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# DRAFT EAST AFRICAN STANDARD

## Lighting products — Minimum energy performance standard — Part 1 — Lamps



## EAST AFRICAN COMMUNITY



First Edition 2021

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## Foreword

Development of the East African Standards has been necessitated by the need for harmonizing requirements governing quality of products and services in the East African Community. It is envisaged that through harmonized standardization, trade barriers that are encountered when goods and services are exchanged within the Community will be removed.

The Community has established an East African Standards Committee (EASC) mandated to develop and issue East African Standards (EAS). The Committee is composed of representatives of the National Standards Bodies in Partner States, together with the representatives from the public and private sector organizations in the community.

East African Standards are developed through Technical Committees that are representative of key stakeholders including government, academia, consumer groups, private sector and other interested parties. Draft East African Standards are circulated to stakeholders through the National Standards Bodies in the Partner States. The comments received are discussed and incorporated before finalization of standards, in accordance with the Principles and procedures for development of East African Standards..

East African Standards are subject to review, to keep pace with technological advances. Users of the East African Standards are therefore expected to ensure that they always have the latest versions of the standards they are implementing.

The committee responsible for this document is Technical Committee EASC/TC 051 Electrical Installation and Lighting.

Attention is drawn to the possibility that some of the elements of this document may be subject of patent rights. EAC shall not be held responsible for identifying any or all such patent rights.

# Lighting products — Minimum energy performance standard — Part 1 — Lamps



## 1 Scope

1.1 This Draft East African standard covers the energy efficiency and functional performance requirements, sampling and test methods for general service lamps and tubular lamps. General service lamps include directional and non-directional lamps of all shapes and finishes; using incandescent, halogen, compact fluorescent, light emitting diode (LED), and other light source technologies.

1.2 This standard does not cover high-intensity discharge lamps and tubular lamps including both fluorescent and LED tubes.

1.3 This standard does not cover safety requirements of lighting products.

For detail on which general service lamps and tubular lamps are included and excluded, see clause 5.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ANSI C78.377, *Electric Lamps — Specifications for the Chromaticity of Solid-State Lighting Products*

CIE 015, *Colorimetry*

CIE 84, *Measurement of Luminous Flux*

CIE 121, *The Photometry and Goniophotometry of Luminaires*

CIE S025, *Test method for led lamps, led luminaires and led modules*

CISPR 15, *Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment*

IEC 60064, *Tungsten filament lamps for domestic and similar general lighting purposes — Performance requirements*

IEC 60081, *Double-capped fluorescent lamps — Performance specifications*

IEC 60357, *Tungsten halogen lamps (non-vehicle) — Performance specifications*

IEC 60969, *Self-ballasted compact fluorescent lamps for general lighting services — Performance requirements*

IEC 61000-3-2, *Electromagnetic compatibility (EMC) — Part 3-2: Limits — Limits for harmonic current emissions (equipment input current ≤16 A per phase)*

IEC 61000-4-7, *Electromagnetic compatibility (EMC) — Part 4-7: Testing and measurement techniques - General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto*

IEC 62612, *Self-ballasted LED lamps for general lighting services with supply voltages > 50 V — Performance requirements*

IEC 62717, *LED modules for general lighting — Performance requirements*

IEC 62722-2-1, *Luminaire performance — Part 2-1: Particular requirements for LED luminaires*

IEC 63103, *Lighting equipment — Non-active mode power measurement*

IEC TR 61341, *Method of measurement of centre beam intensity and beam angle(s) of reflector lamps*

IEC TR 61547-1, *Equipment for general lighting purposes — EMC immunity requirements — Part 1: Objective light flickermeter and voltage fluctuation immunity test method*

IEC TR 63158, *Equipment for general lighting purposes — Objective test method for stroboscopic effects of lighting equipment*

IESNA LM 84, *IES Approved Method for Measuring Lumen and Colour Maintenance LED Lamps, Lighting engines, and Luminaires*

IES LM-79, *Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products*

IES LM-80, *Approved Method: Measuring Luminous Flux and Colour Maintenance of LED Packages, Arrays, and Modules*

IES TM-21, *Projecting long term lumen maintenance of LED light sources*

IEC 60061-1 Lamp caps and holders together with gauges for the control of interchangeability and safety - Part 1: Lamp caps

IEC 60061-2 Lamp caps and holders together with gauges for the control of interchangeability and safety - Part 2: Lamp holders)

## 3 Terms and definitions

For the purposes of this standard, the following terms and definitions apply. ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

**3.1**
**applicant**
manufacturer or importer seeking approval for lighting product(s). The applicant shall be an existing legal entity

**3.2**
**approval**
confirmation by the appropriate government agency that a particular lighting product(s) satisfies all the requirements of this mandatory standard

**3.3**
**arithmetical mean**
average of a set of numerical values, calculated by adding them together and dividing by the number of terms in the set



**3.4**
**beam angle of a directional light source**
angle between two imaginary lines in a plane through the optical beam axis, such that these lines pass through the centre of the front face of the light source and through points at which the luminous intensity is 50% of the centre beam intensity, where the centre beam intensity is the value of luminous intensity measured on the optical beam axis.

Note 1 to entry: For light sources that have different beam angles in different planes, the largest beam angle shall be considered

**Note 2 to entry: For light sources with user-controllable beam angle, the beam angle corresponding to the 'reference control setting' shall be considered.3.5**
**Chromaticity**
property of a colour stimulus defined by its chromaticity coordinates (in either x,y or u',v' coordinate system)

**3.6**
**colour consistency**
maximum deviation of the chromaticity coordinates of samples of a product from the chromaticity coordinates of the nominal CCT value

**3.7**
**colour rendering index (CRI)**
measure of the degree to which the psychophysical colour of an object illuminated by the test illuminant conforms to that of the same object illuminated by the reference illuminant, suitable allowance having been made for the state of chromatic adaptation. CRI is a measure of the ability of a light source to accurately reveal the colours of various objects in comparison with an incandescent source of the same colour temperature

**3.8**
**colour-tuneable light source (CTL)**
connected lamp or luminaire using LED or OLED technology, that can be set to emit light with a large variation of colours outside the range defined in the scope, but can also be set to emit white light inside the colour range defined in the scope.

Note 1 to entry: This term does not include tuneable-white lamps that can only be set to emit white light, with different colour temperatures, within the range defined in the scope.

Note 2 to entry: This term does not include dim-to-warm lamps, that shift their white light output to lower colour temperature when dimmed, simulating the behaviour of incandescent light sources.

**3.9**
**connected lighting product (CL)**
lighting product including data-connection parts that are physically integrated with the light emitting parts in a single inseparable housing, and where the data-connection parts cannot be disconnected, switched-off or their power consumption minimised.

**3.10**
**correlated colour temperature (CCT)**
temperature of the Planckian radiator whose perceived colour most closely resembles that of a given stimulus at the same brightness and under specified viewing conditions. Units: K. Lamps with a high CCT, e.g. 6500 K, produce blueish-white light, whereas those with a low CCT of 2700 K produce light that is more yellowish-white.

