGY AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –

Part 12-1: Selection of lamps and lighting appliances for off-grid electricity systems

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- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

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 second edition cancels and replaces the first edition published in 2007. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition.

- Overall, the narrow focus on the needs of bulk procurement programmes has been shifted to a wider framework for structuring quality assurance using appropriate methods for a range of stakeholders including governments, manufacturers, buyers, and others.
- The document structure has been revised, with modular methods given in annexes.
- Normative references and definitions have been added to support the new document structure.
- The scope has been expanded from self-ballasted compact fluorescent lamps to include DC products and lighting appliances with LED, compact fluorescent, or linear fluorescent light sources.
- Several key test procedures have been created or modified:
  - manufacturer self-reported information;
  - random product sampling;
  - visual screening;
  - light output, distribution, and maintenance;
  - cycling test for fluorescent lights;
  - input voltage range;
  - mechanical durability;
  - physical ingress and water protection;
  - power quality and power consumption.

This Technical Specification is to be used in conjunction with other parts of the IEC 62257 series.

The text of this Technical Specification is based on the following documents:

Enquiry draft	Report on voting
82/941/DTS	82/995/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 renewable energy and hybrid systems for rural electrification*, can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website 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 document using a colour printer.

INTRODUCTION

The IEC 62257 series provides support and strategies for organizations and institutions involved in rural electrification projects. It documents technical approaches for designing, building, testing, and maintaining off-grid renewable energy and hybrid systems with AC nominal voltage below 1 000 V, and DC nominal voltage below 1 500 V.

These documents are recommendations:

- to support buyers who want to connect with good quality options in the market,
- 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 technical aspects of rural off-grid electrification concentrating on but not specific to developing countries. They are not all inclusive to rural electrification. The documents do not describe a range of factors that can determine project or product success: environmental, social, economic, service capabilities and others.

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 affordable costs. The main objectives are to support the capabilities of households and communities that use small renewable energy and hybrid off-grid systems and inform organizations and institutions in the off-grid power market.

The purpose of this part of IEC 62257 is to specify quality assurance strategies for lamps and lighting appliances for off-grid electricity systems, including product specifications and tests. In addition to supporting the selection of products by project developers and implementers, quality assurance can help market support organizations, manufacturers, and governments achieve the goals they have for lighting appliances in off-grid applications.

This part of IEC 62257 presents a quality assurance framework that includes product specifications (a framework for interpreting test results) and test methods. The intended users of this part of IEC 62257 are listed below. In some clauses and subclauses of this part of IEC 62257, a description of the application of the subclause contents is offered to help provide context for each type of user.

- **Market support programmes** are programmes that support the off-grid lighting market with financing, consumer education, awareness, and other services. Market support programmes often use quality assurance to qualify for access to services like
  - greenhouse gas reduction certifications or other incentives,
  - access to financing (trade or consumer finance),
  - use of a buyer seal and certification (government or non-governmental institutional backing, consumer or “business to business” seals),
  - participation in a public product information database (for example, standardized specifications sheets),
  - access to a business network or trade group,
  - business support and development services,
  - access to market intelligence, and
  - participation in consumer awareness campaigns.

- **Manufacturers and distributors** verify the quality and performance of products from different batches and potential business partners. Manufacturers and distributors often use quality assurance plans or requirements to
  - support quality control processes at a manufacturing plant or upon receipt of goods from a contract manufacturer, and
  - choose products to distribute.
- **Bulk procurement programmes** facilitate or place large orders for devices from a distributor or manufacturer. Bulk procurement programmes often use quality assurance to
  - provide devices to a particular, relatively small group of end-users whose needs are understood (for example, project developers and implementers for an electrification project may include quality assurance requirements in the general specification of an electrification project (see IEC TS 62257-3)), and
  - organize a subsidy, buy-down, or giveaway programme that will serve a broad set of users.
- **Trade regulators** are typically government policymakers and officials who craft and implement trade and tax policy. Regulators often use quality assurance requirements to
  - qualify for exemption from tax or duties, and
  - establish requirements for customs.

There is a range of tests outlined in this part of IEC 62257; some are simple enough to be completed in the field by project developers while others require laboratory equipment. The tests and inspections are designed to be widely applicable across different markets, countries, and regions.

RECOMMENDATIONS FOR RENEWABLE ENERGY AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –

Part 12-1: Selection of lamps and lighting appliances for off-grid electricity systems

1 Scope

This part of IEC 62257 establishes the framework for creating a product specification – the basis for evaluating quality for a particular context. Product specifications include minimum requirements for quality standards, warranty requirements, and/or performance criteria. Products are compared to specifications based on test results and other information about the product. The product specification framework is flexible and can accommodate the goals of diverse organizations and institutions.

This part of IEC 62257 applies to lamps and lighting appliances for off-grid electricity systems that have the following characteristics:

- The power supply is AC or DC:
  - AC nominal voltages up to 250 V;
  - DC nominal voltages up to 48 V.
- The light source is CFL, linear fluorescent, or LED.
- Operation of the lamp or lighting appliance does not require any components to be supplied by the testing laboratory other than lampholders, wire, connectors, and a power supply.
- The lamp or lighting appliance does not include a battery or energy source (for example, a photovoltaic module or electromechanical generator).

Luminaires are included in the definition of “lighting appliances” if packaged together with a lamp intended to be used with the luminaire. Luminaires without lamps are not included in the scope of this part of IEC 62257.

2 Normative references

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

IEC 60068-2-6, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

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*

IEC TS 62257-9-5, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 9-5: Integrated system – Selection of stand-alone lighting kits for rural electrification*

CIE 084, *The measurement of luminous flux*

CIE 127, *Measurement of LEDs*

IESNA LM-78-07, *Approved method for total luminous flux measurement of lamps using an integrating sphere photometer*

IESNA LM-79-08, *Electrical and photometric measurement of solid state lighting products*

3 Terms and definitions

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

3.1
environmental conditions
characteristics, such as elevation, temperature, and humidity, that can influence performance

3.2
lux
SI unit of illuminance: illuminance produced on a surface of area 1 square metre by a luminous flux of 1 lumen uniformly distributed over that surface

[SOURCE: IEC 60050-845:1987, 845-01-52]

3.3
illuminance
illuminance of an elementary surface
E
luminous flux received by an elementary surface divided by the area of this surface

Note 1 to entry: In the SI system of units illuminance is expressed in lux (lx) or lumens per square metre (lm/m^2).

[SOURCE: IEC 60050-723:1997, 723-08-30]

3.4
luminous efficacy
luminous efficacy of a source
quotient of the luminous flux emitted by the power consumed by the source

Note 1 to entry: Unit: lm/W.

[SOURCE: IEC 60050-845:1987, 845-01-55]

3.5
full width half maximum
FWHM
range of a variable over which a given characteristic is greater than 50 % of its maximum value

Note 1 to entry: FWHM can be applied to characteristics such as radiation patterns, spectral linewidths, etc. and the variable can be wavelength, spatial or angular properties, etc., as appropriate.

[SOURCE: IEC 60050-731:1991, 731-01-57]

3.6
power factor
under periodic conditions, ratio of the absolute value of the active power P to the apparent power S

[SOURCE: IEC 60050-131:2002, 131-11-46, modified – The formula and note have been omitted.]

3.7
active power
P
real power
effective power
under periodic conditions, mean value, taken over one period T, of the instantaneous power p:

$$P = \frac{1}{T}\int_0^T p\,\mathrm{d}t$$

Note 1 to entry: The coherent SI unit for active power is the watt (W).

[SOURCE: IEC 60050-131:2013, 131-11-42, modified – Note 1 to entry has been omitted.]

3.8
total harmonic distortion
THD
ratio of the total r.m.s. value of the harmonics (in this context harmonic currents I_n of the order n) of orders 2 to 40 to the r.m.s. value of the fundamental:

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

Note 1 to entry: This definition has been chosen in accordance with the relevant standard IEC 61000-2-2.

3.9
IP class
IP rating
ingress protection—degree of protection provided by enclosures for electrical equipment against penetration by foreign bodies and dust/water

[SOURCE: IEC TS 62257-9-5:2013, 3.23]

3.10
metadata
information that relates a test result to a specific sample and provides context about the result (e.g. specific test method used)

[SOURCE: IEC TS 62257-9-5:2013, 3.28]

3.11
multimeter
multirange multifunction measuring instrument intended to measure voltage, current and sometimes other electrical quantities such as resistance

[SOURCE: IEC 60050-312:2001, 312-02-24]

3.12
ammeter
instrument intended to measure the value of a current

[SOURCE: IEC 60050-313:2001, 313-01-01]

3.13
voltmeter
instrument intended to measure the value of a voltage

[SOURCE: IEC 60050-313:2001-07, 313-01-03]

3.14
illuminance meter
instrument for measuring illuminance

[SOURCE: IEC 60050-845:1987, 845-05-16]

3.15
integrating sphere
hollow sphere whose internal surface is a diffuse reflector, as non-selective as possible

Note 1 to entry: An integrating sphere is used to determine the total luminous flux (lumen output) of a lighting device.

Note 2 to entry: An integrating sphere is used frequently with a radiometer or photometer.

[SOURCE: IEC 60050-845:1987, 845-05-24]

3.16
lamp
device including a light source intended to be installed in or permanently fixed to a lampholder or luminaire

3.17
integrated compact fluorescent lamp
compact fluorescent lamp that incorporates, permanently enclosed, all elements that are necessary for starting and for stable operation

3.18
non-integrated compact fluorescent lamp
compact fluorescent lamp that incorporates electrical contacts intended for connection to a ballast through a lampholder

Note 1 to entry: Non-integrated compact fluorescent lamps are not included in the scope of this part of IEC 62257, but can be components of a lighting appliance that is included in the scope.

3.19
compact fluorescent lamp
CFL
tubular fluorescent lamp unit, having a bent tube, which does not include any replaceable or interchangeable parts

3.20
linear fluorescent lamp
straight tubular fluorescent lamp unit that incorporates electrical contacts intended for connection to a ballast through a lampholder, and which does not include any replaceable or interchangeable parts

3.21
light emitting diode
LED
solid state device embodying a p-n junction, emitting optical radiation when excited by an electric current

[SOURCE: IEC 60050-845:1987, 845-04-40]

3.22
integrated LED lamp
device including an LED light source, LED driver, and other optical, mechanical, and thermal components, and intended to connect directly to a power source

3.23
non-integrated LED lamp
device including an LED light source and other optical, mechanical, and thermal components, and intended to connect to an LED driver configured to control the lamp's light output

3.24
LED driver
electronic device configured to control the output of an LED light source, intended to connect directly to a power source, either packaged along with the LED light source in an integrated LED lamp or packaged separately from the LED light source

3.25
cap
base, en US
part of a lamp which provides connection to the electrical supply by means of a lampholder or lamp connector and, in most cases, also serves to retain the lamp in the lampholder

Note 1 to entry: The term "base" is also used in both the United Kingdom and the United States of America to denote an integral part of a lamp envelope which has been so shaped that it fulfils the function of a cap. It may engage either a holder or a connector, depending on other design features of the lamp- and holder system.

Note 2 to entry: The cap of a lamp and its corresponding holder are generally identified by one or more letters followed by a number which indicates approximately the principal dimension (generally the diameter) of the cap in millimetres. The standard code is to be found in IEC 60061.

[SOURCE: IEC 60050-845:1987, 845-08-15]

3.26
lampholder
device which holds the lamp in position, usually by having the cap inserted in it, in which case it also provides the means of connecting the lamp to the electric supply

Note 1 to entry: The term "socket" or, when the context is clear, the abbreviation "holder" are commonly used instead of "lampholder".

Note 2 to entry: See Note 2 to entry 3.25.

[SOURCE: IEC 60050-845:1987:1987, 845-08-24]

3.27
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

Note 1 to entry: Luminaires that are not supplied with lamps are outside the scope of this part of IEC 62257.

[SOURCE: IEC 60050-845:1987, 845-10-01, modified – Note 1 to entry has been added.]

3.28
lighting appliance
apparatus which distributes, filters or transforms the light transmitted from one or more light sources or lamps and which includes 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

Note 1 to entry: A lighting appliance can be a luminaire with one or more lamps installed, including luminaires with integral lamps. A luminaire with no lamp installed or provided is not a complete lighting appliance (and is outside the scope of this part of IEC 62257).

3.29
device under test
DUT
particular sample that is being measured or observed

4 Characteristics of lamps and lighting appliances

4.1 Product categories

Lamps and lighting appliances can be placed into one of three categories based on their expected range of use. It is important to categorize them because they have different inherent utility to the user and will encounter different environmental conditions based on their design.

Different quality standards and performance criteria may apply to different categories.

A product will fall into one of the following categories:

- Indoor-only products are designed for indoor use only, meaning they are generally intended to be mounted permanently or semi-permanently indoors.
- Indoor/outdoor products are designed to be used indoors or outdoors or both, depending on the user's needs.
- Outdoor-only systems are designed specifically for outdoor use, meaning they are generally intended to be mounted permanently or semi-permanently outdoors.

4.2 System measurements and observations

4.2.1 General

Subclause 4.2 describes aspects of a lamp or lighting appliance for off-grid electricity systems that may be measured and/or observed to ascertain its quality and performance. The aspects are grouped into categories, and each aspect begins with a description of its relevance. The aspects may be measured and/or observed using test procedures, which are generally classified as class A or class B. Class A test procedures will generally result in measurements that are more accurate or less subjective than class B procedures, but class A procedures are also generally more costly to implement. The appropriateness of class A or class B procedures depends on the particular aspect and context of the testing. The description of each aspect concludes with a description of the result from the test procedure, the units, and an example result. In some cases, multiple pieces of information are grouped in a single aspect for clarity and concision.

4.2.2 Design, manufacture, and marketing

4.2.2.1 Arrangement of components

The arrangement of components, as in the example below, is a critical aspect to observe because it determines the product category.

a) Class A test procedure(s): Annex F – visual screening

b) Class B test procedure(s): n/a

c) Result: qualitative description of the components comprising the lamp or lighting appliance

d) Units: qualitative description

e) Example: The product is an LED luminaire with all components integrated into a single enclosure.

4.2.2.2 Lighting system information

This aspect describes the types of light sources used in the product and their arrangement. This description is important for understanding the general product design.

a) Class A test procedure(s): Annex F – visual screening

b) Class B test procedure(s): Annex C – manufacturer self-reported information

c) Result: qualitative description of the type, number, and arrangement of light sources

d) Units: qualitative description

e) Example: [Photographs attached to test reports], The luminaire consists of 3 LEDs mounted on a circuit board. The LEDs and board are encased in a clear plastic globe and attached to an Edison screw-type cap, making the entire product appear similar to a traditional incandescent light bulb.

4.2.2.3 Packaging and user's manual information

Information about the packaging, user's manual, and other consumer-facing information helps establish a baseline for comparing measured values in truth-in-advertising assessments. It may also be important to document if certain programmes require particular information to be included in the manual, such as instructions for end-of-life disposal.

a) Class A test procedure(s): Annex F – visual screening

b) Class B test procedure(s): n/a

c) Result: there are two types of results

   1) photographic documentation of the packaging and manual (or digital copies of the original proofs)

   2) notes on the type of manual and which languages are included

d) Units: qualitative type and photographs

e) Example: [Photographs attached to test reports], The user's manual is a single-sheet included in the package and includes pictograms with explanations in Hindi, English, French, and Swahili.

4.2.2.4 Warranty information

The terms and duration of warranty coverage provided to end-users are important factors for engendering confidence in stand-alone off-grid lighting and trying to prevent early failure. In practice, servicing warranties is highly variable depending on the structure of supply and service chains.

a) Class A test procedure(s): Annex F – visual screening

b) Class B test procedure(s): Annex C – manufacturer self-reported information

c) Result: detailed warranty terms and a concise version that highlights the key points of coverage and duration.

d) Units: qualitative type

e) Example: [Detailed warranty terms are documented in scanned attachments to test report], Coverage is against manufacturing defects or under normal use conditions. The product in general is covered for 12 months from the time of purchase.

