UN environment programme

SUPPLEMENT TO THE LIGHTING POLICY GUIDE:
«ACCELERATING THE GLOBAL ADOPTION OF ENERGY-EFFICIENT LIGHTING»

MODEL REGULATION GUIDELINES

FEBRUARY 2021

ENERGY EFFICIENCY AND FUNCTIONAL PERFORMANCE REQUIREMENTS FOR LINEAR LIGHTING

U4E United for Efficiency

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United Nations Environment Programme – Global Environmental Facility | United for Efficiency (U4E)

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Foreword

This model regulation guideline is a supplement to the UN Environment Programme's (UNEP's) United for Efficiency (U4E) Lighting Policy Guide "Accelerating the Global Adoption of Energy-Efficient Lighting."[1] and it covers linear fluorescent tubes and linear fluorescent luminaires (fittings or fixtures). It is intended for use by regulatory authorities in developing countries and emerging economies[2] that are considering a legislative framework[3] to promote energy-efficient linear lamps and luminaires, or those that have a legislative framework but have not yet developed regulations for energy-efficient linear lamps and luminaires.

The model regulation guideline includes the means to regulate a transition for linear lighting systems to more energy-efficient LED solutions. It includes all the key elements that are needed: definitions, scope, performance requirements, information requirements, applicable test methods and compliance criteria.

Separately, U4E has developed similar guidance for general service lighting (GSL), and other categories will follow in the future. For the avoidance of doubt this model regulation guideline does not cover other light sources and equipment such as outdoor street lighting, and industrial lighting.

As stated in the GSL revised edition of the model regulation guideline for developing and emerging economies, LED technology is continuing to evolve and improve, as are the test methods and metrics used to assess the performance of these products. Thus, there are some aspects of the quality and performance criteria in the regulation which have now been added and updated, including for example non-visible flicker (stroboscopic visibility measure – SVM).

The model regulation guideline is a supplement to the Lighting Policy Guide[1] which is one of a series of U4E guidance documents. Others in the series include room air conditioners, residential refrigerators, electric motors, and transformers. As is described further in the Lighting Policy Guide, U4E encourages countries to implement an integrated policy approach, which includes five components – standards and regulations, supporting policies (e.g. communication campaigns), finance and financial delivery mechanisms, monitoring, verification and enforcement,[4] and environmentally sound management.

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[1] Accelerating the Global Adoption Of Energy-Efficient Lighting, available at https://united4efficiency.org/resources/accelerating-global-adoption-energy-efficient-lighting.

[2] This model regulation guideline is not intended for governments that already have effective lighting regulations and policy processes for energy-efficient lighting products in their country or region (e.g. Australia and the European Union).

[3] An effective legislation framework consists of regulatory requirements which can be verified and enforced. In this sense, it's recommended that the regulation include a collection of requirements which are based primarily on testing protocols and requirements set by the International Electrotechnical Commission (IEC),the International Commission on Illumination (CIE) or their national mirror standards. For some parameters, IEC and CIE standards may not be available and thus, regional standards may have to be used.

[4] Please click here to view the en.lighten monitoring, verification and enforcement guidance notes.

Subject Matter and Structure

This model regulation guideline addresses the following for general service linear lighting products:

- energy efficiency and functional performance requirements,
- product information reporting and labelling requirements,
- demonstrating compliance with the requirements, and
- market surveillance and enforcement of the requirements.

This model regulation guideline does not include unique requirements on safety (including ultraviolet (UV) hazard, blue light and infrared radiation)[5], electromagnetic compatibility (EMC), hazardous substances or warranty since these requirements are not primarily related to energy efficiency and functional performance and are therefore typically incorporated in other parallel regulations on these same products. When developing these requirements, countries should investigate and confirm that these other requirements are covered in parallel regulations; if not they could be considered for inclusion in this regulation.

The model regulation guideline applies to linear lighting products used for general illumination, including more energy efficienct products that replace linear fluorescent lighting systems using double capped tubular light sources. It covers two product groups:

- **LED luminaires replacing linear fluorescent lighting systems;** offers a draft policy framework for luminaires used in new buildings and refurbishment designed to leapfrog directly to higher energy-efficiency light-emitting diode (LED) lighting, removing new linear fluorescent luminaires from the market.
- **Linear retrofit lamps;** offers a draft policy framework designed to remove less efficient linear fluorescent lighting from the market, promoting more energy-efficient LED lighting with a staged reduction in the availability of lower efficiency linear fluorescent lighting in the market.