**3.11**
**data-connection parts**
parts that perform one of the following functions:

a) reception or transmission of wired or wireless data signals and the processing thereof (either used to control the light emission function or otherwise),

b) sensing and processing of the sensed signals (either used to control the light emission function or otherwise),



c) actuation by audio control (including voice control),

d) a combination of these.

**3.12**
**declaration report**
report that is issued by an accredited conformity assessment body, indicating the equivalence of standards.

**3.13**
**directional lamp**
lamp which has a beam angle (as defined in IEC TR 61341 and measured in accordance with CIE S 025:2015) of no more than 90 degrees in at least one plane and that being in at least one plane for an asymmetric beam lamp. These lamps are also known as reflector lamps and are commonly installed in recessed cans or track lighting.

**3.14**
**displacement factor: (also called fundamental power factor)**
quantifies the displacement (phase-shift) between the fundamental current and voltage waveforms by calculating the cosine of the phase-shift angle (Cos ϕ1). Displacement factor is a more detailed measure to quantify the displacement of the current and its effect on the power supply network.

**3.15**
**endurance test: (also called a supply switching test)**
switching on and off of a lamp to simulate how the product will perform over its lifetime. The test is carried out to stress the lamp over a period of time to help determine the failure rates and luminous flux maintenance of that product.

**3.16**
**family**
group of lamps, light modules or drivers with the same brand name that has essentially identical: (1) physical characteristics and construction, (2) system design and performance, and (3) quality and safety characteristics. Any variation within a family of models shall have little or no effect on the efficacy and performance of those models.

**3.17**
**flicker**
perception of visual unsteadiness induced by a light stimulus the luminance or spectral distribution of which fluctuates with time, for a static observer in a static environment. The fluctuations can be periodic and non-periodic and may be induced by the light source itself, the power source or other influencing factors.

**3.18**
**fluorescence or fluorescent light source**
phenomenon or a light source using an electric gas discharge of the low-pressure mercury type in which most of the light is emitted by one or more layers of phosphors excited by the ultraviolet radiation from the discharge. Fluorescent light sources may have one ('single-capped') or two ('double-capped') connections (‘caps’) to their electricity supply. For the purposes of this standard, magnetic induction light sources are also considered as fluorescent light sources.

**3.19**
**gas discharge**
phenomenon where light is produced, directly or indirectly, by an electric discharge through a gas, plasma, metal vapour or mixture of gases and vapours

**3.20**
**general illumination purposes**
any light source that fulfils the requirements of products listed in clause 5 of this standard



**3.22**
**halogen lamp**
gas-filled lamp containing halogens or halogen compounds, the light-emitting filament being made of tungsten

**3.23**
**high-intensity discharge, (HID)**
electric gas discharge in which the light-producing arc is stabilised by wall temperature and the arc chamber has a bulb wall loading in excess of 3 Watts per square centimetre. ‘Gas discharge’ means a phenomenon where light is produced, directly or indirectly, by an electric discharge through a gas, plasma, metal vapour or mixture of gases and vapours. For the purpose of this Standard, HID light sources are limited to metal halide, high-pressure sodium and mercury vapour types.

**3.24**
**illumination**
application of light to a scene, objects or their surroundings so that they may be seen

**3.25**
**incandescence**
emission of optical radiation by the process of thermal radiation. In light sources incandescence is typically produced by the passage of an electric current through a threadlike resistive conductor (‘filament’) which generates heat.

**3.26**
**lamp**
light source made in order to produce an optical radiation, usually visible. Note: The term "lamps" is often referred to as a globe, bulb or light bulb.

**3.27**
**lamp cap**
of a lamp which provides connection to the electrical supply by means of a lamp holder or lamp connector and, in most cases, also serves to retain the lamp in the lamp holder

Note 1 to entry: The term base is also used in both the United Kingdom and the US 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.

**3.28**
**life (of a lamp or luminaire)**
total time for which a lamp or luminaire has been operated before it becomes useless or is considered to be so according to specified criteria. Note: life is usually expressed in hours and as an average time at which point half of the light sources concerned are expected to have failed or become noncompliant according to specified criteria. (e.g. 70% of light output).

**3.29**
**light emitting diode (LED)**
technology in which light is produced from a solid-state device embodying a p-n junction of inorganic material or organic material. This latter case is also known as ‘organic light emitting diode’ (OLED). In both cases the junction emits optical radiation when excited by an electric current.

**3.30**
**linear fluorescent light source (LFL)**
cylindrical tube with two ('double-capped') connections (‘caps’) one at each end of the tube. These connect to the electricity supply via control gear and the tube can have different diameters, commonly T5 ø16 mm, T8 ø26 mm and T12 ø38 mm.



**3.31**
**linear LED light source**
equivalent LED based light source to an LFL, physically fitting the same luminaire. It can be a direct retrofit running on the same control gear (i.e., electronic ballast or high frequency ballast) or on a direct mains power connection.

**3.32**
**lumen (lm)**
SI unit of luminous flux which is emitted in unit solid angle (steradian) by a uniform point source having a luminous intensity of 1 candela. It indicates the amount of visible light the lamp provides.

**3.33**
**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. Also referred to as a light fixture or light fitting.

**3.34**
**luminous efficacy (ηv)**
expressed in lm/W, quotient of the luminous flux emitted by the electric power consumed by the light source. It is an expression of how energy efficient a lamp or luminaire is at producing visible light.

**3.35**
**luminous flux or flux (Φ or Φv)**
expressed in lumen (lm), means the quantity derived from radiant flux (radiant power) by evaluating the electromagnetic radiation in accordance with the spectral sensitivity of the human eye.

**3.36**
**model**
all the units in a product line from the same manufacturer, sold under the same brand name, and which are identical except for a serial number or other identifying mark. Any variation within a product line of models shall have no effect on the efficacy and performance of those models and shall only be due to natural manufacturing variation observed within otherwise identical units.

**3.37**
**non-directional lamp**
general service lamp that is not a directional lamp

**3.38**
**passive adaptor (also called lamp holder adaptor)**
connecting device capable of being inserted into a lamp holder and has outlet facilities for connection to a flexible cord or integral flexible cord or fitted with lamp holders. The adaptor may incorporate electronic circuits to control the output.

**3.39**
**rated life, $L_{70}B_{50}$: for LED and OLED light sources**
time in hours between the start of their use and the moment when for 50 % of a population of light sources the light output has gradually degraded to a value below 70 % of the initial luminous flux. This is also referred to as the $L_{70}B_{50}$ lifetime;

**3.40**
**rated luminous flux**
value of the initial luminous flux of a given model of lamp/luminaire declared by the manufacturer or the responsible vendor, the lamp being operated under specified conditions. Unit: lumen (lm)

Note 1 to entry: The initial luminous flux may be the luminous flux of a lamp/luminaire after a short ageing period, as specified in the relevant lamp standard.

Note 2 to entry: The rated luminous flux is sometimes marked on the lamp/luminaire.



**3.41**
**rated input power**
value of the consumed electrical power by a given model of lamp/luminaire declared by the manufacturer or the responsible vendor, the lamp/luminaire being operated under specified conditions. Unit: watt (W).