4.2.2.5 Other visual screening results

This incorporates various other important results obtained from visual screening (Annex F), including, but not limited to, component dimensions, component masses, the number of light output settings, and provided specifications.

a) Class A test procedure(s): Annex F – visual screening

b) Class B test procedure(s): Annex C – manufacturer self-reported information

c) Result: various results including qualitative descriptions and quantitative measurements

d) Units: qualitative descriptions and quantitative measurements

e) Example (for one result): The lighting appliance has a mass of 0,3 kg.

4.2.3 Durability and workmanship

4.2.3.1 Water protection – enclosure

This provides a description of the product enclosure's ability to keep out water in terms of IP class. For products intended to be used and/or charged outside, water protection is important for product function as well as user safety.

a) Class A test procedure(s): IEC 60529, or the alternative methods in Annex O (physical ingress and water protection) if the alternative method results are unequivocal

b) Class B test procedure(s): Annex O – physical ingress and water protection

c) Result: pass or fail for IP class (second digit) and a description of degree of water protection provided by enclosure

d) Units: pass or fail and qualitative description

e) Example: The product is estimated to pass IPx3. The product's enclosure contains tight fitting components, all of which have gaskets to prevent water intrusion.

4.2.3.2 Water protection – circuit protection and drainage

This provides a description of any drainage means incorporated into a product and/or circuit board protection methods used in the product. The incorporation of drainage or circuit board protection is crucial for products intended to be outdoors that have enclosures providing little to no water intrusion protection.

a) Class A test procedure(s): Annex F (visual screening) combined with Annex C (manufacturer self-reported information)

b) Class B test procedure(s): Annex C – manufacturer self-reported information

c) Result: qualitative description of drainage or circuit protection methods used

d) Units: qualitative description

e) Example: The product has a conformal coating on its circuit board as well as drainage holes in the base of the enclosure to allow drainage of collected water.

4.2.3.3 Physical ingress protection

This provides a description of the degree of protection from the intrusion of foreign objects a product's enclosure provides in terms of IP class. Physical ingress protection is important for user safety as well as product functionality.

a) Class A test procedure(s): IEC 60529 or the alternative methods in Annex O (physical ingress and water protection) if the alternative method results are unequivocal.

b) Class B test procedure(s): Annex O – physical ingress and water protection

c) Result: pass or fail for IP class (first digit) and description of degree of physical ingress protection

d) Units: pass or fail and qualitative description

e) Example: The product passes IP4x; the product enclosure's components fit together snugly without gaps, so that only tiny particulate matter (e.g. dust) could intrude.

4.2.3.4 Shipping vibration durability

This provides an evaluation of a product's robustness and ability to withstand vibrations during shipping and distribution.

a) Class A test procedure(s): Annex N – mechanical durability test

b) Class B test procedure(s): n/a

c) Result: pass or fail for functionality, damage, and the presence of user safety hazards

d) Units: a pass or fail result based on whether the DUT functions, incurs damage, or presents a safety hazard to the user

e) Example: When subjected to vibrations similar to those experienced during shipping, the product stopped working. Functional: fail. Damage: pass. Safety hazard: pass.

4.2.3.5 Gooseneck durability

This provides an evaluation of a product's gooseneck's robustness and ability to withstand being torqued through its expected range of motion. Gooseneck durability is important for product functionality and user safety and satisfaction.

a) Class A test procedure(s): Annex N – mechanical durability test

b) Class B test procedure(s): n/a

c) Result: a pass or fail for functionality, damage, and the presence of user safety hazards

d) Units: a pass or fail result based on whether the DUT functions, incurs damage, or presents a safety hazard to the user.

e) Example: After the gooseneck test, the LEDs worked properly but there was visible damage (a cracked housing) that did not pose a hazard. Functional: pass. Damage: fail. Safety: pass.

4.2.3.6 Connector durability

This provides an evaluation of a product's connectors' robustness and ability to withstand plug cycling. Connector durability is important for product functionality and user safety and satisfaction.

a) Class A test procedure(s): Annex N – mechanical durability test

b) Class B test procedure(s): n/a

c) Result: a pass or fail for functionality, damage, and the presence of user safety hazards

d) Units: a pass or fail result based on whether the DUT functions, incurs damage, or presents a safety hazard to the user.

e) Example: After 400 cycles in the connector test, the barrel plug socket detached from the LED driver enclosure, rendering the connector unusable. Functional: fail. Damage: fail. Safety: pass.

4.2.3.7 Switch durability

This provides an evaluation of a product's switches' robustness and ability to withstand switch cycling. Switch durability is important for product functionality and user safety and satisfaction.

a) Class A test procedure(s): Annex N – mechanical durability test

b) Class B test procedure(s): n/a

c) Result: a pass or fail for functionality, damage, and the presence of user safety hazards

d) Units: a pass or fail result based on whether the DUT functions, incurs damage, or presents a safety hazard to the user.

e) Example: After 600 cycles in the switch test, the DUT's light switch stopped turning on the DUT. Functional: fail. Damage: fail. Safety: pass.

4.2.3.8 Strain relief durability

This provides an evaluation of a product's strain reliefs' robustness and ability to withstand being pulled. Strain relief durability is important for product functionality and user safety and satisfaction.

a) Class A test procedure(s): Annex N – mechanical durability test

b) Class B test procedure(s): n/a

c) Result: a pass or fail for functionality, damage, and the presence of user safety hazards

d) Units: a pass or fail result based on whether the DUT functions, incurs damage, or presents a safety hazard to the user.

e) Example: The DUT's strain reliefs all withstood the strain relief test without incurring any damage. Functional: pass. Damage: pass. Safety: pass.

4.2.3.9 Wiring quality

This provides a qualitative evaluation of a product's wiring quality, including (but not limited to) neatness and connection quality.

a) Class A test procedure(s): Annex F – visual screening

a) Class B test procedure(s): n/a

b) Result: a qualitative description of wiring quality

c) Units: qualitative description and number of failures with respect to key indicators

d) Example: The DUT's wires are neatly arranged (e.g. bundled into harnesses and secured with cable ties) and the solder joints are of good quality. There are no bad joints, pinched wires, or other poor wiring indicators.

4.2.4 Electrical characteristics

4.2.4.1 Operating input voltage range

This provides the voltage range over which the DUT can safely and properly operate.

a) Class A test procedure(s): Annex K – input voltage range

b) Class B test procedure(s): n/a

c) Result: table showing relative light output over the operating voltage range; maximum allowable voltage; pass or fail for functionality, damage, and safety

d) Units: volts, DC or AC (V DC or V AC), and percentage (%); volts; pass/fail; qualitative description

e) Example: [Table with column headings: operating voltage (V), DUT voltage (V), and relative light output (%); a maximum allowable voltage of 15,8 V DC achieved.] The DUT remained functional after the test and no damage or safety hazard was present.

4.2.4.2 Power consumption

The power consumed by a lamp or lighting appliance is an important metric for use in off-grid applications in which the supply of energy is limited. The power consumption is also used in the calculation of luminous efficacy.

a) Class A test procedure(s): Annex P – power consumption and power quality

b) Class B test procedure(s): n/a

c) Result: active power (AC) or DC power

d) Units: watts (W)

e) Example: 1,50 W

4.2.4.3 Power factor

The power factor of an AC device is the ratio of the active power (real power, measured in watts) to the apparent power (measured in volt-amperes). The power factor is an important metric for off-grid applications since the power output capacity of generators and inverters is often given in terms of apparent power. Using devices with high power factor results in more efficient use of a given generator or inverter's capacity.

a) Class A test procedure(s): Annex P – power consumption and power quality

b) Class B test procedure(s): n/a

c) Result: active power (AC) or DC power

d) Units: unitless

e) Example: 0,95

4.2.4.4 Current total harmonic distortion (THD)

The current total harmonic distortion is a measure of harmonic content in a device's current waveform – that is, how much the current waveform deviates from a true sine wave. High levels of harmonic current can cause heating in power generation and distribution equipment (such as generators and transformers) and can lead to distortions in the system's voltage waveform, negatively impacting the performance of other equipment connected to the electricity system.

a) Class A test procedure(s): Annex P – power consumption and power quality

b) Class B test procedure(s): n/a

c) Result: active power (AC) or DC power

d) Units: percentage (%)

e) Example: 15 %

4.2.5 Photometric performance measures

4.2.5.1 Luminous flux output

Luminous flux output is the light output of a DUT when it is driven at a specific voltage. This is a key metric that compares the overall light output of DUTs.

a) Class A test procedure(s): CIE 084, CIE 127, IESNA LM-78-07, or IESNA LM-79-08

b) Class B test procedure(s): Annex I – light output

c) Result: luminous flux

d) Units: lumens (lm)

e) Example: 95,6 lm

4.2.5.2 Luminous efficacy

Luminous efficacy is the light output of a DUT (in lumens) divided by the power the DUT is consuming (in watts). This is a key metric that compares the ability of DUTs to turn electrical power into usable light.

a) Class A test procedure(s): CIE 084, CIE 127, IESNA LM-78-07, or IESNA LM-79-08

b) Class B test procedure(s): Annex I – light output

c) Result: luminous efficacy

d) Units: lumens per watt (lm/W)

e) Example: 96,3 lm/W

4.2.5.3 Full width half maximum (FWHM) angles

The full width half maximum angle is a metric used to understand the light distribution of a DUT and is the total angle over which the illumination is greater than or equal to half the illumination at the brightest point at a given distance from the light source in a given plane.

a) Class A test procedure(s): CIE 084, CIE 127, IESNA LM-79-08

b) Class B test procedure(s): Annex J – light distribution

c) Result: vertical and horizontal FWHM angles

d) Units: degrees (°)

e) Example: The DUT's horizontal and vertical FWHM angles are both 65°.

4.2.5.4 Light distribution characteristics

A light distribution is the illuminance "map" of a DUT. This metric is useful for determining the utility with respect to task lighting. The test is done by driving the DUT at a specific voltage.

a) Class A test procedure(s): CIE 084, CIE 127, IESNA LM-79-08

b) Class B test procedure(s): Annex J – light distribution

c) Result: useable area at a specified distance and illuminance on a work surface

d) Units: square metres (m^2)

e) Example: The DUT's useable area at a distance of 0,5 m is 0,76 m^2

4.2.5.5 Colour characteristics

The colour characteristics of light include the colour rendering index (CRI), a measure of how accurately the light renders colours, and the correlated colour temperature (CCT), a measure of the colour of the light expressed as a temperature in kelvin.

a) Class A test procedure(s): Annex I – light output

b) Class B test procedure(s): n/a

c) Result: CRI and CCT values

d) Units: CRI is unitless and the CCT is in kelvin (K)

e) Example: The CRI is 80 and the CCT is 7 000 K.

4.2.6 Photometric durability measures

4.2.6.1 Lumen maintenance (LED)

This is a measure of the amount of degradation in light output after 1 000 h and 2 000 h of operation at a constant voltage, which can provide valuable insight into the quality of the LEDs and/or the DUT's circuitry.

a) Class A test procedure(s): Annex L – lumen maintenance

b) Class B test procedure(s): n/a

c) Result: percentage of lumen output maintained after 1 000 h and 2 000 h of constant operation

d) Units: percentage (%)

e) Example: The DUT maintained 96 % and 93 % of its original lumen output after 1 000 h and 2 000 h of operation, respectively.

4.2.6.2 Cycle life (fluorescent)

This is a measure of the number of on/off cycles a fluorescent DUT can undergo before the DUT ceases to properly function.

a) Class A test procedure(s): Annex M – cycling

b) Class B test procedure(s): n/a

c) Result: a pass or fail for functionality after 3 000, 6 000, and 12 000 on/off cycles

d) Units: a pass or fail for functionality

e) Example: The DUT continued to function after 12 000 on/off cycles.

4.2.7 Self-declaration aspects

4.2.7.1 Product and manufacturer information

Manufacturer-reported product and manufacturer information is important for tracking purposes as well as for ensuring the test laboratory has up-to-date product information.

a) Class A test procedure(s): Annex C – manufacturer self-reported information

b) Class B test procedure(s): n/a

c) Result: various qualitative and quantitative information

d) Units: qualitative and quantitative

e) Example: The product's free-on-board price is 30 USD; it is sold in Kenya and India; etc.

4.2.7.2 Warranty coverage

Warranty coverage goes beyond the terms of a warranty and provides detail on coverage in a particular location. It is typically only provided in cases where it is necessary to verify coverage in a particular town or region.

a) Class A test procedure(s): Annex C – manufacturer self-reported information

b) Class B test procedure(s): n/a

c) Result: qualitative description

d) Units: qualitative description

e) Example: The support in [region name] is provided by a small network of technicians who have been trained to repair products by [manufacturer or distributor name]. For repairs that are beyond the scope of their capabilities, replacement products are provided. The consumers in [region name] can access warranty service by dialling a phone number that is on a sticker placed on the original packaging.

4.2.7.3 Third-party marks and certifications

Third-party marks and certifications (e.g. UL) can be an important aspect in the eyes of consumers and investors, alike.

a) Class A test procedure(s): Annex C – manufacturer self-reported information

b) Class B test procedure(s): n/a

c) Result: qualitative marks and certifications

d) Units: qualitative type

e) Example: ISO 9001 certified.

5 Product specification

5.1 General

Quality standards, warranty requirements, and performance criteria are used to interpret the measurements and observations made about a product. Together they form a product specification. See Figure 1.

Figure 1 – The three components of a product specification

- **Quality standards** set a minimum level of durability and protect buyers and users from false advertising claims.
- **Warranty requirements** set a minimum level of user protection from early failure.
- **Performance criteria** set a recommended level of service and features.

Each criterion in a specification refers to a particular aspect of the product, as listed in 4.2, and requires a minimum level of quality, service, or performance.

The standards, requirements, and performance criteria should be appropriate for the goals of the organization or individual who is using them as a framework for quality assurance and should consider the following factors:

- availability of products on the market with the necessary quality and performance;
- ability of buyers to pay for the products;
- diversity of end-user needs;
- tolerance for manufacturing variation.

Clause 5 describes the framework for standards, requirements, and performance criteria in general and offers insights on the best practices for creating a product specification. It includes a template product specification followed by guidance on completing each section. Annex A presents an example specification for off-grid lighting market support programme qualification. Annex B presents another example, for bulk procurement.

5.2 Applications

Product specifications that include some combination of quality standards, warranty requirements, and performance criteria can support a broad range of quality assurance needs. Table 1 below lists examples of how they are applied depending on the type of quality assurance (QA) framework.

Table 1 – Applications of product specifications

Type of QA framework	Example(s) of applying Clause 5
General market support	Use quality standards and general warranty requirements to qualify for institutional market support; provide additional services if performance criteria are also met. Use quality standards to qualify for “verified product” programmes. Use quality standards and other requirements to qualify for investment or financing.
Manufacturing/ distribution	For manufacturers: incorporate quality standards and performance criteria from market support programmes or distributors in the design and production quality control processes. For distributors: set minimum quality standards, warranty requirements, and/or performance criteria for products to identify suppliers.
Bulk procurement	Set minimum quality standards, warranty requirements, and/or performance criteria for products to qualify in a request for offers. If the project is in a specific location, the warranty requirements may also include specific levels of service in that particular area.
Trade regulation	Set minimum quality standards for tax exemption or customs.

5.3 Quality assurance principles

5.3.1 General

The framework for considering quality standards, warranty requirements, and performance criteria presented in this part of IEC 62257 is designed to support broad types of programmes and institutions in the off-grid lighting market. The following key principles guide the framework:

- Balance quality and affordability for price-sensitive buyers – it does not matter how well products perform if the target users cannot afford them.
- Encourage innovation and technological diversity. Wherever possible, be open-ended in the technical approaches that are allowed.
- Empower buyers to choose the right product for their needs and budget by focusing product specifications and communication on outcomes for end-users.
- Use low-cost, rigorous, targeted tests to match the general affordability requirements for the market and accommodate both incremental and innovative changes to product design. The tests should be feasible for use by a broad set of potential users.
- Focus quality standards on elements of a product that are difficult for typical buyers to assess themselves, like truth-in-advertising and durability.
- Focus warranty requirements on providing a baseline of support.
- Focus performance criteria on bottom-line user experience metrics like run time and brightness.