Designated authorities are encouraged to accelerate the adoption of higher efficency linear LED lighting systems because they offer greater energy savings potential, as well as immediate energy savings, on existing installations and avoid the use of mercury. An energy rating system to support this is recommended as part of the model regulation guidelines. Monitoring, verification and enforcement is simplified with simple, baseline and affordable minimum energy performance standards (MEPS). No correction factors (for example, those typically given for lumen output, or for connected and colour tuneable lamps) are included to reduce loopholes to a minimum.

The policy guidance presented in this document is meant to be a starting point for policy-makers in developing and emerging economies, to encourage regional harmonisation where

[5] See the U4E Lighting Policy Guide (Page 91) for health and safety issue parameters, including on UV. See IEC safety standards for photobiological safety on UV, blue light and infrared radiation.

possible, lowering costs and removing barriers to trade. The work presented in this supplement represents the best available information at the time of publication, however the authors recognise that LED technology is rapidly evolving, as are the International Electrotechnical Commission (IEC) and International Commission on Illumination (CIE) performance and test standards that underpin the metrics and requirements set out in this supplement, thus countries are encouraged to investigate current requirements and performance and test standards at the time of adoption.

Table of Contents

Article 1. Scope of Covered Products

1.1 Scope

This Regulation applies to the following types of linear products used for general illumination:

a) Linear fluorescent luminaire systems and their LED replacements.

b) Double capped linear fluorescent lamps (LFL) in three categories in line with commonly available types, T12,T8 and T5:

   i. T12 category; with a tube diameter >28mm,
   ii. T8 category; with a tube diameter >17mm and ≤28mm,
   iii. T5 category; with tube diameter ≥9mm and ≤17mm.

c) Double capped linear LED lamps of all sizes:

- and connected to an electrical supply
  - directly.
  - using existing magnetic control gear.
  - using existing electronic control gear.
- Having lamp caps that can be connected to one of the following lamps sockets:
  - G5, G13, Fa6, Fa8, R17d, or
  - alternative cap types which can be connected to the above lamp base sockets by using commercially available passive adaptors.

1.2 Exemptions

a) Any linear lamp in the scope of this Regulation shall be exempt from the requirements of Article 3, apart from the information requirements set out in Clause 3.2 (5), if it has a specific technical design for solely emitting light outside the chromaticity coordinates x and y in the range:

$0{,}250 < x < 0{,}570$, and
$-2{,}3172\ x^2 + 2{,}3653\ x - 0{,}2400 < y < -2{,}3172\ x^2 + 2{,}3653\ x - 0{,}1400$.

b) This Regulation shall not apply to light sources and separate control gears specifically tested and approved to operate:

1. in potentially explosive atmospheres,
2. for emergency use,
3. in or on civil aviation aircraft.

c) In addition, this Regulation shall not apply to double capped fluorescent lamps having a diameter of 38 mm (T12) and equipped with an external ignition strip.

d) Any light source or separate control gear within the scope of this Regulation shall be exempt from the requirements of this Regulation, with the exception of the information requirements set out in the footnote* below, if they are specifically designed and marketed for their intended use in at least one of the following applications:

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

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

iii. light sources with a peak radiation around 253,7 nm and intended for germicidal use (destruction of DNA);

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

v. light sources with the primary purpose of emitting radiation around 185,1 nm and intended to be used for the generation of ozone;

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

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

viii. 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 700-800 nm, and intended for use in horticulture;

ix. 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 wave-length, a minimum excitation purity of:

Blue	440 nm — 490 nm	90%
Green	520 nm — 570 nm	65%
Red	610 nm — 670 nm	95%

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

**Information for products specified in Point D:*

For the light sources and separate control gears specified in Point 4 above the intended purpose shall be stated in the technical documentation for compliance assessment and on all forms of packaging, product information and advertisement, together with an explicit indication that the light source or separate control gear is not intended for use in other applications.

The technical documentation file drawn up for the purposes of conformity assessment, shall list the technical parameters that make the product design specific to qualify for the exemption.

Article 2. Terms and Definitions

(a) *'arithmetical mean'* means the average of a set of numerical values, calculated by adding them together and dividing by the number of terms in the set.

(b) 'chromaticity' means the property of a colour stimulus defined by its chromaticity coordinates (x and y).

(c) '*colour rendering index*' (CRI) means the 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 ideal or natural light source. The parameter used in this Regulation is the general colour rendering index known as CRI (R_a).