Note 1 to entry: The rated power is usually marked on the lamp/luminaire.

**3.42**
**rated voltage or rated voltage range**
nominal voltage/range of voltage at which a piece of electrical equipment is designed to operate. The rated voltage is usually required to be marked on the light source.

**3.43**
**reference control setting**
control setting or combination of control settings that is used to verify compliance of a light source with this standard. These settings are relevant for light sources that allow the end-user to control, manually or automatically, directly or remotely, the luminous intensity, colour, colour temperature, spectrum, and/or beam angle of the emitted light.

**3.44**
**sensor**
device permanently connected to the electricity supply and integrated in a lamp or luminaire to sense environmental conditions and control the lamp or luminaire in some way. For example, a daylight sensor that switches the light source on at dusk or a motion detector that turns the light source off when nobody is there.

**3.45**
**short term flicker indicator (PstLM)**
perception of visual unsteadiness induced by a static light stimulus the luminance or spectral distribution of which fluctuates with time, for a static observer in a static environment. The fluctuations can be periodic and non-periodic and may be induced by the light source itself, the power source or other influencing factors. The metric for flicker used in this Standard is the 'PstLM', where 'st' stands for short term and 'LM' for light flicker meter method, as defined in standards. A value of PstLM=1 means that the average observer has a 50% probability of detecting flicker, a measure of flicker evaluated over a duration of at least 180 seconds in accordance with IEC 61547-1.

**3.46**
**stroboscopic effect**
change in motion perception induced by a light stimulus the luminance or spectral distribution of which fluctuates with time, for a static observer in a non-static environment. The fluctuations can be periodic and non-periodic and may be induced by the light source itself, the power source or other influencing factors. The metric for the stroboscopic effect used in this Standard is the 'SVM' (Stroboscopic Visibility Measure), as defined in standards. SVM=1 represents the visibility threshold for an average observer to have a 50% probability of detecting stroboscopic effects.

**3.47**
**stroboscopic effect visibility measure (SVM)**
stroboscopic effect evaluated over a specified time interval of a relatively short duration. The duration is at least 1 second, in accordance with CIE TN 006 and IEC TR 63158.

**3.49**
**valid test report**
copy of an original test report issued for a regulated (covered) product by a laboratory accredited by an internationally recognised body, which is also recognised under a given country's conformity assessment policy. The internationally recognised body should be a member of the IAF/ILAC/IECEE mutual recognition scheme.

## 4 Symbols and/or abbreviated terms

ANSI American National Standards Institute



CCT Correlated Colour Temperature

CFL Compact Fluorescent Lamp

CIE Commission Internationale de l'Eclairage

CISPR Comité International Spécial des Perturbations Radioélectriques

CL Connected Lighting

CLD Control of Light Distribution

CRI Colour Rendering Index

CTL Colour Tuneable Light

EAC East African Community

EASC East African Standards Committee

EMC Electromagnetic Compatibility

EU European Union

GSL General Service Lamp

HID High Intensity Discharge

HT Harmonised Text

Hz Hertz

IAF International Accreditation Forum

IEA International Energy Agency

IEC International Electrotechnical Commission

IECEE IEC Conformity Assessment for Electrotechnical Equipment and Components

IES Illuminating Engineering Society (North America)

ILAC International Laboratory Accreditation Cooperation

ISO International Standards Organisation

K Kelvin

klm kilolumen

LED Light Emitting Diode

LFL Linear Fluorescent Lamp

lm Lumen

mm millimeter

mW milliwatt



NEMA National Electrical Manufacturers Association

nm nanometer

OLED Organic Light Emitting Diode

PstLM Short term flicker indicator

SDCM Standard Deviation Colour Matching

SI Système International

SVM Strobostopic Visibility Measure

TBT Technical Barriers to Trade

TN Technical Note (CIE)

TR Technical Report (IEC)

U4E United for Efficiency (United Nations Environment)

UV Ultraviolet

V Voltage

W Watts

# 5 Product description

## 5.1 General

Products within the scope have light emission with the chromaticity coordinates (x, y) that are within the range defined by the equations below (and shown in Figure 1):

a) $0,250 < x < 0,570$ and

b) $-2,3172\ x^2 + 2,3653\ x - 0,2400 < y < -2,3172\ x^2 + 2,3653\ x - 0,1400$



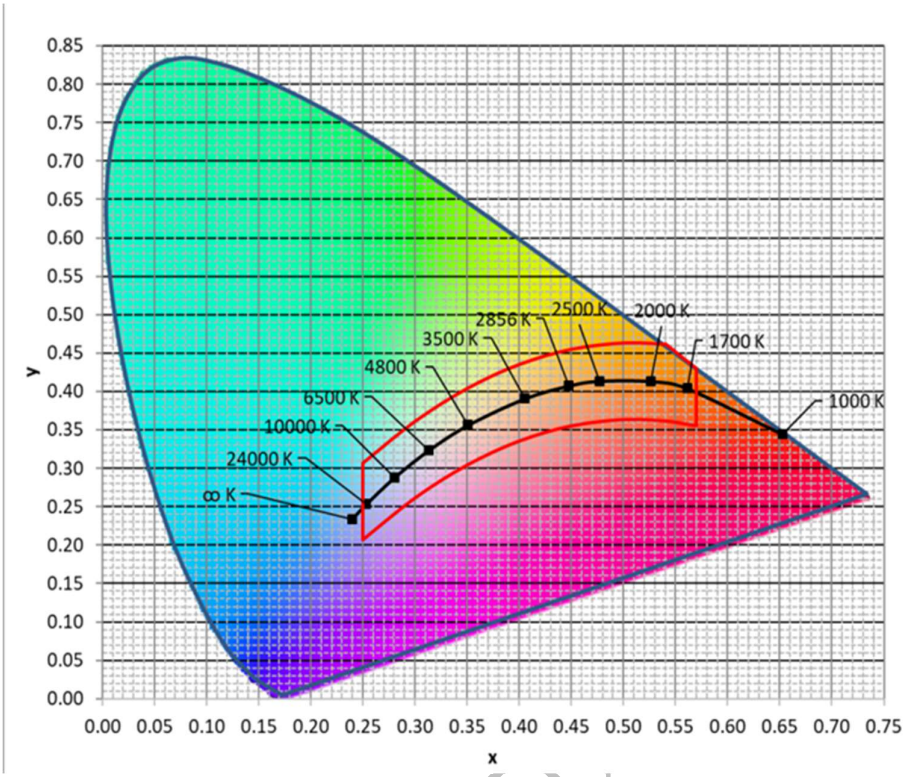



**Figure 1 — Plot of the chromaticity equations defining the light emission region**

## 5.2 General service lamps

### 5.2.1 General service lamps — Inclusions

These lamps shall satisfy the following criteria:

a) Chromaticity coordinates defined in 5.1;

b) Capable of operating on a voltage up to 300 V of either direct current or alternating current with a frequency of 50 Hz;

c) Emitting light with a total luminous flux of 60 to 3 300 lumens;

d)

a lamp base as standardised by IEC, which can be connected to one of the following general service lamp sockets:

i) Screw base types: E10, E11, E12, E14, E17, E26 or E27, or

ii) Bayonet base types: B15d, BA15d, B22, B22d or BC22, or

iii) Pin base types: G4, GU4, G5.3, GU5.3, GX5.3, GY6.35, G9, GU10, GZ10 or GX53 base, or

iv) Double-ended base type: R7s, or

v) Alternative base types which can be connected to the above lamp base sockets by using commercially available passive adaptors.