5.3.2 Rationale for dividing quality, warranty, and performance

Quality standards, warranty requirements, and performance criteria are considered separately to allow programmes and institutions the flexibility to establish targets with their goals in mind:

- Quality standards deal with basic consumer protection (from early product failure, unsafe operation, or false advertising) and typically are a “baseline” or minimum level.
- Warranty requirements deal with aspects of the products and projects that are not controlled at the factory or installation site – the service available for products is typically very dependent on the supply chain and geography.
- Performance criteria are typically in addition to quality standards and define service levels that should be met. The diversity of needs, power availability, and ability of end-users to pay for appliances and electric service shall be known to precisely set performance criteria.
- Enables tiered service offerings for market support programmes. For instance, it is possible to have a tiered support system in which certain services only require meeting quality standards and warranty requirements while others also require meeting performance criteria.

5.4 Product specification framework description

5.4.1 General

Subclause 5.4 describes a framework of product specification documents for lamps and lighting appliances included in the scope of this part of IEC 62257. First, a blank specification is provided that lists all the pieces that may be specified. It is followed by a subclause describing guidelines for setting tolerances in a product specification. Finally, the main sections in a specification are described in more detail with notes and guidance.

There are example product specifications in Annex A and Annex B; one is for general market support programmes and the other is a “sample tender” for bulk purchasing.

A product specification has six parts, as follows:

a) **Scope** defines the applicability and use of the quality standards and performance criteria.

b) **Test requirements** defines requirements for test result validity.

c) **Product category requirements** unambiguously defines the categories that may be referenced later.

d) **Quality standards** lists quality-related aspects and minimum or required results for each aspect with a tolerance; may be subdivided by product category.

e) **Warranty requirements** lists requirements for minimum levels of warranty support.

f) **Performance criteria** lists performance-related aspects and minimum or required results for each aspect with a tolerance; may be subdivided by product category.

5.4.2 Product specification template

5.4.2.1 General

Subclause 5.4.2 is a blank, rough template for setting quality standards, warranty requirements, and performance criteria to support the goals of a programme or institution. Note that in many applications certain criteria or entire categories of criteria may not apply and should be removed.

NOTE *Text in italics* is intended for replacement and describes what should go in each space.

5.4.2.2 Scope

Describe the intended use of the product specification. Describe the contents in general and provide guidance on how to use the document.

5.4.2.3 Test requirements

Specify the level of testing that is required. For example, Quality Test Method (QTM) level testing (see Clause 6).

Describe any product sampling requirements for qualification testing.

5.4.2.4 Product category requirements

Describe which product technology categories (e.g. AC and/or DC, lamps and/or luminaires, LEDs and/or CFLs, etc.) are covered/allowed.

Describe any voltage limits or other required electrical system integration tolerances (e.g. nominal 12 V DC, AC voltage input range 100 V to 250 V, AC frequency 50 Hz, etc.).

Describe any other categorical requirements for products (e.g. shall have an E27 Edison screw cap, etc.).

5.4.2.5 Quality standards

The product shall meet each of the criteria listed in the truth-in-advertising (Table 2), safety and durability (Table 3), power quality for AC products (Table 4), and end-user support (Table 5) tables.

Table 2 – Truth-in-advertising tolerance

Truth-in-advertising criterion	Aspect(s) considered in assessment	Requirement
System performance tolerance – numeric ratings	4.2.5 Photometric performance measures Others, if applicable	*Define the tolerance for deviation from ratings.*
Other numeric ratings tolerance	Multiple	*Define the tolerance for deviation from ratings.*
Overall truth-in-advertising statement	Multiple	*Include an overall description of the requirements for truth-in-advertising that may not be covered by the requirements above.*

Table 3 – Safety and durability standards

Safety or durability criterion	Aspect(s) considered in assessment	Product category (form factor and/or technology)	Requirement
Level of water exposure protection (*overall, technical, or enclosure-only*)	4.2.3.1 Water protection – enclosure 4.2.3.2 Water protection – circuit protection and drainage 4.2.7.1 Product and manufacturer information 4.2.2.3 Packaging and user's manual information	*Category 1*	*Define level of protection in terms of water protection integrated assessment:* *No protection, occasional rain, frequent rain, or permanent outdoor exposure.*
		Category 2…	*Define level of protection in terms of water protection integrated assessment.*
Physical ingress protection	4.2.3.3 Physical ingress protection	*Category 1*	*Define level of protection in terms of IP class.*
		Category 2…	*Define level of protection in terms of IP class.*
Mechanical durability – shipping vibration	4.2.3.4 Shipping vibration durability	All products [a]	*Define maximum number of failures out of the number that are tested for damage, functionality, and safety.*
Mechanical durability – goosenecks	4.2.3.5 Gooseneck durability	Products with goosenecks	*Define maximum number of failures out of the number that are tested for damage, functionality, and safety.*
Mechanical durability – connectors	4.2.3.6 Connector durability	Products with connectors	*Define maximum number of failures out of the number that are tested for damage, functionality, and safety.*
Mechanical durability – switches	4.2.3.7 Switch durability	All products	*Define maximum number of failures out of the number that are tested for damage, functionality, and safety.*
Mechanical durability – strain relief	4.2.3.8 Strain relief durability	Products with connectors	*Define maximum number of failures out of the number that are tested for damage, functionality, and safety.*

Safety or durability criterion	Aspect(s) considered in assessment	Product category (form factor and/or technology)	Requirement
Workmanship	4.2.3.9 Wiring quality	All products	*Define maximum number of samples with bad solder joints, poor wiring, etc. out of the number that are tested.*
Operating input voltage range	4.2.4.1 Operating input voltage range	All products	*Define maximum number of failures out of the number that are tested for functionality and safety.* *Define voltage range and maximum allowable voltage for testing, if different from recommendations in* Table K.2.
Lumen maintenance	4.2.6.1 Lumen maintenance (LED)	All LED products	*Define maximum number of samples that may fail specified lumen maintenance criteria out of the number that are tested.*
Cycling durability	4.2.6.2 Cycle life (fluorescent)	All CFL or linear fluorescent products	*Define maximum number of failures out of the number that are tested.*
Safety ratings	4.2.2.5 Other visual screening results 4.2.7 Self-declaration aspects	All AC products	*Define any safety ratings, markings or certifications required for AC products.*
[a] The shipping vibration test may add significant cost to the test programme, depending on the capabilities of the test laboratory. The costs and benefits of this testing should be weighed carefully when deciding whether to include a shipping vibration durability requirement in the product specification.			

Table 4 – Power quality standards for AC products

Power quality criterion	Aspect(s) considered in assessment	Product category (form factor and/or technology)	Requirement
Power factor	4.2.4.3 Power factor	All AC products	*Define minimum acceptable power factor.*
Current total harmonic distortion	4.2.4.4 Current total harmonic distortion (THD)	All AC products	*Define maximum acceptable THD.*

Table 5 – End-user support standards

Truth-in-advertising criterion	Aspect(s) considered in assessment	Requirement
Information on product design, use, and care	4.2.2.3 Packaging and user's manual information	*Define if there are requirements for consumer-facing information on packaging or in a user's manual, such as end-of-life disposal instructions.*
Other	4.2.2.5 Other visual screening results	*Define other product requirements that support end-users to maintain the quality of the product.*

5.4.2.6 Warranty requirements

The product shall meet each of the end-user support requirements listed in Table 6.

Table 6 – End-user support requirements

Support type	Aspect(s)	Requirement
Maintenance and warranty terms	4.2.2.4 Warranty information	*Define minimum warranty requirements (length, components covered, etc.)*
Service capabilities	4.2.7.2 Warranty coverage	*Define "on the ground" requirements for warranty service (typically only for projects in a specific location)*

5.4.2.7 Performance criteria

In addition to meeting the quality standards and warranty requirements, the product shall meet one of the lighting service criteria (Table 7).

Table 7 – Lighting service criteria for performance assessment

Light output criterion	Aspect(s)	Requirement
General illumination service	4.2.5.1 Luminous flux output	*Define minimum average lumen output (lm) and compliance tolerance (%).*
Luminous efficacy	4.2.5.2 Luminous efficacy	*Define minimum luminous efficacy (lm/W) and compliance tolerance.*
Other illumination requirements	Various	*Define minimum performance for other aspects, such as colour rendering, colour temperature, light distribution and illuminance characteristics*
Usability requirements	Various	*Define minimum requirements related to usability, such as flicker and warm-up requirements.*

5.4.3 Tolerances

Tolerances are an allowable deviation from the target value for a particular criterion in a product specification and are part of the product specification. In the case of truth in advertising, the target value is what is advertised. For performance criteria, the target value is the minimum performance level. Durability tests and other pass/fail criteria also have a target – passing the test.

Tolerances should be set carefully, considering how the measured or observed values from a test (with a limited number of samples) characterize the true quality or performance aspects of every product in the market. The sample size, expected manufacturing tolerance, and testing uncertainty should each be considered.

There are trade-offs between protecting buyers/end-users and suppliers from "false positive" and "false negative" results, respectively. Tighter tolerance tends to protect buyers/end-users better from poor quality or performance products but will also result in a higher number of good quality or performance products being excluded based on non-representative sampling or test results. The dynamic is reversed for looser tolerances.

The type of tolerance depends on the aspect being specified:

a) Qualitative: aspects that are descriptive (e.g. type of light source) do not typically have a tolerance.

b) Numeric: aspects that are described with a measured value (e.g. luminous flux) should have a tolerance defined in terms of percentage deviation of the average DUT measurement from a particular value. Often it is allowable for the test result to deviate in one "direction" but not the other. For instance, it is allowable to overperform on the run time but not underperform. There may also be a tolerance defined for the variance in results of the DUT.

In general, the percentage deviation from a target value is calculated using the following formula:

$$D = 100\ \% \times \frac{x_{\text{meas}} - x_{\text{target}}}{x_{\text{target}}}$$

where:

D is the percentage deviation in a numeric value;

x_{target} is the target value;

x_{meas} is a measured value or the average of the measured values for each sample.

c) Boolean: aspects that are described in terms of “pass/fail” (e.g. switch test) should have a tolerance defined in terms of the number of allowable failures out of a set number of trials or tests. Note that the statistical power of Boolean results for predicting population pass/fail rates is not very high with small sample sizes. The implication is that it is not possible to accurately predict population failure rates for a particular aspect from a small sample size, and it is often appropriate to allow some small but reasonable failure rate to avoid false negative results.

5.4.4 Quality standards criteria

5.4.4.1 General

Subclause 5.4.4 describes the quality standards aspects and gives guidance on how to implement a quality standard.

There are several categories of quality criteria listed below. For each category, it is important for a set of quality standards to specify the following information:

- Which aspects are referenced by the criteria?
- What level of failure or minimum quality level is acceptable for each aspect?
- Which product categories are subject to each criterion if there are differences across categories?

5.4.4.2 Truth in advertising

The goal of a truth-in-advertising standard (see Table 8) is to protect buyers and end-users from false advertising claims. It is particularly important to ensure that the description of advertised values corresponds with test results in cases where buyers (anywhere in the supply chain) will make product purchasing decisions based partly or solely on advertising and packaging or where users have expectations set by them.

In practice it is ideal to check **any** advertised quality or performance statements against the test results, keeping in mind that often the framing or messaging for advertised statements is different from test conditions and that there is always inherent uncertainty in the test result. In cases where the advertised values will not be directly comparable to test results, care should be taken to avoid wrongly identifying false advertising while maintaining vigilance for buyers.

For aspects that are described with numeric information, a tolerance should be defined for truth in advertising.

For aspects that are described with qualitative or Boolean information, judgement is required to discern if the test results match advertised values.

Table 8 – Truth-in-advertising criteria for quality standards

Truth-in-advertising criterion	Aspect(s) considered in assessment	Standard specification	Remarks
System performance tolerance – numeric ratings	4.2.5 Photometric performance measures Others, if applicable	The tolerance between the rated performance and measured performance.	These are key aspects for end-user experiences with the product, but also tend to have test results with higher uncertainty due to a combination of intrinsic manufacturing variation and test uncertainty due to the system-level nature of the aspects.
Other numeric ratings tolerance	Multiple	The tolerance between the rated performance and measured performance.	n/a
Overall truth-in-advertising statement	Multiple	Describe the general policy for interpreting truth-in-advertising requirements. Suggested statement: "Each description of the product that appears on the packaging, inside the package, and in any other media should be truthful and accurate. No statements should mislead buyers or end users about the features or utility of the product."	It is important to lay out a broad expectation of truth-in-advertising and to interpret it on a case-by-case basis.

Table 9 includes notes with guidance on aspects that are often part of a truth-in-advertising check because they are commonly advertised.

Table 9 – Notes on common truth-in-advertising aspects

Aspect(s)	Remarks
4.2.5.1 Luminous flux output	Manufacturers may list the luminous flux at the nominal voltage rather than the standard operating voltage, which can be more representative of typical service levels.
4.2.5.4 Light distribution characteristics	Peak illuminance at a specified distance is often advertised in lieu of luminous flux. It is important to carefully adjust the test result to match the distance specified in the advertised value using known light propagation relationships ("inverse square law").
4.2.3.1 Water protection – enclosure 4.2.3.2 Water protection – circuit protection and drainage	Ensure that there is no information that misleads consumers about the level of protection afforded them by the combination of the enclosure and other water protection systems.
4.2.6.1 Lumen maintenance (LED) 4.2.6.2 Cycle life (fluorescent)	Lifetime is often given in lieu of lumen maintenance, and the advertised lifetime is often much longer than the duration of the lumen maintenance or cycle life test (e.g. 20 000 h for some LEDs). Except in cases where the lifetime is less than the duration of the test, the advertised lifetime cannot be directly compared to the results of these tests.

5.4.4.3 Safety and durability

5.4.4.3.1 General

Safety and durability criteria protect the user from harm and the product from early failure during typical use. It is important to balance the safety and durability requirements with cost implications and reasonable expectations of consumer care, or the safety and durability criteria risk being over-prescribed. It is helpful to consider the expected minimum product lifetime when determining durability-related criteria.

For pass/fail tests, tolerances for failure rates should be specified (see Table 10).

Table 10 – Safety and durability criteria for quality standards

Safety or durability criterion	Aspect(s) considered in assessment	Standard specification	Remarks
Level of water exposure protection (overall, technical, or enclosure-only)	4.2.3.1 Water protection – enclosure 4.2.3.2 Water protection – circuit protection and drainage 4.2.2.3 Packaging and user's manual information 4.2.7.1 Product and manufacturer information	The required level of water protection (see list below) and which aspects may contribute to protection. Levels of water protection: No protection Occasional rain Frequent rain Permanent outdoor exposure	The degree of protection should include consideration of product category and expected exposure. Specify the aspects that may contribute to the level of water exposure protection by choosing an overall, technical, or enclosure-only criterion.
Physical ingress protection	4.2.3.3 Physical ingress protection	The required level of physical ingress protection in terms of the minimum IP Class.	Degree of protection should include consideration of product category and expected exposure. Also, consider how connectors will be incorporated. Most external power connectors are not protected above IP2x.
Mechanical durability – shipping vibration	4.2.3.4 Shipping vibration durability	The required success rates in the shipping vibration test for functionality and safety (two success rates).	Failure allowance should consider Boolean nature of results.
Mechanical durability – goosenecks	4.2.3.5 Gooseneck durability	The required success rates in the gooseneck durability test for functionality and safety (two success rates).	Only applies to products with goosenecks.
Mechanical durability – connectors	4.2.3.6 Connector durability	The required success rates in the connector test for functionality and safety (two success rates).	Failure allowance should consider Boolean nature of results.
Mechanical durability – switches	4.2.3.7 Switch durability	The required success rates in the switch test for functionality and safety (two success rates).	Failure allowance should consider Boolean nature of results.
Mechanical durability – strain relief	4.2.3.8 Strain relief durability	The required success rates in the switch test for functionality and safety (two success rates).	Failure allowance should consider Boolean nature of results.
Workmanship	4.2.3.9 Wiring quality	The required success rate for each aspect of the wiring quality inspection.	Failure allowance should consider the prevalence of each fault type.