(d) '*colour-tuneable lamp*' (CTL) means a connected lamp (CL) 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 range defined in the scope, and with which the lamp is in the scope of this Regulation.

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

(e) '*compliance*' means conforming to a rule, such as a law, policy, specification or standard. Also, fulfilment by countries/businesses/individuals of emission reduction and reporting commitments under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol.

(f) *'Conformity Assessment Report' (CAR)* means the documentation prepared by the manufacturer or importer of the lighting product which contains the compliance declaration, the evidence and the test reports to demonstrate that the product is fully compliant with all applicable regulatory requirements.

(g) *'connected lighting product'* (CL) means a 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.

(h) '*correlated colour temperature*' (CCT) means the 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. Unit: K (Kelvin). Lamps with a high CCT, i.e. 5000K produce blueish-white light, whereas those with a CCT of 2700K produce light that is more yellowish-white.

(i) '*data-connection parts*' means parts that perform one of the following functions:

- reception or transmission of wired or wireless data signals and the processing thereof (either used to control the light emission function or otherwise),
- sensing and processing of the sensed signals (either used to control the light emission function or otherwise),
- actuation by audio control (including voice control),
- a combination of these.

(j) '*endurance test*' (also called a supply switching test) is the switching on and off of a solid-state lighting product to simulate how a product will perform over its lifetime. The test is carried out to stress a solid-state lighting product over a period of time to help determine the failure rates of a product.

(k) '*flicker*' means the 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 Regulation is the 'P_{st}^{LM}', where 'st' stands for short term and 'LM' for light flicker meter method, as defined in standards. A value $P_{st}^{LM} = 1$ means that the average observer has a 50% probability of detecting flicker.

(l) *'fluorescence'* or *'fluorescent light source'* (FL) means the phenomenon of 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.

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

(n) *'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.

(o) *Linear fluorescent light source* (LFL) is a 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 tubes can have different diameters, commonly T5 ø16 mm, T18 ø26 mm & T12 ø38 mm

(p) *Linear LED light source* is an 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 or require direct mains connection. Essentially there can be three types; electromagnetic ballast compatible, high frequency electronic ballast compatible and direct mains connected. A fourth type is also possible where a dedicated LED driver is externally connected to the tube.

(q) ‘Ambient linear luminaires’:

- *300x1200 mm, 600x600 mm, and 600x1200 mm modular luminaires for ambient lighting of interior commercial spaces*. Common recessed, suspended, or surface-mounted luminaires intended to provide ambient lighting in settings such as office spaces, schools, retail stores, and other commercial environments. Products close to the stated form factors within a tolerance of ±100 mm are included in this definition;

- *Direct linear ambient luminaires*. Suspended or surface-mounted luminaires or recessed luminaires, no wider than 305 mm, designed to provide direct lighting in indoor spaces. Products may be designed to be installed end-to-end to create long chains, and may be described as direct, indirect, semi-direct, semi-indirect, or general ambient, depending on intended lighting distribution. Utilitarian ’strip‘ style luminaires are also included under this definition;

- *Linear ambient luminaires with indirect component.* Suspended-mounted luminaires or recessed luminaires, no wider than 305 mm, designed to provide ambient lighting in indoor spaces, including an intentional lighting component that is indirect. Products may be designed to be installed end-to-end to create long chains, and may be described as indirect, semi-direct, semi-indirect, direct-indirect, indirect-direct, or general ambient, depending on intended lighting distribution.

(r) ‘*illumination*’ means the application of light to a scene, objects or their surroundings so that they may be seen.

(s) ‘*lamp*’ means a light source made to produce an optical radiation, usually visible. Note: The term ’lamp‘ is often referred to as a bulb or light bulb and is also sometimes used to describe certain types of luminaires/lighting fixtures.

(t) ‘*lamp cap*’ means that 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: The term ‘base’ is also used in both the United Kingdom and the United States 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: 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.

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

(v) '*light emitting diode'* (LED) means a 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.

(w) '*lumen*' (lm) is an SI unit of luminous flux where 1 lumen is defined as the amount of luminous flux emitted in unit solid angle (steradian) by a uniform point source having a luminous intensity of 1 candela. The amount of light a lamp provides is stated in lumens.

(x) '*luminaire*' means an apparatus which distributes, filters or transforms the light transmitted from integrated LED modules or 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.

(y) *'luminous efficacy'* (η_v or Φ_v) is defined as the quotient of the luminous flux emitted by the power consumed by the lamp or integrated LED module. It is an indicator of how energy efficient a lamp (or bulb) or integrated luminaire is. Unit: lm/W (lumen/Watt).