### 5.2.2 General service lamps — Exclusions

The following lamps are exempted from this standard:

a) the primary purpose of the light is not general illumination and the product packaging is prominently marked (see 6.3), for example, but not limited to:

   i) emission of light as an agent in chemical or biological processes (other than human visual perception), e.g. but not limited to:

      1) polymerization,

      2) ultraviolet light used for curing/drying/hardening,

      3) photodynamic therapy,

      4) horticulture,

      5) food service,

      6) medical applications,

      7) aquarium,

      8) animal care, and

      9) anti-insect products;

   ii) image capture and image projection, e.g. but not limited to:

      1) camera flashlights,

      2) photocopiers and scanners, and

      3) video projectors;

   iii) signalling, e.g. but not limited to:

      1) railway-signalling

      2) marine-signalling,

      3) road-signalling and traffic control, and

      4) air traffic-signalling and airfield lamps;

   v) UV Light (e.g for disinfection and sun tanning)

b) the spectral distribution of the light is adjusted to the specific needs of particular technical equipment, in addition to making the scene or object visible for humans, e.g. but not limited to:

   i) studio lighting,

   ii) performance special effects lighting, and

   iii) theatre lighting;

c) the scene or object lit requires special protection from the negative effects of the light source, e.g. but not limited to:

i) lighting with dedicated filtering for photosensitive patients, and

ii) lighting with dedicated filtering for photosensitive museum exhibits;

d) lighting is required only for emergency situations, e.g. but not limited to lamps for emergency lighting luminaires;

e) requiring ambient temperatures above 120°C and this exemption only applies to incandescent and halogen oven lamps with the following characteristics:

i) an overall length of maximum 60 mm,

ii) a rated power of maximum 25 W,

iii) a base type of E14 or B15,

iv) a rated luminous flux of maximum 225 lm; and

v) bayonet and G9 base types

f) reference lamps used for national measurement standards and testing and calibration services;

g) light sources for battery operated products, including but not limited to mobile phones, torches, camping lights, toys, armbands, solar powered garden lamps, bicycle lights and other non-motorized vehicle lights, etc.; and

h) double-ended halogen light sources with R7s cap and luminous flux ≤ 2700 lumens.

## 5.3 Tubular lamps

### 5.3.1 Tubular lamps — Inclusions

The following products are covered:

a) Chromaticity coordinates defined in section 5.1;

b) Single and double capped fluorescent lamps including linear, U-bend, circle-line, 2D and other shapes; and all lamp diameters, including < 9 mm (e.g., T2); ≥ 9 mm and ≤ 17 mm (e.g. T5); > 17 mm and ≤ 28 mm (e.g. T8); > 28 mm (e.g. T12);

c) Single and double capped LED replacements for the fluorescent lamps including models designed to be retrofit into existing luminaires using existing magnetic and electronic control gear as well as products designed to be connected directly to mains-voltage; and

d) Having lamp caps that can be connected to the following fluorescent socket types: miniature bipin (G5); medium bipin (G13), single pin (Fa6, Fa8), recessed double contact (R17d) or alternative cap types which can be connected to these lamp socket types by using commercially available passive adaptors.

### 5.3.2 Tubular lamps — Exclusions

**5.3.2.1** This standard shall not apply to tubular lamps specifically tested and approved to operate:

a) in potentially explosive atmospheres;

b) for emergency use; and

c) in or on aircraft.



**5.3.2.2** Any tubular lamp within the scope of this Standard shall be exempt from the requirements of this Standard, with the exception of the information requirements given in 6.3, if they are specifically designed and exclusively marketed for use in one of the following applications:

a) image capture and image projection (including, but not limited to, photocopying, printing (directly or in pre-processing), lithography, film and video projection, holography);

b) reference tubular lamps used for national measurement standards and testing and calibration services;

c) light sources with specific effective ultraviolet power > 2 mW/klm and intended for use in applications requiring high UV-content;

d) light sources with a peak radiation around 253.7 nm and intended for germicidal use (destruction of DNA);

e) light sources emitting 5 % or more of total radiation power of the range 250 nm - 800 nm in the range of 250nm - 315 nm and/or 20 % or more of total radiation power of the range 250 nm - 800 nm in the range of 315 nm - 400 nm, and intended for disinfection or fly trapping;

f) light sources with the primary purpose of emitting radiation around 185.1 nm and intended to be used for the generation of ozone;

g) light sources emitting 40 % or more of total radiation power of the range 250 nm - 800 nm in the range of 400-480 nm, and intended for coral zooxanthellae symbioses;

h) light sources emitting 80 % or more of total radiation power of the range 250nm - 800 nm in the range of 250-400 nm, and intended for sun-tanning;

i) light sources with a photosynthetic efficacy > 1.2 µmol/J, and/or emitting 25 % or more of total radiation power of the range 250-800 nm in the range of 700 nm - 800 nm, and intended for use in horticulture;

j) colour-tuneable light sources that can be set to at least the colours listed in this point and which have for each of these colours, measured at the dominant wavelength, a minimum excitation purity of:

a) Blue 440 nm — 490nm 90 %,

b) Green 520 nm — 570nm 65 %,

c) Red 610 nm — 670nm 95 %;

1. and are intended for use in applications requiring high-quality coloured light;

# 6 Requirements

## 6.1 Energy efficiency requirements

### 6.1.1 Luminous efficacy requirement

6.1.1.1 All covered lamps shall comply with the minimum luminous efficacy requirements for the entire light source (i.e., lamp) set out in Table 1:



**Table 1 — Minimum luminous efficacy of lamps**

| Type of product* | Minimum luminous efficacy (lm/W)<br>Phase 1 – 1 April 2022 | Minimum luminous efficacy (lm/W)<br>Phase 2 – 1 April 2024 |
|---|---|---|
| General service lLamps – Non-directional | 90 | 105 |
| General service lamps – Directional | 75 | 85 |
| Tubular lamps | 115 | 130 |
| *The scope of coverage of these lamps is given in Clause 5 of this Standard | | |

.

**6.1.1.2** Depending on the characteristics of the lamp, the minimum luminous efficacy values required in Table 1 may be decreased by the following efficacy allowances given in Table 2. For example, a General Service Lamp that emits 350 lumens could adjust the Phase 1 requirement by subtracting 10 lm/W, such that the minimum required 90 lm/W is adjusted down to 80 lm/W.