Safety or durability criterion	Aspect(s) considered in assessment	Standard specification	Remarks
Operating input voltage range	4.2.4.1 Operating input voltage range	The required success rates for functionality and safety (two success rates). The operating voltage range and maximum allowable voltage for testing, if different from the recommendations in Table K.2.	Failure allowance should consider Boolean nature of results. Operating voltage range and maximum allowable voltage may be specified if known (for example, if the product specification is for a specific project) or if requirements differ from values in Table K.2.
Lumen maintenance	4.2.6.1 Lumen maintenance (LED)	The minimum average level of lumen maintenance after 2 000 h and the required success rate on a sample-to-sample basis.	Consider the expected rate of use and desired product lifetime.
Cycling durability	4.2.6.2 Cycle life (fluorescent)	The required success rate for functionality.	Failure allowance should consider Boolean nature of results.
Safety ratings	4.2.2.5 Other visual screening results 4.2.7 Self-declaration aspects	Any requirements for safety markings, certifications, or third-party testing.	Lighting appliances shall meet the safety requirements of IEC 60598-1 and IEC 60598-2-1 for class II luminaires suitable for mounting on a flammable surface.

5.4.4.3.2 Water exposure protection considerations

The specifying organization should consider several factors when establishing water exposure protection requirements for solar lighting products. The product category (as outlined in 4.1) is primarily responsible for determining these requirements, as some products are more likely than others to be exposed to water based on the product design. Cost is also a consideration, as products designed to be resistant to higher levels of water exposure are often more expensive because of the additional manufacturing costs associated with sealing the enclosure or internal circuit elements.

Table 11 describes how various levels of water protection are determined based on a combination of laboratory test results, product design and manufacturing information, and consumer information. The levels of protection are the following:

- no protection;
- occasional rain;
- frequent rain;
- permanent outdoor exposure.

The results of an assessment will include several “types” of water protection level. A quality standard will need to specify which type is applicable. The types are the following:

- Overall protection: water protection by all the potential sources, including user behaviour.
- Technical protection: protection from all product design and manufacturing aspects.
- Enclosure-only protection: protection from the enclosure only.

Table 11 – Recommended level of water protection by product category

Product category	Recommended level of water protection	Remarks
Indoor only	No protection	Products intended for indoor use only are unlikely to be exposed to water and do not require water protection.
Indoor/outdoor	Frequent rain	Products that may be used outdoors, but may also be used indoors, are likely to be exposed to water when used outdoors and should have good water exposure protection.
Outdoor only	Permanent outdoor exposure	Outdoor-only products (e.g. security lights) are certain to be exposed to rain and should have a high degree of water exposure protection.

5.4.4.4 Power quality criteria for AC systems

LED and fluorescent lights often include electronic ballasts or drivers, which can have low power factors and can introduce harmonic currents into an AC power system. Especially when lighting is a large proportion of the total load on the power system, products with low power factor can result in inefficient utilization of generation capacity, while excessive harmonic currents can reduce the efficiency and lifetime of power distribution system components (e.g. transformers and generators) and can introduce distortion in the system voltage waveform, negatively affecting other devices connected to the power system. Power quality criteria (Table 12) should be established to avoid these impacts. As with safety and durability, the specifying organization should balance the power quality requirements with the cost implications, considering the intended applications, if known, of the products under test. For example, products intended for use in hospitals may require stronger power quality criteria than those for use in residences.

Table 12 – Power quality criteria for quality standards

Power quality criterion	Aspect(s) considered in assessment	Standard specification	Remarks
Power factor	4.2.4.3 Power factor	Minimum acceptable value	Applies to AC products only.
Current total harmonic distortion	4.2.4.4 Current total harmonic distortion (THD)	Maximum acceptable value	Applies to AC products only.

5.4.4.5 End-user support

End-user support criteria describe the information (labelling, instructions, and built-in indicators) that enables end-users to maintain and fully realize the potential of a device (Table 13).

Table 13 – End-user support criteria for quality standards

End user support criterion	Aspect(s) considered in assessment	Standard specification	Remarks
Information on product design, utilization, and care	4.2.2.3 Packaging and user's manual information	Requirements for end-user information.	Define if there are requirements for consumer-facing information on packaging or in a user's manual**. This may be more appropriate for specific, targeted programmes than general market support or market offerings, since it is unlikely that a broad set of products will be available that meet any particular set of guidelines.** In some cases, a specific piece of information may have implications for the required level of quality in another criterion (e.g. advising the user to protect the device from exposure to water on the packaging or in the user's manual may warrant a reduction in the requirements for water protection defined by 4.2.3.1 and 4.2.3.2)
Other	4.2.2.5 Other visual screening results	Requirements for particular aspects of the visual screening.	Define if there are requirements for other aspects of end-user support (e.g. indicator lights). As with requirements for consumer-facing information, these requirements should be added with care to avoid over-prescribing.

5.4.5 Warranty requirements criteria

Warranty requirements are generally narrow in scope, focusing on the minimum duration and coverage for product warranties. In situations where there is a specific need for service in a particular location, service capabilities may be added to the warranty requirements. Table 14 lists criteria that are included in a warranty standard.

Table 14 – Criteria for warranty standards

End user support criterion	Aspect(s) considered in assessment	Standard specification	Remarks
Maintenance and warranty terms	4.2.2.4 Warranty information	Minimum warranty duration and coverage.	Define the minimum warranty terms with consideration for the implications on availability of service and reasonable expectations for guaranteed lifetime.
Service capabilities	4.2.7.2 Warranty coverage	Minimum availability of service to end-users in a particular location	These requirements typically should be specifically tailored to each location.

5.4.6 Performance criteria

5.4.6.1 General

Subclause 5.4.6 describes aspects that are appropriate for use as performance criteria and gives guidance on implementing a set of performance criteria.

There are several categories of performance criteria listed below. For each category, it is important for a set of performance criteria to specify the following information:

- the level of performance that is acceptable for each aspect;
- the number of product settings that shall meet the criteria;

NOTE It is generally appropriate to set performance criteria that should be met by one setting or more, but allow flexibility for the remaining settings.

- the product categories which are subject to each criterion if there are differences across categories.

5.4.6.2 Lighting service targets

Lighting service levels determine the usefulness of a device for particular activities.

It may be important to consider the form factor (i.e. task, ambient, etc.) of the product or the needs of a particular target set of users (in the case of a targeted project) when setting lighting service level requirements (Table 15).

Table 15 – Lighting service criteria for performance assessment

Lighting service criterion	Aspect(s) considered in assessment	Target specification	Remarks
General illumination service	4.2.5.1 Luminous flux output	Minimum luminous flux.	Set the target high enough to meet general illumination needs, considering the affordability trade-offs and the size of spaces typically lit in off-grid households.
Luminous efficacy	4.2.5.2 Luminous efficacy	Minimum luminous efficacy.	Set the target high enough to ensure that poor-quality products are not included, considering the affordability trade-offs and the efficacy losses associated with measures to reduce glare and other measures to improve user comfort.
Other illumination requirements	Various	Minimum levels or acceptable ranges for colour rendering, colour temperature, light distribution and luminance characteristics.	Acceptable levels or ranges need to consider preferences and requirements of the intended users.
Usability requirements	Various	Maximum levels or acceptable methods of flicker, warm-up, and glare mitigation.	Acceptable levels or methods need to consider preferences and requirements of the intended users.

Table 16 lists some benchmarks for lighting service requirements that may be helpful for setting performance criteria.

Table 16 – Lighting service benchmarks

Service type / context	Service level	Remarks and source
General illumination expectations in off-grid India	25 lm / 40 lux	A set of focus groups in 2013 across several regions of India established that 25 lm is generally favourable for a variety of end-users in terms of meeting their expectations (Lighting Asia).
General illumination expectations in off-grid Sub-Saharan Africa	20 lm / 45 lux	A set of focus groups in 2010–2011 across five countries in Sub-Saharan Africa established that 20 lm is generally favourable for a variety of end-users in terms of meeting their expectations (Lighting Africa).
General illumination from typical fuel based lighting	10 lm to 30 lm	Unpressurized fuel based lighting (candles, "wick" lamps, and hurricane lamps) provide a range of lighting service from 10 lm to 30 lm.
General illumination from a 60 W incandescent light bulb (or 15 W CFL)	900 lm	This is representative of typical minimum lighting service levels in grid-connected homes and businesses.
Reading (children in off-grid village)	25 lux	This is based on a review of lighting needs in Nepali villages. (Bhusal et al 2007 doi: 10.1582/LEUKOS.2007.03.04.003).
General illumination in public buildings (industrialized country standards)	100 lux to 700 lux	From a review of lighting standards (Mills, E. and N. Borg, 1999. Trends in Recommended Illuminance Levels: An International Comparison Journal of the Illuminating Engineering Society, Winter 1999)
General detail-oriented work (industrialized country standards)	1 000 lux	From a review of lighting standards (Mills and Borg 1999)

Further, the following notes provide some guidance on choosing an appropriate luminous efficacy. The efficacy for LED products can be measured for an individual LED lamp or for a complete lighting system. The numerical value of the efficacy measurement will reflect the various efficiencies of the components included in the test, and while a high efficacy number is a good measure of the lighting value of the product it is not the only measure of quality.

Today's lighting technology is capable of producing LEDs with component efficacy (i.e. the efficacy of the individual LEDs) of more than 150 lm/W. The electrical losses of the LED driver and other electronics in a complete lighting system, combined with optical losses from lenses and diffusers, will result in a system efficacy well below this value. Diffusers, for example, are less efficient than transparent optics but may be preferable in applications where user comfort and glare control are considered important. LED products with system efficacy of more than 40 lm/W are generally acceptable, particularly where the optics have a strong influence on the appearance of the light. As LED technology continues to improve, system efficacy is also likely to improve and higher efficacy requirements may become appropriate.

CFL technology is capable of producing CFL lamps with lamp efficacy (i.e. the efficacy of the CFL bulb and ballast) of more than 70 lm/W. Low quality CFLs have efficacies less than 40 lm/W. If lamp shades or optics are included in this measurement the efficacy will be lower, though CFLs do not emit concentrated light and so do not require as much glare control as LEDs.

6 Quality test method (QTM)

6.1 General

The quality test method (QTM) is a rigorous set of tests with a relatively large sample size that uses randomly procured samples. It is the most stringent set of tests in this part of IEC 62257 and is appropriate for the following purposes:

- qualification for market support programmes;
- generating information for third-party verified specification sheets.

6.2 Applications

QTM tests can support a broad range of quality assurance needs where rigorous, unbiased test results are required. Table 17 lists examples of how they are applied depending on the type of quality assurance framework.

Table 17 – Applications of product specifications

Type of QA framework	Example(s) of applying Clause 6
General market support	Require QTM results to qualify for market support. Accept QTM results from any accredited laboratory. Use QTM results to produce standardized specification sheets.
Manufacturing/distribution	Use QTM results to assess the full production/supply chain. Require QTM results for assessing potential business partners. Accept QTM results from any accredited laboratory.
Bulk procurement	Require QTM results for assessing potential suppliers. Accept QTM results from any accredited laboratory.
Trade regulation	Require QTM results to qualify for tax exemption. Accept QTM results from any accredited laboratory.

6.3 Sampling requirements

The product samples should be selected and shipped to the test laboratory according to the random sampling guidelines outlined in Annex D. The recommended number of samples to procure for QTM testing is 18.

6.4 Laboratory requirements

The test laboratory should be properly trained to undertake the test methods described below and accredited by an international or national standards body (e.g. the International Laboratory Accreditation Corporation [ILAC] using ISO/IEC 17025). The measurement equipment should be calibrated against reference instruments annually, or as directed by the equipment manufacturer or laboratory accreditation organization.

6.5 Testing requirements

Each of the aspects listed in Table 18 should be measured where they are applicable to a product. It is not necessary that each aspect be measured on each sample under test, but it is important to note in the test results which samples were the source of each result in an unambiguous way. A general description of the test method family for each aspect is listed for informative purposes only.

For products with multiple settings, at least one set of test results should fully characterize the performance on the highest light output setting. At least one other set of test results should characterize a setting with lower output. Additional settings may be measured at the discretion of the test laboratory.

Table 18 – QTM testing requirements *(1 of 2)*

Aspect	Reference	Applicability	Sample size	Test classes	Test method family
Product design, manufacture, and marketing aspects	4.2.2				
Arrangement of components	4.2.2.1	All products	1	A	Visual screening
Lighting system information	4.2.2.2	All products	1	A	Visual screening
Packaging and user's manual information	4.2.2.3	All products	1	A	Visual screening
Warranty information	4.2.2.4	All products	1	A	Visual screening
Other visual screening results	4.2.2.5	All products	6	A	Visual screening
Product durability and workmanship aspects	4.2.3				
Water protection – enclosure	4.2.3.1	All products	1	A,B	IP class assessment
Water protection – circuit protection and drainage	4.2.3.2	At the request of the testing client	1	A	n/a
Physical ingress protection	4.2.3.3	All products	1	A,B	IP class assessment
Shipping vibration durability [a]	4.2.3.4	All products (if required by programme)	6	A	Durability
Gooseneck durability	4.2.3.5	Products with a gooseneck	6	A	Durability
Connector durability	4.2.3.6	Products with connectors	6	A	Durability
Switch durability	4.2.3.7	Products with switches	6	A	Durability
Strain relief durability	4.2.3.8	Products with cords	6	A	Durability
Wiring quality	4.2.3.9	All products	6	A	Visual screening
Electrical characteristics	4.2.4				
Operating input voltage range	4.2.4.1	All products	6	A	Input voltage range
Power consumption	4.2.4.2	All products	6	A	Power consumption and power quality
Power factor	4.2.4.3	All AC products	6	A	Power consumption and power quality
Current total harmonic distortion	4.2.4.4	All AC products	6	A	Power consumption and power quality

Table 18 *(2 of 2)*

Aspect	Reference	Applicability	Sample size	Test classes	Test method family
Photometric performance measures	4.2.5				
Luminous flux output	4.2.5.1	All products	6	A	Luminous flux
Luminous efficacy	4.2.5.2	All products	6	A	Luminous flux
Full width half maximum (FWHM) angles	4.2.5.3	All products	6	A	Light distribution
Light distribution characteristics	4.2.5.4	All products	6	A	Light distribution
Colour characteristics	4.2.5.5	All products	6	A	Luminous flux
Photometric durability measures	4.2.6				
Lumen maintenance	4.2.6.1	LED products	6	A	Lumen maintenance
Cycle life	4.2.6.2	Fluorescent products	6	A	Cycle life
Self-declaration aspects	4.2.7				
Product and manufacturer information	4.2.7.1	All products	n/a	A	Self-reported
Warranty coverage	4.2.7.2	As required by programme	n/a	A	Self-reported
Third-party marks and certifications	4.2.7.3	All products	n/a	A	Self-reported

[a] The shipping vibration test may add significant cost to the test programme, depending on the capabilities of the test laboratory. The costs and benefits of this testing should be weighed carefully when deciding whether to include a shipping vibration durability requirement in the product specification.

6.6 Recommended test programme

6.6.1 General

6.6.1.1 Overview

The following programme is one strategy to accomplish all the tests in a timely manner. Figure 2 illustrates the recommended flow for the programme of tests.