(z) *'luminous flux' or 'flux'* (Φ) means the quantity derived from radiant flux (radiant power) by evaluating the electromagnetic radiation in accordance with the spectral sensitivity of the human eye. If not specified differently, it refers to the rated, maximum initial luminous flux of a light source, after a short operating period, and to the total flux emitted in a solid angle of 4π steradians (corresponding to a 360˚ sphere). Unit: lm (lumen).

(aa) '*rated luminous flux*' (of a type of lamp or integrated luminaire) means the value of the initial luminous flux of a given model of lamp or integrated luminaire declared by the manufacturer or the responsible vendor, the light source being operated under specified conditions. Unit: lm (lumen). Note 1: The initial luminous flux may be the luminous flux of a light source after a short ageing period, as specified in the relevant standard. Note 2: The rated luminous flux is sometimes marked on the light source. (IEC)

(bb) '*rated power*' (of a type of lamp or integrated luminaire) means the value of the power of a given type of lamp or integrated luminaire declared by the manufacturer or the

responsible vendor, the light source being operated under specified conditions. Unit: W (Watts). Note: The rated power is usually marked on the light source. (IEC)

(cc) '*rated voltage*' or '*rated voltage range*' means the 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.

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

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 the reference control setting(s) for testing the product.

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

- the light source is in scope of this Regulation according to Clause 1.1 and none of the conditions for exemption of Clause 1.2 apply (if this is not possible, the light source is out-of-scope or exempted),
- the power consumption of lighting control parts and non-lighting parts is minimal (if these parts cannot be disconnected or switched-off),
- 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.

(ee) *'sensor'* means a device permanently connected to the electricity supply and integrated in a lamp or luminaire to sense environmental conditions and control the lamp in some way. For example, a daylight sensor that switches the lamp or luminaire on at dusk or a presence detector that turns the lamp or luminaire off when nobody is there.

(ff) *'stroboscopic effect'* means a change in motion perception induced by a static 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 Regulation 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.

Article 3. Requirements

The products in the scope of this Regulation shall meet the energy efficiency requirements and functional performance requirements of Clause 3.1 and the product information requirements of Clause 3.2 and shall be assessed according to the compliance criteria and the referenced standards of Clause 3.3. All luminares in this article must be supplied with the light source.

3.1 Energy efficiency and functional performance requirements

3.1.1 Linear luminaires

<table>
<tr><th>Phenomena</th><th>Level</th></tr>
<tr><td>Luminous Efficacy of luminaire system as a whole</td><td>
<table>
<tr><th>Luminous Efficacy lm/W</th><th>Energy Rating Level</th></tr>
<tr><td>≥100</td><td>MEPS – 0</td></tr>
<tr><td>≥115</td><td>1</td></tr>
<tr><td>≥130</td><td>2</td></tr>
<tr><td>≥145</td><td>3</td></tr>
<tr><td>≥160</td><td>4</td></tr>
</table>
Luminaires that allow the end user to adapt the spectrum of the emitted light shall be evaluated using the reference control settings.

The MEPS level is a true baseline, no correction factors are allowed and test results for each of 3 luminaires measured must comply. Note; if one luminaire fails catastrophically then the supplier is given the option of supplying 10 more none of which my fail, then 1 of the 10 will be selected at random to complete the tests. (see Clause 3.3).
</td></tr>
<tr><td>Fundamental Power Factor (also called Displacement Factor or Cos φ_1)</td><td>
<table>
<tr><th>Rated Input Power
P in W</th><th>Fundamental
Power Factor</th></tr>
<tr><td>P ≤ 5 W</td><td>No limit</td></tr>
<tr><td>5 W < P ≤ 10 W</td><td>≥ 0.5</td></tr>
<tr><td>10 W < P ≤ 25 W</td><td>≥ 0.7</td></tr>
<tr><td>P > 25W</td><td>≥ 0.9</td></tr>
</table>
</td></tr>
<tr><td>Standby Power</td><td>
<table>
<tr><th>Linear LED Lighting System Characteristic</th><th>Standby Power in W</th></tr>
<tr><td>Connected</td><td>≤ 0.5</td></tr>
<tr><td>With internal sensor</td><td>≤ 0.5</td></tr>
</table>
</td></tr>
</table>