**Table 2 — Efficacy allowances for specific lamps with special characteristics**

| Special characteristics of lamps | Efficacy allowances<br>lm/W |
|---|---|
| General Service Lamps – Directional with Beam Angle < 20° (only) | -10 |
| Luminous flux Φ (lm) below 400 lm | -10 |
| CCT < 2500 K | -10 |
| High CRI (Ra >90) | -10 |

**6.1.1.3** With respect the efficacy allowances listed in Table 2, the following notes also apply:

Note 1: Where applicable, efficacy allowances are additive

Note 2: Light sources that allow the end-user to adapt the spectrum and/or the beam angle of the emitted light, thus changing the values for luminous flux, CRI-Ra and/or colour temperature (Tc), and/or changing their directional lamp or non-directional lamp status, shall be evaluated using the reference control settings (defined in Clause 3).

### 6.1.2 Standby power (applicable to connected lamps and)

Standby power ($P_{sb}$) for lamps shall not exceed 0.5 W. Networked standby power ($P_{net}$) for Connected Lamps shall not exceed 0.5 W. The allowable values for standby power and networked standby power shall not be added together.

### 6.1.3 Fundamental power factor (also called displacement factor or Cos ϕ1)

All lamps shall have a displacement factor as set out in Table 3:

Table 3 – Required values for displacement factor

| Rated Input power, P (W) | Displacement factor |
|---|---|
| P ≤ 2 W | No limit |
| 2 W < P ≤ 5 W | ≥ 0.4 |
| 5 W < P ≤ 10 W | ≥ 0.7 |
| P > 10 W | ≥ 0.9 |

## 6.2 Functional performance requirements

### 6.2.1 Colour Rendering Index (CRI)

CRI (Ra) shall be ≥ 80

### 6.2.2 Harmonics

**, The harmonics shall conform to IEC 61000-3-2**

### 6.2.3 Nominal CCT

CCT shall be ≥ 2200 K and ≤ 6500 K and be within the 7-step quadrangles as set out in ANSI 78.377.

### 6.2.4 Lumen maintenance factor

The lumen maintenance factor $X_{LMF}$% after testing according to Annex A shall be not less than $X_{LMF,MIN}$%, calculated as follows:

$$X_{LMF,MIN}\% = 100 \times e^{\frac{(3000 \times \ln(0.7))}{L_{70}}}$$

where

$L_{70}$ is the declared $L_{70}B_{50}$ lifetime (in hours)

Upper limit for $X_{LMF,MIN}$ % is the calculated required lumen maintenance of the sample shall not exceed 96.0% (i.e., $X_{LMF,MIN} \leq 96.0$ %).

### 6.2.5 Survival factor

No less than 90 % of sample units should be operational following endurance testing according to Annex A.

### 6.2.6 EMC emissions

Electromagnetic emissions shall comply with CISPR 15.

### 6.2.7 EMC immunity

Electromagnetic immunity (including voltage surge and dip) shall comply with IEC 61547.

#### 6.2.8 Short term flicker indicator (PstLM)

PstLM shall be ≤ 1.0 at full load and a sinusoidal input voltage (i.e. intrinsic performance) inaccordance with IEC TR 61547-1.

#### 6.2.9 Stroboscopic effect visibility measure (SVM)

SVM shall be ≤ 0.4 at full load and a sinusoidal input voltage (i.e. intrinsic performance) in accordance with IEC TR 63158.

#### 6.2.10 Colour consistency

Products shall comply with either the requirements given in Table 4 the x,y chromaticity coordinates column or the u',v' chromaticity coordinates column, based on the Nominal CCT

:

Table 4 - Requirements for colour consistency

| Product Type | x,y chromaticity coordinates | u',v' chromaticity coordinates |
|---|---|---|
| General service lamps | ≤ 5 SDCM | ≤ 5 step u'v' circle |
| Tubular lamps | ≤ 3 SDCM | ≤ 3 step u'v' circle |

### 6.2.11 Control settings

The reference control settings shall be those predefined by the manufacturer as factory default values and encountered by the user at first installation (out-of-the-box values). If the installation procedure foresees an automatic software update during first installation, or if the user has the option to perform such an update, the resulting change in settings (if any) shall be taken into account.

The light source manufacturer shall define the reference control settings such that:

a) The light source is in scope of this standard according to 5.21 or 5.3 and none of the conditions for exemption of 5.3 applies (if this is not possible, the light source is out-of-scope or exempted);

b) The adjustable/selectable beam angle is the narrowest available;

c) The power consumption of lighting control parts and non-lighting parts is minimal (if these parts cannot be disconnected or switched-off);

d) The full-load condition is obtained (maximum initial luminous flux given the other chosen settings);

When the end-user opts to reset factory defaults, the reference control settings are obtained.

## 6.3 Labelling

#### 6.3.1 General

The information listed in 6.3.2 and 6.3.3 apply to the products covered in clauses 5.2 and 5.3.

#### 6.3.2 Labelling on lamp

The following information shall be legibly and indelibly printed on the lamps or included on a nameplate attached to the lamps.

a) rated power in Watts;



b) rated operating voltage;

c) rated frequency;

d) trade name or brand name;

e) rated initial luminous flux in lumens;

f) rated correlated colour temperature (CCT) in Kelvin (K);

g) current rating; and

h) for directional lamps only, beam angle in degrees.

### 6.3.3 Labelling on packaging

The following information shall be legibly and indelibly indicated on the packaging and in all other forms of product information for all products covered by this standard:

a) rated power in Watts;

b) rated operating voltage including the minimum voltage specified (i.e., the voltage range) and frequency;

c) trade name or brand name and physical address;

d) displacement factor;

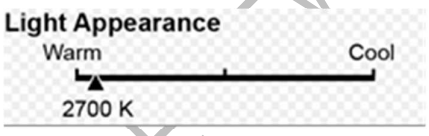
e) rated initial luminous flux in lumens;

f) rated efficacy in lumens per Watt (lm/W) for the complete lamp;

g) rated lifetime in hours and $L_{70}B_{50}$ if longer;

h) rated correlated colour temperature (CCT) in Kelvin (K) combined with a sliding scale;

2.




i) statement on dimmability. clearly state whether dimmable or not dimmable. If dimmable, then information on dimmer compatibility, or web link to this information;

j) efficiency label compliant with EASC regional energy label or a recognised equivalent; and

k) safety certifications and statement.

### 6.3.4 Labelling requirements applicable to specific types of lamps

The following information on the packaging and in all forms of product information is mandatory only for the lamp types specified below:

a) For general service lamps and tubular lamps, base type;

b) For general service lamps and tubular lamps which are, according to 5.2.2 or 5.3.2, exempted from the requirements of this standard, the intended purpose shall be stated on all forms of packaging, product information and advertisement, together with a clear indication in large font on the front of the package

that "**This Product is NOT Intended for General Illumination Purposes"** or by adding the pictogram to the packaging:

3. 

c) General service lamps that are directional: Beam angle

d) Any covered lighting product where standby power is not zero: Rated standby power ($P_{sb}$), expressed in W and rounded to the second decimal

e) Any covered lighting product where networked standby power is not zero: Rated networked standby power ($P_{net}$) for the connected light source, expressed in W and rounded to the second decimal

f) General Service Lamps which incorporate an incandescent equivalency claim: Manufacturers are not required to provide an incandescent equivalency claim (i.e. "This lamp is as bright as a 60W incandescent" or "10 W = 60 W"). However, if they do, then the equivalency shall be based on Table 5 which depicts the minimum initial luminous flux that is required to claim a specific incandescent lamp wattage equivalency:

**Table 5 — Incandescent wattage equivalencies for LED lamps**

| Incandescent Wattage Equivalency [W] | Minimum Initial Luminous Flux [lm] |
|---|---|
| | Non-directional Lamps |
| 15 | 150 |
| 25 | 250 |
| 40 | 500 |
| 60 | 800 |
| 75 | 1000 |
| 100 | 1500 |
| 150 | 2500 |
| 200 | 3500 |
| NOTE: The listed incandescent wattage equivalencies may be interpolated (e.g. 50 Watts) and extrapolated (e.g. 7 Watts) using the values in the given table | |

.

g) Any covered lighting product that incorporates a voltage surge and dip immunity claim: Manufacturers are not required to provide a voltage surge and dip immunity claim (e.g. “Withstands Power Surge”, “Power Surge Protected”). However, if they do, then the claim shall meet the EMC immunity requirements for equipment for general lighting purposes as set out in IEC 61547.