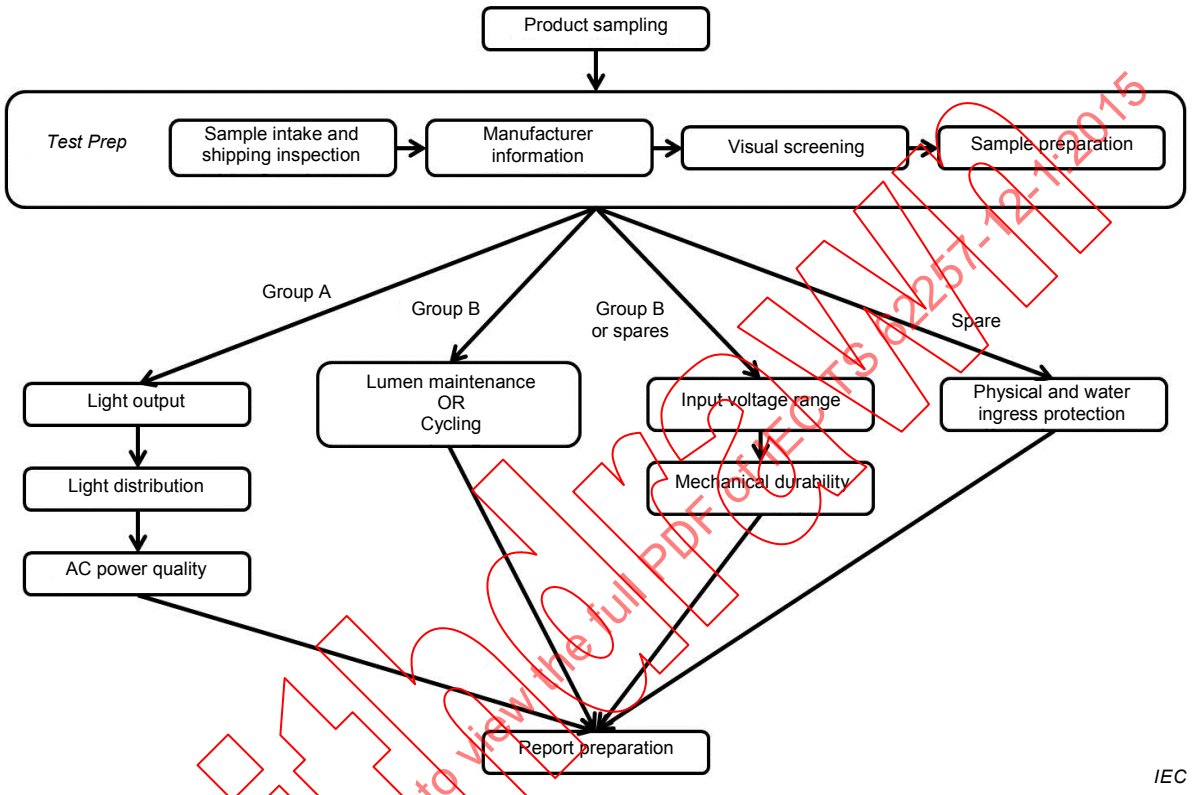


Figure 2 – Recommended sequence of testing for QTM

6.6.1.2 Product sampling

Samples are randomly procured in the supply chain or market and shipped to the test centre. The product sampling procedure is presented in Annex D.

6.6.1.3 Test preparation

6.6.1.3.1 General

The initial intake steps involve ensuring the samples are intact, preparing them for further tests, and requesting self-reported information from the manufacturer.

6.6.1.3.2 Test sample intake and shipping inspection

The samples should all be inspected for shipping damage, unambiguously labelled for identification during the testing process, and placed into batches.

6.6.1.3.3 Manufacturer self-reported information

If it has not already been done, the manufacturer (or their proxy) should be contacted to ask for self-reported information that is outlined in Annex C and to inform them the test samples were received.

6.6.1.3.4 Visual screening

The visual screening should be done before any other tests and before the samples are altered to prepare them for other tests. The visual screening procedure is presented in Annex F.

6.6.1.3.5 Sample preparation

After the visual screening, prepare the samples for further testing, following the procedures in Annex G. All samples, except for spares, shall be prepared.

6.6.1.4 Group A tests

6.6.1.4.1 General

6.6.1.4.2 Light output test

The light output test is not strictly on components, but of a system including a driver, light source, and optical components. The light output test procedure is presented in Annex I.

6.6.1.4.3 Light distribution test

Like the light output test, the light distribution test is not strictly on components, but of a system including a driver, light source, and optical components. The light distribution test procedure is presented in Annex J.

6.6.1.4.4 Power consumption and power quality

The power consumption and power quality test is performed on all products; there are different versions of the test for DC and AC products. The power consumption and power quality test procedure is presented in Annex P.

6.6.1.5 Group B tests

6.6.1.5.1 General

Group B undergoes long-term lumen maintenance or cycling testing in parallel with Group A testing. The Group B samples shall not have undergone any other testing prior to lumen maintenance or cycling testing.

6.6.1.5.2 Lumen maintenance test

The lumen maintenance test shall only be conducted on LED-based lamps and lighting appliances. The lumen maintenance test procedure is presented in Annex L.

6.6.1.5.3 Cycling test

The cycling test shall only be conducted on fluorescent-based lamps and lighting appliances. The cycling test procedure is presented in Annex M.

6.6.1.6 Group C / potentially destructive tests

6.6.1.6.1 General

In general it is best to save destructive testing to the end of the test programme to ensure sufficient samples are available in other tests. These tests may be performed on spare samples or Group A or B samples that have finished all other testing.

6.6.1.6.2 Input voltage range test

The input voltage range test assesses a product's ability to operate properly and safely over a range of input voltages. The input voltage range procedure is presented in Annex K.

6.6.1.6.3 Mechanical durability test

It is preferable to do durability testing (switches, connectors, gooseneck, and vibration tests) on the spare samples that have not been altered for testing. However, it is often infeasible to accomplish this if the unadulterated spares are required for other tests. In this case, the least modified samples from Group A or Group B should be used. The mechanical durability test procedure is presented in Annex N.

6.6.1.6.4 Physical and water ingress protection test

Physical and water ingress protection shall be assessed on a sample that has the least amount of impact or adulteration from the testing process. Unused spares should be the preferred samples for this assessment. The physical and water ingress protection test procedure is presented in Annex O.

6.6.1.7 Report preparation

After testing is complete and the results are validated, a report is generated and checked for accuracy before submission to the client.

6.6.2 Reporting

The report for QTM testing should support any activities that depend on the information from QTM testing.

At a minimum the report should include the following elements:

a) informative cover page;

b) summary test results page(s);

c) detailed test reports that include results for the aspects described in 6.5 that were measured at the primary test laboratory;

d) detailed test reports for tests performed at other laboratories (e.g. ingress protection test results done at a specialty IP test laboratory);

e) annexes that include supplementary images and/or other supporting information;

f) annexes that indicate manufacturer-provided information and self-reported evidence (e.g. certificates of compliance).

7 Market check method (MCM)

7.1 General

The market check method (MCM) is a flexible set of tests that is designed for market monitoring and enforcement. The MCM may comprise all the QTM tests, or a targeted subset of the QTM tests. The tests are designed for use in the following situations:

- when a programme wants to monitor the ongoing quality and performance of previously tested products;
- when there is suspicion that products on the market are substandard compared to those that were originally tested for programme qualification or the production of a standardized specification sheet;
- when a product is partially updated and an update is required for a standardized specification sheet.

MCM testing may be implemented as a two-stage process. In the first stage, which is referred to as Primary Check Testing, the QTM (Clause 6) is used with a sample size between two and six. If results from these tests meet or exceed performance from prior QTM testing, no further action is required. However, if the results indicate possible deficiencies relative to the quality standards and/or prior QTM test results, additional testing may be used to confirm the problem. This subsequent testing, which is referred to as Secondary Check Testing, will focus only on the aspects of the product that appeared to have deficiencies according to the Primary Check Testing results. The required sample size and allowable test classes for Secondary Check Testing using the MCM should be the same as those required for QTM testing of the same aspect (see 6.5, Table 18).

Alternatively, if a product is partially updated or only suspected to be substandard in particular aspects, a programme may choose to forego the first stage of Primary Check Testing and conduct targeted Secondary Check Testing on only those aspects.

7.2 Applications

MCM tests may have a narrower focus than QTM results – they can be targeted for determining if a deviation has occurred from previous QTM results for particular aspects. Table 19 lists examples of how MCM tests are applied depending on the type of quality assurance framework.

Table 19 – Applications of MCM results

Type of QA framework	Example(s) of applying MCM testing
General market support	Use MCM results for market monitoring and enforcement. Use MCM results to update standardized specification sheets. Use MCM results to renew QTM test results.
Manufacturing / distribution	Use MCM results for market monitoring.
Bulk procurement	N/A
Trade regulation	Use MCM results for market monitoring and enforcement.

7.3 Sampling requirements

The test samples should be randomly procured from retail outlets in the market according to procedures in Annex D. In select cases, at the discretion of the organization that is managing the market check testing, it may be appropriate to accept samples randomly sampled from a manufacturer's warehouse according to procedures in Annex D.

Enough samples should be provided or selected so it is possible to complete the tests in a timely manner and account for unforeseen needs of additional samples.

The recommended number of samples for Primary Check Testing is six: two per batch plus two spares. The recommended number of samples for Secondary Check Testing will depend on the aspects under test, but may be up to 18: six per batch plus adequate spares.

7.4 Laboratory requirements

The test laboratory should be properly trained to undertake the test methods described below and accredited by an international or national standards body (e.g. ILAC using ISO/IEC 17025). The measurement equipment should be calibrated against reference instruments annually, or as directed by the equipment manufacturer or laboratory accreditation organization.

7.5 Testing requirements

Each of the aspects listed in Table 20 should be measured where they are applicable to a product. It is not necessary that each aspect be measured on each sample under test, but it is important to note in the test results which samples were the source of each result in an unambiguous way. A general description of the test method family for each aspect is listed for informative purposes only.

For products with multiple settings, at least one set of test results should fully characterize the performance on the highest light output setting. At least one other set of test results should characterize a setting with lower output. Additional settings may be measured at the discretion of the test laboratory.

Table 20 – MCM testing requirements *(1 of 2)*

Aspect	Reference	Applicability	Sample size	Test classes	Test method family
Product design, manufacture, and marketing aspects	4.2.2				
Arrangement of components	4.2.2.1	All products	1	A	Visual screening
Lighting system information	4.2.2.2	All products	1	A	Visual screening
Packaging and user's manual information	4.2.2.3	All products	1	A	Visual screening
Warranty information	4.2.2.4	All products	1	A	Visual screening
Other visual screening results	4.2.2.5	All products	2	A	Visual screening
Product durability and workmanship aspects	4.2.3				
Water protection – enclosure	4.2.3.1	All products	1	A,B	IP class assessment
Water protection – circuit protection and drainage	4.2.3.2	At the request of the testing client	1	A	n/a
Physical ingress protection	4.2.3.3	All products	1	A,B	IP class assessment
Shipping vibration durability [a]	4.2.3.4	As required by programme	2	A	Durability
Gooseneck durability	4.2.3.5	Products with a gooseneck	2	A	Durability
Connector durability	4.2.3.6	Products with connectors	2	A	Durability
Switch durability	4.2.3.7	Products with switches	2	A	Durability
Strain relief durability	4.2.3.8	Products with cords	2	A	Durability
Wiring quality	4.2.3.9	All products	2	A	Visual screening

Table 20 *(2 of 2)*

Aspect	Reference	Applicability	Sample size	Test classes	Test method family
Electrical characteristics	4.2.4				
Operating input voltage range	4.2.4.1	All products	2	A	Input voltage range
Power consumption	4.2.4.2	All products	2	A	Power consumption and power quality
Power factor	4.2.4.3	All AC products	2	A	Power consumption and power quality
Current total harmonic distortion	4.2.4.4	All AC products	2	A	Power consumption and power quality
Photometric performance measures	4.2.5				
Luminous flux output	4.2.5.1	All products	2	A	Luminous flux
Luminous efficacy	4.2.5.2	All products	2	A	Luminous flux
Full width half maximum (FWHM) angles	4.2.5.3	All products	2	A	Light distribution
Light distribution characteristics	4.2.5.4	All products	2	A	Light distribution
Colour characteristics	4.2.5.5	All products	2	A	Luminous flux
Photometric durability measures	4.2.6				
Lumen maintenance	4.2.6.1	LED products	2	A	Lumen maintenance
Cycle life	4.2.6.2	Fluorescent products	2	A	Cycle life
Self-declaration aspects	4.2.7				
Product and manufacturer information	4.2.7.1	All products	n/a	A	Self-reported
Warranty coverage	4.2.7.2	As required by programme	n/a	A	Self-reported
Third-party marks and certifications	4.2.7.3	All products	n/a	A	Self-reported

[a] The shipping vibration test may add significant cost to the test programme, depending on the capabilities of the test laboratory. The costs and benefits of this testing should be weighed carefully when deciding whether to include a shipping vibration durability requirement in the product specification.

7.6 Recommended tests programme

See 6.6.

7.7 Report requirements

The report for MCM testing should support any activities that depend on the information from MCM testing.

At a minimum, the report should include the following elements:

a) informative cover page;
b) table of contents;
c) summary test results page(s);
d) detailed test reports that include results for the aspects described in 7.5;
e) annexes that include images and other supporting information;
f) annexes that indicate manufacturer-provided information and self-reported evidence (e.g. certificates of compliance).

Annex A
(informative)

Example quality standards and performance criteria for off-grid lighting market support programme qualification

A.1 Overview

These quality standards, warranty requirements, and performance criteria are appropriate for qualification for market support programmes that support energy access for broad sets of end-users with low to middle incomes who are off-grid in the developing world.

The target end-users are typically cash-poor and will be expected to purchase qualifying products outright or under financing terms.

This is a bi-level qualification document. Meeting only the quality standards and warranty requirements provides access to basic programme services and incentives. Extended services and incentives are available if the performance criteria are met.

The aim of these quality standards is to protect end-users from early failure and ensure that advertised information is valid. The warranty requirements provide a baseline of support. The goal of the performance criteria is to ensure users receive service levels that are at least as good as the incumbent technology – fuel based lighting.

NOTE This product specification is meant to be an informative example, with a structure and set of standards and performance criteria based on experience in a particular context. It is expected that programmes that reference this part of IEC 62257 will tailor a product specification to meet their needs.

A.2 Test requirements

Initial qualification under these standards and performance criteria requires QTM test results (Clause 6). Ongoing qualification is subject to successful market checks according to the market check method (Clause 7). Full re-testing with QTM is required after two years.

A.3 Quality standards

The product shall meet each of the criteria listed in Table A.1, Table A.2, and Table A.3 to meet the quality standards.

Table A.1 – Truth-in-advertising tolerance

Truth-in-advertising criterion	Aspect(s) considered in assessment	Requirement
Performance tolerance – numeric ratings	4.2.5 Photometric performance measures Others, if applicable	≤15 % deviation from ratings (always ok if actual performance is better than advertised).
Other numeric ratings tolerance	Multiple	≤15 % deviation from ratings (always ok if actual performance is better than advertised).
Overall truth-in-advertising statement	Multiple	Any description of the product that appears on the packaging, inside the package, and in any other media shall be truthful and accurate. No statements shall mislead buyers or end users about the features or utility of the product.

Table A.2 – Safety and durability standards

Safety or durability criterion	Aspect(s) considered in assessment	Product category	Requirement
Overall water exposure protection	4.2.3.1 Water protection – enclosure 4.2.3.2 Water protection – circuit protection and drainage 4.2.7.1 Product and manufacturer information 4.2.2.3 Packaging and user's manual information	Indoor only	No protection required.
		Indoor/outdoor	Protection from occasional exposure to rain.
		Outdoor only	Protection from permanent outdoor exposure.
Physical ingress protection	4.2.3.3 Physical ingress protection	All except outdoor only	Minimum of IP 2x protection.
		Outdoor only	Minimum of IP 5x protection
Mechanical durability – shipping vibration [a]	4.2.3.4 Shipping vibration durability	All products as required by programme	Maximum failure rate for functionality is 1/6; none result in safety hazards.
Mechanical durability – goosenecks	4.2.3.5 Gooseneck durability	Any with gooseneck	Maximum failure rate for functionality is 1/6; none result in safety hazards.
Mechanical durability – connectors	4.2.3.6 Connector durability	All products	Maximum failure rate for functionality is 1/6; none result in safety hazards.
Mechanical durability – switches	4.2.3.7 Switch durability	All products	Maximum failure rate for functionality is 1/6; none result in safety hazards.
Mechanical durability – strain relief	4.2.3.8 Strain relief durability	All products	Maximum failure rate for functionality is 1/6; none result in safety hazards.
Workmanship	4.2.3.9 Wiring quality	All products	Maximum prevalence of bad solder joints is 1/6 samples; maximum prevalence of poor wiring is 1/6 samples; maximum prevalence of overall workmanship failure is 1/6.
Input voltage	4.2.4.1 Operating input voltage range	All products	Maximum failure rate for functionality is 1/6; none result in safety hazards.
Lumen maintenance	4.2.6.1 Lumen maintenance (LED)	All LED products	L_{85} time is greater than 2 000 h for the average sample. No more than 1/6 samples fails (defined as being more than 10 % below L_{85} at 2 000 h).
Cycling durability	4.2.6.2 Cycle life (fluorescent)	All CFL or fluorescent tube products	Maximum failure rate for functionality is 1/6.
Safety ratings	4.2.2.5 Other visual screening results 4.2.7 Self-declaration aspects	All AC products	Lighting appliances shall meet the safety requirements of IEC 60598-1 and IEC 60598-2-1 for class II luminaires suitable for mounting on a flammable surface.

[a] The shipping vibration test may add significant cost to the test programme, depending on the capabilities of the test laboratory. The costs and benefits of this testing should be weighed carefully when deciding whether to include a shipping vibration durability requirement in the product specification.

Table A.3 – Power quality standards for AC products

Power quality criterion	Aspect(s) considered in assessment	Product category (form factor and/or technology)	Requirement
Power factor	4.2.4.3 Power factor	All AC products	≥ 0,9
Current total harmonic distortion	4.2.4.4 Current total harmonic distortion (THD)	All AC products	≤ 20 % (relative to fundamental)

A.4 Warranty requirements

The product shall meet each of the criteria listed in Table A.4 to meet the warranty requirements.

Table A.4 – End-user support requirements

Support type	Aspect(s)	Requirement
Maintenance and warranty terms	4.2.2.4 Warranty information 4.2.7.2 Warranty coverage	End-users are provided at least 12 months of warranty coverage from the point of purchase; it shall cover manufacturing defects that impede operation under normal use and protection from early failure.

A.5 Performance criteria

In addition to meeting the quality standards, the product shall meet the luminous efficacy criteria and at least one other of the lighting service criteria listed in Table A.5 below to meet the performance criteria. The tolerance for all performance criteria is as follows: The average DUT should be no worse than 10 % below the target. No DUT should fall more than 20 % below the target.

Table A.5 – Lighting service criteria for performance assessment

Light output criterion	Aspect(s)	Requirement
General illumination service	4.2.5.1 Luminous flux output	≥ 25 lm
Luminous efficacy	4.2.5.2 Luminous efficacy	≥ 40 lm/W
Task lighting service	4.2.5.4 Light distribution characteristics	≥ 0,1 m^2 area of illumination ≥ 50 lux when the lamp or lighting appliance is self-supported on the task surface or suspended from a 0,75 m distance from the surface.

Annex B
(informative)

Example quality standards, warranty requirements, and performance criteria for bulk procurement qualification (“sample tender”)

B.1 Overview

These quality standards, warranty requirements, and performance criteria are appropriate for qualification to provide products for a bulk procurement programme where products will be offered to end-users at a substantially discounted rate.

Products with LED light points qualify for this procurement.

B.2 Test requirements

Qualification requires QTM test results (Clause 6).

The test results and/or other information should be presented for each of the criteria listed in the quality standards, warranty requirements, and performance criteria in support of the offer.

B.3 Product category requirements

This document applies to indoor, indoor/outdoor, and outdoor only LED products.

B.4 Quality standards

The product shall meet each of the criteria listed in Table B.1, Table B.2, and Table B.3.

Table B.1 – Truth-in-advertising tolerance

Truth-in-advertising criterion	Aspect(s) considered in assessment	Requirement
System performance tolerance – numeric ratings	4.2.5 Photometric performance measures Others, if applicable	≤ 15 % deviation from ratings.
Other numeric ratings tolerance	Multiple	≤ 15 % deviation from ratings.
Overall truth-in-advertising statement	Multiple	Any description of the product that appears on the packaging, inside the package, and in any other media shall be truthful and accurate. No statements shall mislead buyers or end users about the features or utility of the product.

Table B.2 – Safety and durability standards

Safety or durability criterion	Aspect(s) considered in assessment	Product category	Requirement
Overall water exposure protection	4.2.3.1 Water protection – enclosure 4.2.3.2 Water protection – circuit protection and drainage 4.2.7.1 Product and manufacturer information 4.2.2.3 Packaging and user's manual information	Indoor only	No protection required.
		Indoor/outdoor	Protection from occasional exposure to rain.
		Outdoor only	Protection from permanent outdoor exposure.
Physical ingress protection	4.2.3.3 Physical ingress protection	All except outdoor only	Minimum of IP 2x protection.
		Outdoor only	Minimum of IP 5x protection
Mechanical durability – shipping vibration [a]	4.2.3.4 Shipping vibration durability	All products as required by programme	Maximum failure rate for functionality is 1/6; none result in safety hazards.
Mechanical durability – goosenecks	4.2.3.5 Gooseneck durability	Any with gooseneck	Maximum failure rate for functionality is 1/6; none result in safety hazards.
Mechanical durability – connectors	4.2.3.6 Connector durability	All products	Maximum failure rate for functionality is 1/6; none result in safety hazards.
Mechanical durability – switches	4.2.3.7 Switch durability	All products	Maximum failure rate for functionality is 1/6; none result in safety hazards.
Mechanical durability – strain relief	4.2.3.8 Strain relief durability	All products	Maximum failure rate for functionality is 1/6; none result in safety hazards.
Workmanship	4.2.3.9 Wiring quality	All products	Maximum prevalence of bad solder joints is 1/6 samples; maximum prevalence of poor wiring is 1/6 samples; maximum prevalence of overall workmanship failure is 1/6.
Input voltage	4.2.4.1 Operating input voltage range	All products	Maximum failure rate for functionality is 1/6; none result in safety hazards.
Lumen maintenance	4.2.6.1 Lumen maintenance (LED)	All LED products	L_{85} time is greater than 2 000 h for the average sample. No more than 1/6 samples fails (defined as being more than 10 % below L_{85} at 2 000 h).
Cycling durability	4.2.6.2 Cycle life (fluorescent)	All CFL or fluorescent tube products	Maximum failure rate for functionality is 1/6.
Safety ratings	4.2.2.5 Other visual screening results 4.2.7 Self-declaration aspects	All AC products	Lighting appliances shall meet the safety requirements of IEC 60598-1 and IEC 60598-2-1 for class II luminaires suitable for mounting on a flammable surface.

[a] The shipping vibration test may add significant cost to the test programme, depending on the capabilities of the test laboratory. The costs and benefits of this testing should be weighed carefully when deciding whether to include a shipping vibration durability requirement in the product specification.

Table B.3 – Power quality standards for AC products

Power quality criterion	Aspect(s) considered in assessment	Product category (form factor and/or technology)	Requirement
Power factor	4.2.4.3 Power factor	All AC products	≥ 0,9
Current total harmonic distortion	4.2.4.4 Current total harmonic distortion (THD)	All AC products	≤ 20 % (relative to fundamental)

B.5 Warranty requirements

The product shall meet each of the criteria listed in Table B.4.

Table B.4 – End-user support requirements

Support type	Aspect(s)	Requirement
Maintenance and warranty terms	4.2.2.4 Warranty information 4.2.7.2 Warranty coverage	End-users are provided at least 12 months of warranty coverage from the point of purchase; it should cover manufacturing defects that impede operation under normal use.

B.6 Performance criteria

The product shall have a luminous efficacy of at least 40 lm/W and meet at least one of the lighting service criteria listed in Table B.5 below to meet the performance criteria.

Table B.5 – Lighting service criteria for performance assessment

Light output criterion	Aspect(s)	Requirement
General illumination service	4.2.5.1 Luminous flux output	≥ 25 lm
Task lighting service	4.2.5.4 Light distribution characteristics	≥ 0,1 m^2 area of illumination ≥ 50 lux when the lamp or lighting appliance is self-supported on the task surface or suspended from a 0,75 m distance from the surface.

B.7 Performance criteria tolerance

The tolerance for all performance criteria is as follows: The average DUT should be no worse than 10 % below the target. No DUT should fall more than 20 % below the target.

Annex C
(normative)

Manufacturer self-reported information

C.1 Background

Having proper manufacturer information is important for communication throughout the testing process as well as for understanding key product information and any certifications the manufacturer's laboratory or product may have. To this end, there are three categories of self-reported information: manufacturer information, product information, and manufacturer self-declaration regarding either the manufacturing laboratory or product.

C.2 Outcomes

The manufacturer self-reported information outcomes are listed in Table C.1.

Table C.1 – Manufacturer self-reported information outcomes

Metric	Reporting units	Related aspects	Notes
Manufacturer information	Varied	4.2.7.1 Product and manufacturer information	Record all provided manufacturer information
Product information	Varied	4.2.7.1 Product and manufacturer information	Record all provided product information
Self-declaration information	Varied	4.2.7.3 Third-party marks and certifications	Record all manufacturer or product certifications

C.3 Solicited information

Follow the recommendations supplied in the manufacturer self-reported information procedure of IEC TS 62257-9-5. All of the information listed should be requested, with the following modifications.

a) The method in IEC TS 62257-9-5 is relevant for off-grid lighting products consisting of a light source, energy storage device, and energy generation device; therefore, any information listed in IEC TS 62257-9-5 that is not relevant for stand-alone off-grid lamps or lighting appliances shall not be requested.

b) The nominal drive voltage and operating voltage range for the stand-alone off-grid lamp or lighting appliances shall be requested, as this is key information for the test laboratory as well as the consumer.

Annex D
(normative)

Product sampling

D.1 Background

Proper product sampling is the first step in the testing process, and it is critical to maintaining the test method's fairness and credibility.

D.2 Test outcomes

The product sampling outcomes are listed in Table D.1.

Table D.1 – Product sampling outcomes

Metric	Reporting units	Related aspects	Remarks
Sample type	Retail/warehouse	n/a	--
Sample procurement agency	Agency name	n/a	The third-party agency that procures the samples
Sample procurement agent	Name	n/a	The name of the person that procures the samples
Sample procurement date	Date	n/a	--
Sample procurement address(es)	Address(es)	n/a	--
Sample shipping date	Date	n/a	The date the samples are shipped to the test lab(s) from the third-party sampling agency
Test lab(s)	Test lab name(s)	n/a	--
Test lab address(es)	Address(es)	n/a	--
Sample delivery date(s)	Date(s)	n/a	The date the samples are received by the test lab(s)

D.3 Related tests

Testing is predicated upon the product samples already being procured, shipped, and received at the test laboratory or laboratories.

D.4 Procedure

The product sampling procedures of IEC TS 62257-9-5 shall be used.

Annex E
(normative)

Power supply requirements for testing

E.1 Background

Several of the test procedures replace the system battery or other power source with a DC power supply, while others may require testing an AC system at a different operating frequency than is standard for the country where the tests occur. Electronic testing hardware shall be selected and configured so as to correctly simulate the electrical operating conditions that a DUT will experience in real world operation.

Examples of problems that can occur with electrical test configurations include the following:

- voltage drops from the resistance of test lead wires;
- electronic noise in the lead wires from either the DUT or the test environment;
- AC waveform harmonic distortion.

Some products will include wiring and/or wiring instructions that can help determine the specifics of a test setup. In these cases, the test operator should follow these directions as closely as possible to provide a test setup that will replicate the most common configuration of the DUT when placed in real world service.

E.2 Related tests

Annex E is related to Annex I (light output), Annex J (light distribution), Annex K (input voltage range), Annex L (lumen maintenance), Annex M (cycling), and to Annex P (power consumption and power quality).

E.3 Equipment requirements

E.3.1 DC systems

DC power supplies shall be capable of delivering stable, accurate DC inputs to the DUT. The power supply should have a voltage readout resolution of 0,01 V or smaller and a current readout resolution of 0,001 A or smaller. The voltage applied to the DUT shall be regulated to within 0,2 % of the readout value during photometric measurements and within 3 % for the duration of lumen maintenance tests. The current readout shall have an accuracy of ±1 % or better.

E.3.2 AC systems

AC systems shall be capable of providing the required test AC test voltages at the proper frequency (usually either 50 Hz or 60 Hz). For DUTs with the same AC operating frequency as the utility power available at the test laboratory, no frequency conversion is required, but a means to adjust the input voltage will be needed. For DUTs with a different AC operating frequency than the utility power available at the test laboratory, both frequency conversion and voltage adjustment will be necessary. AC voltages and frequencies can be controlled with the following equipment options.

- AC power supply or frequency converter: AC power supplies are available that can deliver regulated, variable AC voltage and frequency to the DUT. The AC power supply should be capable of accepting the test facility input power and delivering the required voltage, frequency, and current to the DUT. Most AC power supplies allow both voltage and frequency adjustment, while a few are built specifically to adjust only the output frequency.

- Variable transformer (variac) – Variable transformers convert an AC input voltage up or down. Most are coil wound transformers. Some include digital voltmeters and/or ammeters. Variable transformers are not capable of adjusting the frequency of the input power.
- Inverters – Battery-supplied inverters can be used to provide 50 Hz or 60 Hz output frequencies in situations where the test laboratory has a different frequency than the DUT. Pure sine wave inverters should be used unless the product specification specifically requires operation with modified sine wave or square wave inverters. A variable transformer may be needed to adjust the output voltage of the inverter; note that the load capacity of the transformer may need to be derated if the inverter produces a nonsinusoidal waveform. Deviations from a sinusoidal voltage waveform can have a significant effect on the results of the AC power quality test (Annex P).

The output voltage from the AC power supply equipment shall be measured with a device capable of performing a true rms voltage measurement with an accuracy of ±1,0 %. This functionality may be integrated into the power supply equipment, or a voltmeter, multimeter, or similar device may be used.

E.4 Reporting

The test report shall state the type of power supply used (e.g. DC power supply, AC true sine wave inverter, utility power) and the nominal voltage and frequency.

Annex F
(normative)

Visual screening

F.1 Background

The visual screening process covers DUT specifications, properties (such as external DUT measurements), functionality, observations, and internal/external construction quality.

The DUT's components, materials, and utilities are categorized and, in some cases, evaluated. This test provides a thorough qualitative and quantitative assessment of the DUT as received from the manufacturer and serves to uniquely identify a DUT. The DUT's operation out of the packaging is documented before any modifications are made for subsequent tests.

F.2 Test outcomes

The test outcomes of the visual screening process are listed in Table F.1.

Table F.1 – Visual screening test outcomes

Metric	Reporting units	Related aspects	Notes
DUT specifications	Varied	4.2.2 Design, manufacture, and marketing	Record all provided specifications
DUT information	Varied	4.2.2 Design, manufacture, and marketing 4.2.7.1 Product and manufacturer information	Record dimensions and qualitative descriptors
Internal DUT inspection	Varied	4.2.3 Durability and workmanship	Describe/document wiring and electronics fixtures
Internal DUT inspection	Number of defects	4.2.3 Durability and workmanship	Record the number of soldering and/or electronics quality defects

F.3 Related tests

Annex F is not related to any of the other annexes.

F.4 Procedure

F.4.1 Properties, features, and information

F.4.1.1 General

Relevant DUT information, such as external DUT measurements and observations, are recorded to capture the DUT's characteristics. Sufficient comments should be provided to thoroughly describe the DUT's characteristics. This part of the procedure may be completed on a single sample.

F.4.1.2 Equipment requirements

The following equipment is required:

- callipers and/or ruler;
- balance (scale);
- bright task light with good colour rendering (≥ 700 lux and ≥ 85 CRI recommended);
- camera.

F.4.1.3 Test prerequisites

The DUT should be new, unaltered, and in its original packaging. Read the DUT's box and documentation for instructions on using the DUT. Consult the manufacturer for missing information pertaining to the required observations.

F.4.1.4 Apparatus

The DUT may be positioned under a bright task light in the examination, if necessary.