# 7 Sampling and testing

## 7.1 General

The metrics, referenced standards, conformity assessment and surveillance testing for all the covered products are set out in this clause.

Standards issued by different standardization bodies such as ISO, IEC and ARSO will only be accepted if it is proven, in the form of a declaration report from an accredited conformity assessment body, that they are technically equivalent to the relevant standards listed in Table 6 in this clause. The applicant shall be responsible for obtaining such a declaration report.

## 7.2 Referenced standards and assessment for general service lamps and tubular lamps

**7.2.1** Table 6 sets out the metrics, lamp type, standards and sample size and pass criteria for conformity assessment (for suppliers) and surveillance testing (for governments).

**7.2.2** Table 6 shall be assessed taking into account the following:

a) Valid Test reports or certificates. Test reports or certificates based on previous editions of reference standards are valid if the product has not undergone technical revisions/updates

b) ;

c) The same sample of lamps may be used for certain metrics as set out in the test sequence in Annex C;

d) The first compliance check to be luminous efficacy after initial ageing to avoid unnecessary testing of non-compliant product;

e) For suppliers (i.e., importers and manufacturers), the required sample sizes and criteria for conformity assessment shall be the same as those set-out in the requirements of the referenced measurement standards;

f) For governments (i.e., market surveillance authorities) the surveillance testing for certain criteria for verification testing are less stringent than the criteria in the Measurement Standards to allow for measurement uncertainties and manufacturing tolerances;

g) The surveillance testing criteria shall not be used by suppliers for conformity assessment with this standard (see Note 4 above);

h) Tubular LED lamps which can be connected directly to the electrical supply and to a magnetic control gear shall be tested as being connected to the electrical supply; and

i) Tubular LED lamps that can only operate on magnetic control gear shall be tested using an inductive reference ballast in series.

**Table 6 — Relevant test standards, conformity assessment and surveillance testing for general service lamps and tubular lamps**

| **Phenomena** | **Lamp type** | **Standard** | **Conformity assessment (for suppliers)** | **Surveillance testing (for government)** |
|---|---|---|---|---|
| Luminous Efficacy in [lm/W] | All | Calculated.<br>See below for (measured luminous flux / measured power) | Sample of 10 units. The arithmetical mean of the calculated luminous efficacy of the 10 units shall not be less than required level. | Sample of 10 units. The arithmetical mean of the calculated luminous efficacy of the 10 units shall not be less than required level. |
| Luminous flux in [lm] | Incandescent / Halogen | IEC 60064<br>CIE 84 / IEC 60357 | Sample of 10 units. The arithmetical mean of the measured luminous flux of the 10 units shall not be less than 92.5% of the rated luminous flux and the measured luminous flux of each individual lamp of the sample shall not be less than 90% of the rated luminous flux | Sample of 10 units. The arithmetical mean of the measured luminous flux of the 10 units shall not be less than 90% of the rated luminous flux |
| | CFL | IEC 60969<br>CIE 84 | | |
| | LFL | IEC 60081<br>CIE 84 | | |
| | LED | IEC 62612<br>CIE S 025<br>IEC 62722-2-1<br>IEC 62717 | | |
| Power in [W] | Incandescent / Halogen | IEC 60064<br>CIE 84 | Sample of 10 units. The arithmetical mean of the measured power of the 10 units shall not exceed 107.5% of the rated power, and the measured power of each individual lamp of the sample shall not exceed 110% of the rated power. | Sample of 10 units. The arithmetical mean of the measured power of the 10 units shall not exceed 110% of the rated power, and the measured power of each individual lamp of the sample shall not exceed 115% of the rated power. |
| | CFL | IEC 60969<br>CIE 84 | | |
| | LFL | IEC 60081<br>CIE 84 | | |
| | LED | IEC 62612<br>CIE S 025<br>IEC 62722-2-1<br>IEC 62717 | | |

| Phenomena | Lamp type | Standard | Conformity assessment (for suppliers) | Surveillance testing (for government) |
|---|---|---|---|---|
| Standby Power in [W] | Connected LED lamp | IEC 63103 | Sample of 10 units. The measured standby power of each individual lamp of the 10 units shall not exceed the required level by more than 100 mW. | Sample of 10 units. The arithmetical mean of the measured standby power of the 10 units shall not exceed the required level by more than 100 mW. |
| Displacement Factor | LED | IEC 62612 | Sample of 10 units. The measured displacement factor of each individual lamp of the sample shall not be less than the required level minus 0.05. | Sample of 10 units. The arithmetical mean of the measured displacement factor of the 10 units shall not be less than the required level minus 0.05. |
| Colour Rendering Index (CRI) | LED | IEC 62612<br>CIE S 025<br>CIE 13.3 | Sample of 10 units. The measured CRI of each individual lamp of the sample shall not be less than the required CRI-$R_a$ level minus 3 | Sample of 10 units. The arithmetical mean of the measured CRI of the 10 units shall not be less than the required CRI-Ra level minus 3 |
| Colour Consistency | LED | IEC 62612<br>CIE S 025<br>CIE 015 | Sample of 10 units. For each individual lamp of the sample, the measured CCT shall conform to the industry standard tolerances contained in the IEC standards used for testing. | Sample of 10 units. The arithmetical mean of the measured CCT shall conform to the industry standard tolerances contained in the standards used for testing. |
| Correlated colour temperature (CCT) in [K] | LED | IEC 62612<br>CIE S 025<br>CIE 015<br>ANSI C78.377 | Sample of 10 units. For each individual lamp of the sample, the measured chromaticity coordinates shall conform to the tolerances contained in ANSI C78.377 for the nominal CCT. | Sample of 10 units. For each individual lamp of the sample, the measured chromaticity coordinates shall conform to the tolerances contained in ANSI C78.377 for the nominal CCT. |
| Luminous flux maintenance factor | LED | See Annex A | The determined $X_{LMF}$% of the sample following the test in Annex A shall not be less than $X_{LMF, MIN}$%.[a] | The determined $X_{LMF}$% of the sample following the test in Annex A shall not be less than $X_{LMF, MIN}$%. |
| Survival Factor | LED | See Annex A | Sample of 10 units. At least 9 light units of the test sample shall be operational after completing the endurance test in Annex A. | Sample of 10 units. At least 9 light sources of the test sample shall be operational after completing the endurance test in Annex A. |