F.4.1.5 Procedure

The following steps shall be followed.

a) Provide the following:
   1) Note all available manufacturer contact information (e.g. name, address, phone number, email, website, etc.).
   2) Photograph all sides of the DUT's retail box and describe the box's quality, if available.
   3) Note if a user's manual is included with the DUT. If so, report the type of manual it is (e.g. booklet, sheet, etc.), report the language(s) in which it is written, and photograph each page.
   4) If a warranty is available for the DUT, record the warranty duration, in months, describe the terms and conditions, and photograph the warranty material.
   5) Note and describe any instructions for proper disposal of the product.

b) Measure the following (in the specified units) without disassembling the DUT:
   1) Measure the DUT's mass, in grams (g), as it would typically be used in a lighting application (not including any external connectors), and indicate the specific components included in mass measurement.
   2) Measure and describe the length, in metres (m), of any cables connecting the light unit(s) to the power source.
   3) Measure the length, width, and height, in centimetres (cm), of the DUT's light unit(s) and any additional components or interconnected parts, separately.

c) Observe the following (consult the documentation for any explanations; see Clause 3 for details on the terminology in this subclause):
   1) Note the DUT's total number of unique lighting units, indicate the technology used in each (LED, linear fluorescent, or CFL), and provide a description and photographs of each.
   2) Note the number of light points in each lighting unit.
   3) Note the number of arrays contained in each light point (a group of LEDs that function as a single unit is an array).

      EXAMPLE For a light unit that contains 10 LEDs: if 5 LEDs illuminate for one DUT setting, and all 10 LEDs illuminate for the DUT's only other setting, this light unit contains two arrays (5-LED and 10-LED).

   4) Note the number of independent light sources (i.e. the total number of LEDs or other light source types) in each array.

5) Determine the number of DUT light output settings. Use the setting descriptions provided by the DUT's literature. If no setting descriptions are provided, use appropriate descriptions (e.g. high, medium, low, 1 high-power LED, 3 low-power LEDs, etc.).

6) Describe and photograph the arrangement of applicable components of the submitted product (i.e. lamps, lampholders, controller, etc.) in terms of housing/cases.

7) Describe the materials that compose the DUT's light units and/or any other housings (e.g. plastic, metal, glass, or other).

8) Note if the DUT has any indicators (e.g. low-voltage indicator) and, if so, include descriptions of indication meanings and photographs of the indicators.

9) Note and photograph any other features present on or included with the DUT (e.g. handles, mounting brackets, stands, etc.).

10) Describe and photograph any other included accessories or connectors not yet documented.

d) Note the DUT's primary form factor (luminaire, integrated LED lamp, non-integrated LED lamp, integrated compact fluorescent lamp, or other) and also note any secondary form factors. Use terms from Clause 3 where appropriate.

e) Note the DUT's expected use(s) (e.g. ambient light, task light, etc.).

f) Provide any general comments regarding the DUT's properties, features, and/or information.

F.4.2 Specifications

F.4.2.1 General

All relevant DUT specifications are recorded for later comparison in testing results. This part of the procedure may be completed on a single sample.

F.4.2.2 Equipment requirements

No equipment is required for this part of the visual screening procedure.

F.4.2.3 Test prerequisites

The DUT should be new, unaltered, and in its original packaging. Read the DUT's box and documentation for instructions on using the DUT. Consult the manufacturer for missing information pertaining to the required observations.

F.4.2.4 Apparatus

No apparatus is required for this part of the visual screening procedure.

F.4.2.5 Procedure

Examine the DUT's packaging, user's manual, and components for specifications. While obtaining the specifications, the DUT should not be opened or otherwise tampered with in any way. The internal inspection of F.4.3 may reveal more product specifications, which should be included with the specifications determined in this subclause and noted accordingly.

a) When provided, note the following specifications (in the specified units), indicate the source(s) of each, and comment on any specification discrepancies. Indicate if the specification is not provided but can be ascertained by observation (e.g. lamp type):

1) colour rendering index;

2) correlated colour temperature (K);

3) power consumption (W);

4) operation voltage and/or voltage range (V);

5) light source type (LED, integrated compact fluorescent, non-integrated compact fluorescent, linear fluorescent);

6) lamp driver (constant voltage source, constant current source, pulse width modulation, resistor, or specify other).

b) Where available, note any light output specifications, in lumens (lm), indicate the source(s) of each, the corresponding setting(s), and comment on any discrepancies.

F.4.3 Functionality and internal inspection

F.4.3.1 General

An internal inspection is performed to assess the electronics and soldering workmanship. The DUT may fail the inspection if poor internal workmanship inhibits the DUT from properly functioning. A functionality check is also performed to assess that the product properly functions upon receipt. This part of the procedure should be completed for every sample being tested.

F.4.3.2 Equipment requirements

The following equipment is required:

- bright task light with good colour rendering (≥ 700 lux and ≥ 85 CRI recommended);
- miscellaneous hand tools (screwdrivers, wrenches, etc.) to disassemble DUT;
- camera to document DUT characteristics with particular attention to potential points of failure (e.g. cold solder joints);
- DC voltmeter or multimeter for conducting basic electronic integrity and functionality tests (at least 0,5 % accuracy);
- DC power supply, for DUTs that accept DC power (see Annex E);
- AC power supply or frequency and/or voltage conversion equipment, if needed, for DUTs that accept AC power (see Annex E).

F.4.3.3 Test prerequisites

The DUT should be new, unaltered, and in its original packaging. Read the DUT's box and documentation for instructions on using the DUT. Consult the manufacturer for missing information pertaining to the required observations.

F.4.3.4 Apparatus

The DUT should be positioned under a bright task light for examination.

F.4.3.5 Procedure

The following steps shall be followed:

a) Check the DUT's functionality before disassembling:

1) Does the DUT work as described with provided documentation when powered at the DUT's nominal operating voltage?

2) Do all of the DUT's switches and connectors function as they should?

3) Comment on any faulty operation and provide photographs, if necessary.

b) Disassemble the DUT so the following internal observations may be made:

1) Indicate whether the DUT uses cable strain reliefs and, if so, which cables have strain reliefs. Document with photographs.

2) Inspect the electronic components' quality and workmanship. Note any poor solder joints, such as cold joints or joints with little solder. Document the workmanship with comments and photographs.

3) Indicate methods used to secure parts inside the DUT (e.g. screws, glue, tape, clamps/straps, or other) and document with photographs.
4) Indicate methods used for securing wire and cable connections (e.g. solder, harness, terminal junction, etc.) and document with photographs.
5) Note the DUT's overall internal workmanship quality. Document the internal workmanship with descriptions and photographs.

F.5 Reporting

Report the following in the visual screening test report.

- Metadata:
  - report name;
  - procedure(s) used;
  - DUT manufacturer;
  - DUT name;
  - DUT model number;
  - name of test laboratory;
  - approving person;
  - date of report approval.
- Manufacturer contact information (e.g. website, email address, phone number, etc.).
- Retail box description, if available.
- User's manual information:
  - included with DUT (yes/no);
  - type (e.g. booklet, pamphlet, sheet, etc.);
  - language;
  - comments.
- Warranty information, if available:
  - length (months);
  - description of terms and conditions.
- Proper disposal instructions information, if available.
- Complete DUT information (e.g. light units, etc.):
  - mass (g);
  - list of components included in mass measurement.
- DUT cable information:
  - length of all cables (m);
  - description of all cables.
- DUT component information:
  - length of each component (cm);
  - width of each component (cm);
  - height of each component (cm);
  - number of each component included with DUT;
  - description of each component.
- DUT lamp unit technology information:
  - type of each unique lamp unit variety (e.g. LED, CFL, linear fluorescent);

  - number of light points in each unique light unit variety;
  - number of arrays in each unique light unit variety;
  - description of each unique light unit variety's technology use.
- Description of DUT arrangement in expected typical use.
- DUT setting information:
  - name of all individual light output settings;
  - description of each individual light output setting.
- DUT materials information:
  - list of all materials used to construct each DUT component (e.g. glass, balsa wood, plastic, etc.);
  - description of all DUT construction materials.
- DUT indicators information:
  - list of all indicators present on each DUT component;
  - description of all DUT indicators.
- DUT features information:
  - list of all features present on each DUT component (e.g. handles, mounting brackets, stand, etc.);
  - description of all DUT features.
- DUT form factor and use information:
  - DUT's primary form factor (e.g. luminaire, integrated LED lamp, non-integrated LED lamp, integrated compact fluorescent lamp, etc.);
  - DUT's secondary form factor(s);
  - DUT's expected use(s) (e.g. ambient light, task light, etc.).
- Overall comments based on the visual inspection.
- Provided DUT specification information, if available:
  - colour rendering index and source of information;
  - correlated colour temperature and source of information;
  - power consumption and source of information;
  - operating voltage and source of information;
  - lamp type(s) and source of information;
  - lamp driver and source of information.
- Description of any provided DUT specification discrepancies.
- Provided light output (lm) for each setting and source of information.
- Description of any light output discrepancies.
- DUT functions out of box (yes/no).
- All switches and connectors function for each DUT sample with comments as necessary (yes/no).
- Description of cable strain relief methods used and for which connections, if applicable.
- Number of poor solder joints and workmanship deficiencies for each DUT sample with comments as necessary.
- Means (e.g. screws, glue, tape, etc.) used to secure parts in each DUT component (e.g. light unit(s), charge controller, photovoltaic module(s), etc.)
- General fixture of parts comments.
- Overall description of internal workmanship.

- Figures:
  - properties, features, and information photographs;
  - specifications photographs;
  - functionality and internal inspection photographs.

Annex G
(normative)

Sample preparation

G.1 Background

The product shall be prepared before starting the tests. The preparation includes making the input leads for powering the product accessible in order to facilitate powering the product with a laboratory power supply. Some DUTs may not require any alterations.

Wire lengths and conductor thickness may influence the operation and performance of the DUT in real-world conditions. Whenever practical, tests shall use all wires, connectors and other hardware included with the DUT and necessary for normal operation. Manufacturer instructions, when provided, should be followed in an attempt to replicate the recommended setup procedures and use of the product by an end user. Manufacturer-provided hardware and instructions should take precedence over procedures outlined here unless this would prevent safe testing of the device. In instances where modifications to original product equipment are required to allow testing or ensure personnel safety, the laboratory shall note these modifications in the test report.

When hardware or setup guidance is not provided by the manufacturer, the DUT shall be prepared and tested according to the instructions given here.

G.2 Test outcomes

There are no sample preparation outcomes.

G.3 Related tests

The sample preparation procedures shall be performed on all DUTs prior to conducting the light output test (Annex I), lumen maintenance test (Annex L), cycling test (Annex M), input voltage range test (Annex K), AC power quality test (Annex P), and light distribution test (Annex J).

G.4 Procedure

G.4.1 General

The DUT is rewired or fitted in order to supply a specified voltage to the input wire leads or terminals of the DUT during selected tests.

G.4.2 Equipment requirements

The following equipment may be required depending on the DUT:

- for DC-powered DUTs – wire (0,8 mm^2 ± 0,05 mm^2 conductor cross section) in two different colours;
- for AC-powered DUTs – appropriate plug with line, neutral, and earth connections;
- for AC-powered DUTs – wire (0,8 mm^2 ± 0,05 mm^2 conductor cross section) in three different colours;
- wire cutters;
- wire strippers;

- soldering iron and solder;
- heat-shrink tubing and heat gun, or electrical tape;
- screwdrivers and/or other appropriate tools for opening the DUT;
- may be required depending on the DUT – a drill with an appropriately sized drill bit to make a hole in the DUT's enclosure to fit the extension wires;
- for DC-powered bulb DUTs – appropriate lampholder with positive and negative leads accessible (e.g. E26);
- for AC-powered bulb DUTs – appropriate lampholder configured to plug into the DUT's specified grid voltage (e.g. E26);
- optional – connectors appropriate for the voltage and current (e.g. pin-and-socket connectors).

G.4.3 Test prerequisites

The DUT's visual screening shall be completed prior to performing the sample preparation procedures.

G.4.4 Procedure

The following steps shall be followed.

a) Determine the correct input power for the DUT and how the DUT is connected to a power source. If the DUT is supplied with setup instructions, follow these instructions where practical and use wires, lampholders, and connectors supplied with the DUT. Note any discrepancies between DUT instructions and test setup configurations in the test report.

b) If the DUT is an **integrated LED lamp or integrated CFL**, proceed with substeps 1) through 3) below; otherwise, proceed to step c).

   1) Obtain a lampholder or connector that is compatible with the DUT and rated for the DUT's specified power type (i.e. DC or AC, appropriate voltage and power rating).

   2) If the cable from the lampholder is shorter than 3 m, extend the wires from the lampholder to a length between 3 m and 5 m by attaching additional lengths of wire.

   3) When undergoing the lumen maintenance or cycling test, the lamp shall remain in the lampholder for the duration of the test; therefore, every sample undergoing the lumen maintenance or cycling test shall be fitted with a lampholder. Lampholders may be shared between samples when undergoing the light output and light distribution tests; only when the DUT requires power does it need to be in a lampholder.

c) If the DUT is a **luminaire and a power cable is extended from its enclosure,** proceed with substeps 1) and 2) below; otherwise, proceed to step d).

   1) If the power cable is at least 3 m long and the wire ends are bare, no DUT alterations are necessary.

   2) If the power cable is shorter than 3 m, extend the wires to a length between 3 m and 5 m by using an adapter with the appropriate mating connector or removing (cutting) the DUT connector and attaching additional lengths of wire. Note the modification details and final wire length in the test report.

d) If the DUT is a **luminaire and no power cable is extended from its enclosure**, proceed with substeps 1) through 3) below; otherwise, proceed to step e).

   1) If the DUT has external power terminals, insert extension wires (between 3 m and 5 m in length) into the appropriate terminal junctions.

   2) If no power input can be identified from outside the DUT, proceed with the following substeps; otherwise, proceed to step e).

      a) Open the DUT without incurring damage.

      b) Identify the positive and negative input terminals or leads for DC-powered DUTs, or the line, neutral, and earth input terminals or leads for AC-powered DUTs.

c) Make wire connections to the terminals or leads. The wires should be between 3 m and 5 m in length and preferably of two or three different colours. Cover any exposed wire connections to prevent accidental contact.

d) If the DUT is AC-powered, connect the ends of the wires to an appropriate AC power plug.

e) Close the DUT such that the wires may extend outside the DUT's enclosure without being pinched. A hole may be drilled into the side of the DUT's enclosure if necessary.

e) If the DUT has a **separate LED driver and non-integrated LED lamp(s) and no power cords are included with the DUT**, proceed with substeps 1) through 3); otherwise, proceed to step f).

1) Connect the power supply to the LED driver unit with wires 1 m in length.

2) Connect the LED driver to the non-integrated LED lamp(s). Use a 3 m to 5 m wire length between the LED driver and any lamps.

3) When testing any individual lamp, other lamps in the product shall be connected to the LED driver and powered on during the test.

f) Configure the DUT to allow a voltage measurement close to the luminaire or lamp. This voltage measurement point can be at terminal leads, at the power input point inside the luminaire, or externally on the input wire as close to the luminaire or lampholder as possible. Insulated wires that go straight into the luminaire or lampholder can be stripped to allow access or cut, stripped, and re-joined. Avoid introduction of additional electrical resistance in the circuit. The voltage measurement location shall be noted in the test report.

g) To ensure the DUT still works after it has been altered, connect the wire pair to a power supply at appropriate voltage and current settings.

G.5 Calculations

No calculations are required with the sample preparation procedures.

G.6 Reporting

Alterations made to the DUT to allow for testing shall be reported. Discrepancies between DUT instructions and testing setup shall be reported.

Annex H
(normative)

Voltage and frequency settings, voltage measurement points, and product stabilization procedures

H.1 Background

The photometric test procedures require the use of an external laboratory (bench) power supply to provide electrical power to the DUT for the duration of the test. Annex H specifies the voltage settings and voltage and current measurement locations for these tests.

In order to correctly provide the DUT with accurate DC or AC power, power supplies used for testing shall conform to requirements in Annex E. Wire and connector setups used for testing shall conform to requirements in Annex G.

H.2 Related tests

Annex H is related to setup procedures in Annex E and Annex G, the light output test (Annex I), the light distribution test (Annex J), the input voltage range test (Annex K), the lumen maintenance test (Annex L), and the AC power quality test (Annex P).

H.3 Equipment requirements

Some test configurations may use power supplies without voltage and current readouts capable of measuring voltage and current values according to Annex E. For example, a single power supply may be used to run concurrent lumen maintenance tests on multiple DUTs (the DUTs are run in parallel from a single voltage rail). For these configurations, voltage measurements may be made at the input to the wire leads of each DUT using a voltmeter or multimeter and current measurements may be made using an ammeter or multimeter or a voltage drop measurement on a series shunt resistor using Ohm's Law.

H.4 Procedure

H.4.1 Test setup

The following steps shall be followed:

a) Prepare the DUT for testing according to Annex G.

b) Set the voltage level at the power supply to the standard operating voltage given in H.4.2 and frequency (for AC products) determined in H.4.3. Record the power supply voltage and frequency (if applicable) in the test report.

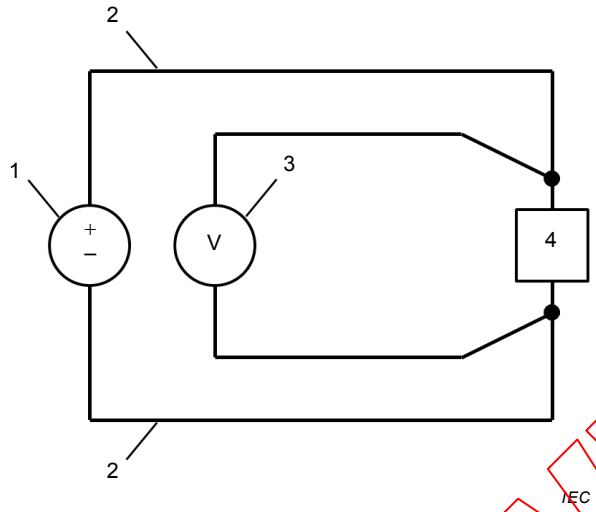
c) Power on the DUT and allow it to stabilize according to H.4.4.

d) Measure the voltage at the point where the wire leads are connected to the DUT as shown in Figure H.1 and described in G.4.4 step f). Record the voltage at the DUT in the test report.

NOTE The voltage measured at the DUT will be the voltage set at the power supply, in accordance with H.4.2, minus the voltage drop in the wire leads.

e) Measure the current from the power supply using the power supply's current measurement capability (when available) or with a shunt resistor placed in series with the wire leads.

During testing, monitor the DUT for erratic behaviour that may indicate a problem with the test setup. This may include light output flickering, voltage and current instability, and difficulty in device start-up.



Key

1 power supply (set to the standard operating voltage)

2 lead wire (see Annex G for conductor specifications and wire lengths)

3 voltage at light fixture (see also G.4.4 step f))

4 DUT

Figure H.1 – Test configuration

H.4.2 Standard operating voltages

The constant DC or AC voltage level for testing a DUT is based on test requirements and the DUT's specifications.

For the light output test (Annex I), light distribution test (Annex J), and lumen maintenance test (Annex L), a standard operating voltage is used. The standard operating voltage is dependent on the DUT's specified nominal system voltage. Standard operating voltage values for specified nominal system voltages are listed in Table H.1. If the DUT's nominal system voltage is not specified, contact the product manufacturer to obtain the DUT's nominal system voltage. If the DUT's nominal system voltage is not listed in Table H.1, determine an appropriate operating voltage based on typical battery charge and discharge curves for systems with which the DUT is likely to be used (for DUTs with DC input), utility power conditions (for DUTs with AC input), information provided by the manufacturer, and any other relevant information about the DUT's typical operating conditions. Standard operating voltages may be specified in the product specification; values required by the product specification take precedence over the values in Table H.1.

Table H.1 – Standard operating voltage for several nominal system voltages

DC input		AC input		
Nominal system voltage (V)	**Standard operating voltage** (V)	**Nominal system voltage** (V)	**Standard operating voltage** (V)	**Frequency** (Hz)
5	5,00	110 to 127	120	As specified by manufacturer (e.g. 60 or 50)
6	6,15	220 to 250	240	
12	12,30	—	—	

During testing, some DUTs may not start up at the desired voltage and may require an input slightly greater than the desired voltage. In this case, incrementally increase the power supply voltage by 0,05 V until the DUT is operational at the desired light setting. After start-up, reduce the voltage back to the desired value and allow the DUT to stabilize. If the DUT will

not remain on when the voltage is reduced, repeat this step and run the DUT as close to the desired voltage as possible, making note of the issue in the test report.

Some products have multiple rated voltages (e.g. 120 V/240 V AC) or a range of allowed operating voltages (e.g. 110 V to 240 V AC). For these products, use the following procedure to identify the standard operating voltage(s).

a) If the rated operating voltage is given by the manufacturer as a range, identify the standard operating voltage(s) corresponding to all nominal system voltage ranges from Table H.1 (plus any additional ranges given in the product specification) that overlap with the DUT's rated voltage range. For example, if the DUT is marked "115 V–220 V AC," there are two standard operating voltages: 120 V AC and 240 V AC.

b) If multiple rated operating voltages are given by the manufacturer, identify the standard operating voltages corresponding to each. For example, if the DUT is marked "115 V/230 V AC", there are two standard operating voltages: 120 V AC and 240 V AC.

c) If multiple standard operating voltages were identified in steps a) and b), the input voltage range test (Annex K) shall be performed multiple times, once for each standard operating voltage. For the remaining tests, one standard operating voltage shall be chosen from the possible options. Unless a different voltage is specified in the product specification, 240 V shall be preferred over 120 V.

H.4.3 Frequency selection

The DUT shall be tested at its rated frequency. For DUTs rated to operate at both 50 Hz and 60 Hz, the input voltage range test (Annex K) shall be performed at both frequencies. The frequency for the remaining tests shall be selected using the following procedure.

a) If a frequency is specified in the product specification, that frequency shall be used.

b) Otherwise, use 60 Hz if the nominal system voltage is between 110 V and 127 V, 50 Hz for all other products.

The above procedure is only to be used if the DUT is rated for both 50 Hz and 60 Hz. If no rated frequency is given, the manufacturer should be contacted to determine the rated frequency. Note that frequency may be given as a range (such as 47 Hz to 53 Hz or 47 Hz to 63 Hz); only 50 Hz and/or 60 Hz should be used unless a non-standard frequency is given in the product specification.

NOTE When the DUT is rated for multiple voltages and frequency ranges, the input voltage range test (Annex K) will be performed several times, once for each combination of voltage and frequency. For example, a product marked "115 V/230 V AC 50/60 Hz" would undergo the input voltage range test four times, at 120 V/50 Hz, 120 V/60 Hz, 240 V/50 Hz, and 240 V/60 Hz. The other tests would be performed at 240 V/50 Hz.

H.4.4 Stabilization period

A DUT shall be allowed to stabilize (warm up) before light output measurements are made. There are two approved stabilization procedures.

a) The DUT is powered on and allowed to stabilize for 20 min (for LED lamps) or 15 min (for CFL lamps).

b) The DUT is powered on and is considered stable when three consecutive output measurements, taken 15 min apart, have a variation of ≤ 0,5 % (IES LM-79-08).

In order to facilitate testing of multiple samples, 20 min (for LED lamps) or 15 min (for CFL lamps) is specified as the minimum stabilization time and is adequate for most products. Longer times may be necessary for DUTs with large heat sinks or high-powered LEDs. Voltage, current, and light output for a DUT should be monitored to determine if 20 min or 15 min is an adequate stabilization time. If a longer stabilization time is necessary, the IES LM-79-08 procedure may be used to determine the stabilization time for a single DUT sample, and this time may then be used to test additional DUT samples of the same type.

H.5 Reporting

The voltage and current for tests using an external power supply should be reported according to Table H.2.

Table H.2 – Voltage and current reporting requirements

Parameter	Notes
Voltage at power supply	Regulated to within ±3 % for the duration of lifetime tests and ±0,2 % for all other related tests.
Voltage at DUT	Measured as close to DUT as possible (see Annex G).
Current	Measured using the power supply readout or series shunt resistor during the light output test. Readout resolution should be ≥ 0,001 mA.
Frequency	Measured for DUTs with AC inputs only.

Annex I
(normative)

Light output

I.1 Background

The light output of a lamp or lighting appliance is a key parameter, as products that do not provide a sufficient amount of light have limited value. In addition, the correlated colour temperature (CCT) and colour rendering index (CRI) are other key aspects measured in the light output test that may be of particular importance in some applications. Another key aspect, luminous efficacy, is particularly important for lighting appliances that are meant to be used in battery-operated applications (such as mini solar home systems), as luminous efficacy provides an indication of how much power is necessary to achieve a given level of lighting service.

I.2 Test outcomes

The test outcomes of the light output test are listed in Table I.1.

Table I.1 – Light output test outcomes

Metric	Reporting units	Related aspects	Notes
Luminous flux	Lumens (lm)	4.2.5.1 Luminous flux output	Measured using a DC power supply, light sensor, and integrating sphere or goniophotometer (or using a multi-plane measurement)
Luminous efficacy	Lumens per watt (lm/W)	4.2.5.2 Luminous efficacy	Measured using a DC power supply, light sensor, and integrating sphere or goniophotometer (or using a multi-plane measurement)
Correlated colour temperature (CCT)	Kelvin (K)	4.2.5.5 Colour characteristics	Measured using equipment capable of characterizing spectral distribution
Colour rendering index (CRI)	0–100 (unitless)	4.2.5.5 Colour characteristics	Measured using equipment capable of characterizing spectral distribution

I.3 Related tests

Annex I is related to the light distribution test (Annex J). The power consumption and power quality test (Annex P) may be performed before, after, or concurrently with the procedure for this test, but the results are used in the calculation of luminous efficacy in I.5.

I.4 Procedure

The light output test procedure of IEC TS 62257-9-5 shall be used to measure luminous flux, CCT, and CRI, with the following modification: The DUT shall be driven at the voltage specified in H.4.2 and frequency (for AC products) determined in H.4.3 and allowed to stabilize according to H.4.4. If this test is being performed concurrently with the AC power quality test (Annex P), and an AC power meter is being used, the voltage shall be measured at the output of the power meter, upstream of the DUT's wires or cables and any added wire as described in Annex G.

I.5 Calculations

The calculations in the light output test procedure of IEC TS 62257-9-5 shall be performed. In addition, the luminous efficacy (luminous flux divided by input power) of each sample shall be calculated.

I.6 Reporting

The reporting requirements of the light output test procedure of IEC TS 62257-9-5 shall be followed. In addition, the luminous efficacy of each sample (lm/W) shall be reported.

Annex J
(normative)

Light distribution

J.1 Background

Luminous flux and light distribution are two primary metrics used to assess the performance of a lamp or lighting appliance. Measurements of luminous flux (the total amount of light emitted by a source) are appropriate for any type of light and are discussed in Annex I. Measurements of light distribution are also appropriate for any type of light, with particular relevance to the performance of task lights that have focused light outputs. While there is no distribution that is necessarily "ideal", some distributions are more appropriate for certain applications than others. Annex J is intended to characterize a product's light distribution so purchasers can select products that are appropriate for the applications in which they are used.

J.2 Test outcomes

The light distribution test outcomes are listed in Table J.1.

Table J.1 – Light distribution test outcomes

Metric	Reporting units	Related aspects	Notes
Vertical and horizontal full width half maximum (FWHM) angles	Degrees (°)	4.2.5.3 Full width half maximum (FWHM) angles 4.2.5.4 Light distribution characteristics	–
Usable area with illuminance greater than a specified threshold	Square metres (m^2)	4.2.5.4 Light distribution characteristics	Determined from a specified distance
Luminous flux	Lumens (lm)	4.2.5.1 Luminous flux output	Only obtained when using multi-plane or gonio-photometer test methods

J.3 Related tests

Annex J is related to the light output test (Annex I).

J.4 Procedure

The light distribution test procedure of IEC TS 62257-9-5 shall be used to measure FWHM angles, usable area, and luminous flux (if necessary), with the following modification: The DUT shall be driven at the voltage specified in H.4.2 and frequency (for AC products) determined in H.4.3 and allowed to stabilize according to H.4.4.

J.5 Calculations

The calculations in the light distribution test procedure of IEC TS 62257-9-5 shall be performed.

J.6 Reporting

The reporting requirements of the light distribution test procedure of IEC TS 62257-9-5 shall be followed.

Annex K
(normative)

Input voltage range

K.1 Background

When a product is placed in service it is paired by the end-user with an external power source. This will result in different input voltages that may be supplied to the DUT as, for example, a battery discharges or the local power grid fluctuates. Based on the DUT's nominal operating voltage, a range of possible operating voltages has been determined that are dependent on potential existing power sources that could reasonably be paired with the DUT. The DUT shall be expected to operate over the possible operating voltage range or within the manufacturer's specified operating voltage range if it is wider than the range supplied in this method's procedures.

In some cases the battery of an external power source may be equalized. The DUT is not expected to function under this condition, but the DUT is expected to continue functioning afterwards. By supplying the DUT with a maximum allowable voltage, the product's ability to withstand possible high voltage conditions will be tested.

Additionally, depending on how the DUT is wired to its external power source, potential noise and/or voltage drop may be introduced under realistic use conditions. This aspect shall be captured when measuring the DUTs relative light output response while varying its input voltage range.

K.2 Test outcomes

The input voltage range test outcomes are listed in Table K.1.

Table K.1 – Input voltage range test outcomes

Metric	Reporting units	Related aspects	Notes
Operating voltage range table	Voltage (V), Voltage (V), percentage (%)	4.2.4.1 Operating input voltage range	A table with 3 columns and 8 rows, including the column headings
Maximum allowable voltage	Voltage (V)	4.2.4.1 Operating input voltage range	Maximum voltage the product can be subjected to for a brief period of time without sustaining permanent damage
Functionality after test	Yes/no	4.2.4.1 Operating input voltage range	–
Damage after test	Yes/no, description	4.2.4.1 Operating input voltage range	–
User safety hazards present after test	Yes/no, description	4.2.4.1 Operating input voltage range	–

K.3 Related tests

Annex K is not related to any other tests.

K.4 Procedure

K.4.1 General

The DUT is tested for functionality and the presence of safety hazards over a range of input voltages.

K.4.2 Equipment requirements

The following equipment is required:

- AC and/or DC power supply meeting the requirements in Annex E;
- illuminance meter;
- camera.

K.4.3 Test prerequisites

At the start of the input voltage range test the DUT samples shall be minimally altered (ideally unaltered) and fully functional.

This test may be destructive. Do not carry out additional tests with the tested samples.

K.4.4 Apparatus

The input voltage range test requires an accurate measurement of relative light output at several voltage levels. In practice, this means using an integrating sphere or a fixed-geometry measurement cavity to measure the illuminance level[1)] under constant conditions. Three approved measurement cavities are listed below in order of preference[2)]. The lighting measurement is taken indirectly (reflected) in the first two types, while it is taken directly in the last type.

- an integrating sphere;
- a self-built photometer box with a baffled measurement of illuminance on a port (i.e. an "integrating cube" as described in IEC TS 62257-9-5);
- a darkened room or cabinet with direct illuminance measurement under fixed geometry.

The DUT should be enclosed to protect personnel from debris expelled by a catastrophic failure of the DUT at high voltage.

NOTE Since a catastrophic failure could damage the apparatus, a low-cost apparatus such as a photometer box or darkened cabinet can be preferable to an integrating sphere.

K.4.5 Procedure

The following steps shall be performed.

a) Prepare the DUT according to Annex G.

b) Identify the DUT's recommended operating voltage range using Table K.2 by looking up the DUT's specified nominal operating voltage. If the specified range in the DUT's provided documentation exceeds the identified recommended operating voltage range,

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1) A measurement of illuminance in a fixed geometry (such as a dark room or isolated box) is always directly proportional in a linear fashion to the luminous flux of a lamp. Therefore, fixed-geometry measurements of illuminance may be used in place of luminous flux measurements for this test, which relies on relative light output to indicate the end of a discharge cycle.

2) Any of these cavities can result in identical estimates for full-battery run time. The preference order is related to the degree of operator care required to maintain a fixed geometry in each, with a preference for cavities whose relative measurement is less sensitive to small changes in the system (e.g., from accidentally bumping into the cavity during a test).