| Phenomena | Lamp type | Standard | Conformity assessment (for suppliers) | Surveillance testing (for government) |
|---|---|---|---|---|
| Short-term Flicker indicator ($P_{st}^{LM}$) | LED | IEC TR 61547-1 | Sample of 10 units. For each individual lamp of the sample, the measured intrinsic [b] $P_{st}^{LM}$ of the 10 units shall not be more than the required level plus 0.1. | Sample of 10 units. For each individual lamp of the sample, the measured intrinsic $P_{st}^{LM}$ of the 10 units shall not be more than the required level plus 0.1. |
| Stroboscopic effect Visibility Measure (SVM) | LED | IEC TR 63158 | Sample of 10 units. For each individual lamp of the sample, the measured intrinsic SVM of the 10 units shall not be more than the required level plus 0.1. | Sample of 10 units. The arithmetical mean of the measured intrinsic SVM of the 10 units shall not be more than the required level plus 0.1. |
| EMC emissions | LED | CISPR 15 | Sample of 1 unit. Shall meet the requirements of the standard | Sample of 1 unit. Shall meet the requirements of the standard |
| EMC immunity (including voltage surge and dip) | LED | IEC 61547 | Sample of 1 unit. Shall meet the requirements of the standard | Sample of 1 unit. Shall meet the requirements of the standard |
| Harmonics | LED | IEC 61000-4-7<br>IEC 61000-3-2 | Sample of 1 unit. Shall meet the requirements of the standard | Sample of 1 unit. Shall meet the requirements of the standard |

[a] There is no tolerance associated with this metric as it is a fixed requirement and it is up to the manufacturer to declare an L70B50 value to meet it.

[b] Intrinsic performance is where test is conducted with a stable mains voltage without fluctuations

## 8 Requirements for applicant

**8.1** With respect to the performance requirements (Clause 6), the following evidence shall be submitted to the national regulatory authority as proof of conformity with the requirements of this standard:

i) A completed application form as specified in Annex B or a similar form as required by the national regulatory authority;

ii) Evidence of conformity to requirements set out in Clause 6 - A valid test report issued by a laboratory appropriately accredited by an internationally recognised body being a member of an IAF/ILAC/IECEE mutual recognition scheme in accordance with the country's conformity assessment policy; and

iii) Other documents as required by the national regulatory authority;

**8.2** The applicant shall ensure that each model of the lighting product has been approved and successfully registered by the relevant regional or national regulatory authority before offering it for sale, or import, or supply in accordance with the requirements set out in the relevant regulations.

**8.3** Evidence of conformity which is deemed unacceptable includes, for example, self-certification reports, declaration of one product being applied to another, data sheets without valid test reports and so on. Only valid test reports will be accepted as evidence of compliance to the requirements of covered products.

**8.4** The applicant shall inform the regulatory authority of any change in design or materials affecting any mandatory requirement in terms of this standard for any product, even within a family of products. In the event of such change(s) the regulatory authority may, at its discretion, demand that the applicant submits a new application for approval.

**8.5**

The applicant shall, on request, provide the regulatory authority with proof of compliance in respect of any model of lighting product included in the scope of this standard. Failure to provide such proof shall constitute reasonable grounds for suspicion of non-compliance with the requirements of this mandatory regulation of the product.



# Annex A
(normative)

# Lifetime and endurance test

## A.1 General

Light sources shall undergo a switching cycle endurance testing to verify their luminous flux maintenance factor and survival factor. This endurance testing consists of the test method outlined below for LED and OLED light sources:

## A.2 Ambient conditions and test setup

**A.2.1** The switching cycles are to be conducted in a room with an ambient temperature of 25°C ± 10°C and an average air velocity of less than 0.2 m/s.

**A.2.2** The switching cycles on the sample shall be conducted in free air in a vertical base-up position. However, if a supplier has declared the light source is suitable for use in a specific orientation only, then the sample shall be mounted in that orientation.

**A.2.3** The applied voltage during the switching cycles shall have a tolerance within 2 %. The total harmonic content of the supply voltage shall not exceed 3 %. Standards provide guidance on the supply voltage source.

## A.3 Provisional endurance test method

**A.3.1** Initial flux measurement: measure the luminous flux of the light source prior to starting the endurance test switching cycle.

**A.3.2** Switching cycles: operate the light source for 1200 cycles of repeated, continuous switching cycles without interruption. One complete switching cycle consists of 150 min of the light source switched on at full power followed by 30 min of the light source switched off. The hours of operation recorded (i.e., 3000 h) include only the periods of the switching cycle when the light source was switched on, i.e. the total test time is 3600 h.

**A.3.3** Final flux measurement: at the end of the 1200 switching cycles, note if any lamps have failed (see 'Survival Factor' requirements in Clause 6.2.5) and measure the luminous flux of the light sources that have not failed.

**A.3.4** For each of the units in the sample which have not failed, divide the measured final flux by the measured initial flux. The arithmetical mean of the resulting values of all the units that did not fail provides the determined value for the luminous flux maintenance factor $X_{LMF}$%.

# Annex B
(informative)

## Lighting products conformity assessment reporting form

<table>
<tr><th colspan="5">APPLICANT DETAILS</th></tr>
<tr><td colspan="2">Applicant’s Name:</td><td colspan="3"></td></tr>
<tr><td colspan="2">Applicant’s Address:</td><td colspan="3"></td></tr>
<tr><td colspan="2">Applicant’s Postal Address (if applicable):</td><td colspan="3"></td></tr>
<tr><td colspan="2">Applicant’s Email Address:</td><td colspan="3"></td></tr>
<tr><td colspan="2">Applicant’s Telephone number:</td><td colspan="3"></td></tr>
<tr><td colspan="2">Applicant’s Website:</td><td colspan="3"></td></tr>
<tr><td colspan="2">Applicant’s Country:</td><td colspan="3"></td></tr>
<tr><td colspan="2">Applicant’s contact person:</td><td colspan="3"></td></tr>
<tr><th colspan="5">PRODUCT DETAILS</th></tr>
<tr><td colspan="2">Lighting Product Type (Tick as appropriate)</td><td colspan="3">• General service lamp<br>• Tubular lamp</td></tr>
<tr><td rowspan="6">Product model information</td><td>For single models</td><td colspan="3">For family of models</td></tr>
<tr><td>Model number</td><td>Family name of the models covered by this application</td><td colspan="2"></td></tr>
<tr><td rowspan="5">Brand</td><td colspan="3">Details of each model</td></tr>
<tr><td>Model Number</td><td colspan="2">Brand</td></tr>
<tr><td></td><td colspan="2"></td></tr>
<tr><td></td><td colspan="2"></td></tr>
<tr><td></td><td colspan="2"></td></tr>
</table>



| | | | |
|---|---|---|---|
| | | | |
| Manufacturer Details | Manufacturer Name: | | |
| | Manufacturer Address: | | |
| | Manufacturer Email Address: | | |
| | Manufacturer Telephone Number: | | |
| | Manufacturer Website: | | |
| | Country of Manufacture: | | |
| | Manufacturer Contact Person: | | |
| **TEST LABORATORY AND REPORT** | | | |
| Test Laboratory Details | Laboratory name | | |
| | Laboratory address | | |
| | Is the laboratory accredited to test according to the applicable test methods relevant to the lighting product? (Y/N) Provide details. | | |
| Test report details | Test report number: | | |
| | Report signatory: | | |
| | Test Date: | | |
| | Test units serial numbers: | | |
| | Test Report Findings | | "Compliant to abc Standard", partial acceptance, exclusions, etc<br>Just a summary |

| CONFORMITY ASSESSMENT CHECKLIST<br>Does the product meet the mandatory requirements as set out in Clause 6 of this standard? *(Please tick as appropriate)* | | |
|---|---|---|
| Mandatory requirement | Lighting product Type | |
| | GSL | Tubular Lamps |
| Luminous Efficacy | □ | □ |
| Displacement Factor (Cos ϕ1) | □ | □ |
| Harmonics | □ | □ |
| Standby Power (applicable to connected lamps and luminaires) | □ | □ |
| Colour Rendering Index (CRI) | □ | □ |
| Lumen maintenance factor | □ | □ |
| Survival factor | □ | □ |
| EMC emissions | □ | □ |
| EMC immunity | □ | □ |
| Short term flicker indicator ($P_{st}LM$) | □ | □ |
| Stroboscopic effect visibility measure (SVM) | □ | □ |
| Colour consistency | □ | □ |
| Lamp or Luminaire Information on the Product | □ | □ |
| Lamp and Luminaire Information on the Packaging and Other Forms of Product Information | □ | □ |

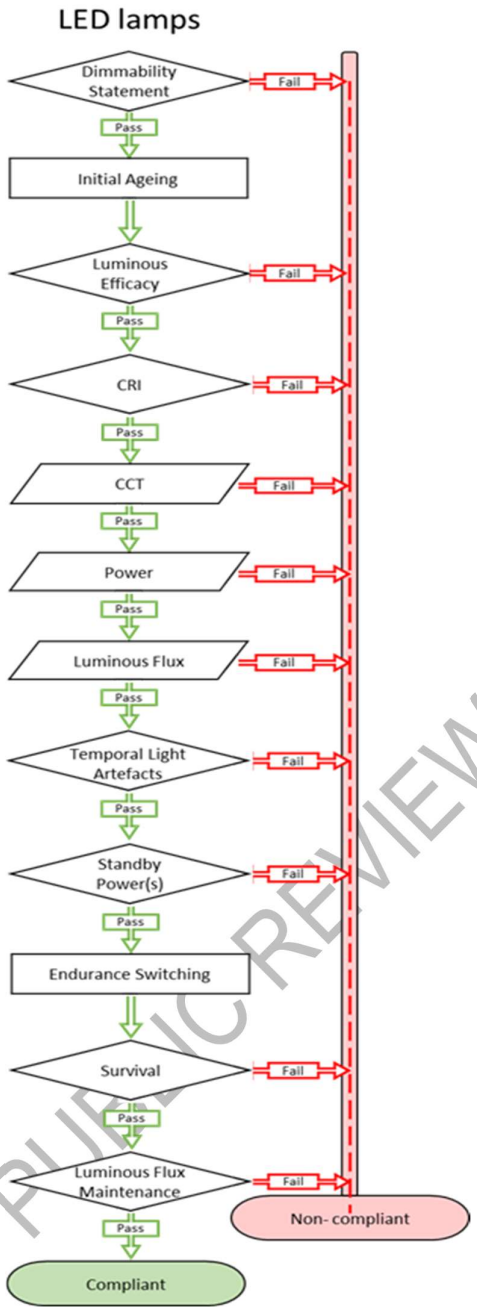


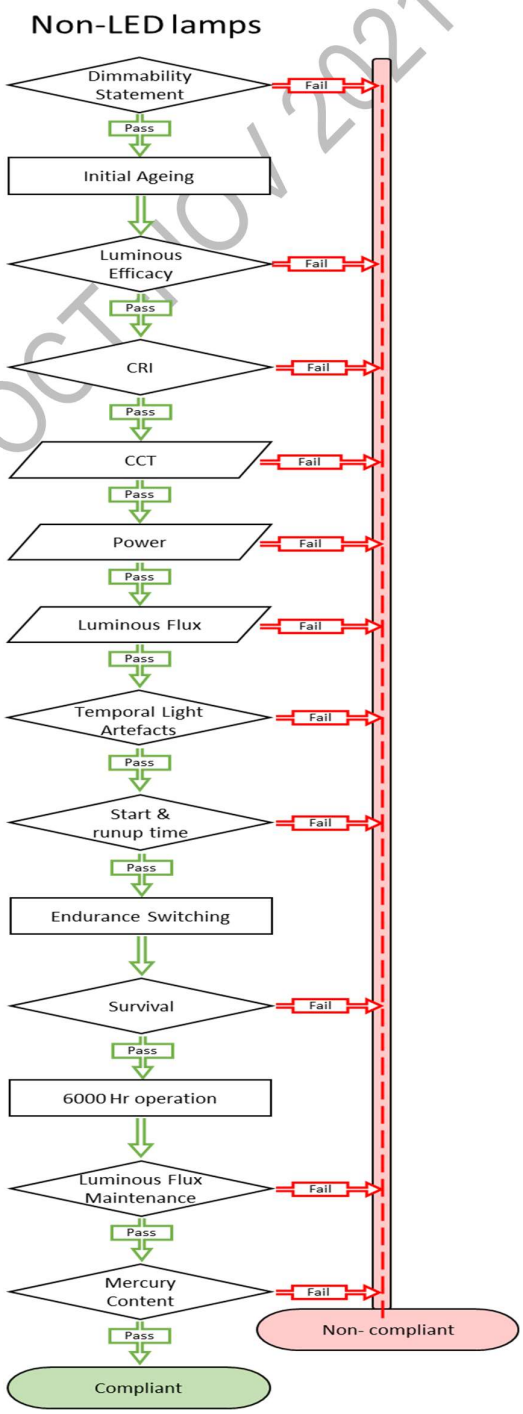
 

| PREVIOUS APPLICATIONS |
| --- |
| Have you applied for product registration in the past? □Yes □No<br>If yes, provide the registration number(s):_____ |
| Has any previous application for a registration been rejected under the relevant national regulations? □Yes □No<br>If yes, provide details. |

## Annex C
(informative)

## Sequence for compliance testing of lamps



# Bibliography

[1] United Nations Environment's United for Efficiency (U4E) model regulations (https://united4efficiency.org/lightingguidelines/)

[2] IEA 4E Solid State Lighting Annex's Quality and Performance Tiers (https://ssl.iea-4e.org/product-performance)

[3] South Africa's draft national regulation on general service lamps

[4} European Commission's Lighting Regulation (EU) 2019/2020 of 1 October 2019 (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R2020&from=EN)