Phenomena	Level
Colour Rendering Index (CRI (R_a))	≥ 80 R_a
Early Failure Test	After 3000 hours operation per the prescribed cycling rate of 150 minutes ON and 30 minutes OFF in Appendix B, the average lumen maintenance must be ≥ 96%
Short Term Flicker Perceptibility (P_{st}^{LM})	≤ 1.0 at full load and a sinusoidal input voltage
Stroboscopic Effect Visibility (SVM)	≤0.4 Note: Luminaires directly connected to mains supply and at full load. **Context to Readers of the Model Regulation Guidelines** The value 0.4 SVM was decided upon by reviewing policy trends, including: • International Energy Agency (IEA) – Energy Efficient End-use Equipment (4E) Solid State Lighting (SSL) Annex which has a value of 0.4. • European Commissions Ecodesign Directive – currently also has a value of 0.4 but it is under consideration for a transition value of 0.9. All are a more onerous level than legacy conventional fluorescent technology which achieves 1.3 to 1.6. Governments and stakeholders interested in implementing the Model Regulation Guidelines should research on the latest information and/or contact U4E for more information and the current status.
Mercury Content	The luminaire and light source shall not contain any mercury (0.0 mg)

3.1.2 Linear double capped lamps – for retrofit

Phenomena	Level
Luminous Efficacy of Lamp	**Luminous Efficacy lm/W** / **Energy Rating Level** ≥110 / MEPS – 0 ≥125 / 1 ≥140 / 2 ≥155 / 3 ≥170 / 4 The MEPS level is a true baseline, no correction factors are allowed and test results for each of 10 lamps measured must comply, with only one lamp out of 10 allowed below the baseline by up to 5%. Note: 11 lamps are sampled and 10 selected for test with one reserve. Only one catastrophic failure is allowed and must be substituted with the reserve. (see Clause 3.3)

<table>
<tr><th>Phenomena</th><th>Level</th></tr>
<tr><td>Luminous Efficacy of Lamp continued…</td><td>In order to facilitate the phased transition from LFL to LED, LFL only come into scope step by step firstly T12, then T8 and finally T5 as defined in Article 4. As each category comes into scope they will have to be replaced with LED alternatives in order to meet the minimum energy performance above.

Lamps that allow the end user to adapt the spectrum of the emitted light shall be evaluated using the reference control settings.</td></tr>
<tr><td>Standby Power</td><td>
<table>
<tr><th>Linear Lamp Characteristic</th><th>Standby Power in W</th></tr>
<tr><td>LFL</td><td>Not applicable</td></tr>
<tr><td>connected</td><td>≤ 0.5</td></tr>
<tr><td>with internal sensor</td><td>≤ 0.5</td></tr>
</table>
</td></tr>
<tr><td>Fundamental Power Factor (also called Displacement Factor or Cos φ_1)</td><td>
<table>
<tr><th>Rated Input Power
P in W</th><th>Fundamental
Power Factor</th></tr>
<tr><td>P ≤ 5 W</td><td>No limit</td></tr>
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<tr><td>P > 25W</td><td>≥ 0.9</td></tr>
</table>
</td></tr>
<tr><td>Colour Rendering Index (CRI (R_a))</td><td>≥ 80 R_a</td></tr>
<tr><td>Early Failure Test</td><td>After 3000 hours operation per the prescribed cycling rate of 150 minutes ON and 30 minutes OFF in Appendix B, the average lumen maintenance must be ≥ 95%</td></tr>
<tr><td>Short Term Flicker Perceptibility (P_{st}^{LM})</td><td>≤ 1.0 at full load and a sinusoidal line voltage input.</td></tr>
<tr><td>Stroboscopic Effect Visibility (SVM)</td><td>≤0.4 at full load and a sinusoidal line voltage input.

Context to Readers of the Model Regulation Guidelines

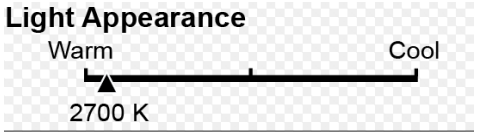
The value 0.4 SVM was decided upon by reviewing policy trends, including:
• International Energy Agency (IEA) – Energy Efficient End-use Equipment (4E) Solid State Lighting (SSL) Annex which has a value of 0.4.
• European Commissions Ecodesign Directive – currently also has a value of 0.4 but it is under consideration for a transition value of 0.9.

All are a more onerous level than legacy conventional fluorescent technology which achieves 1.3 to 1.6. Governments and stakeholders interested in implementing the Model Regulation Guidelines should research on the latest information and/or contact U4E for more information and the current status.</td></tr>
<tr><td>Mercury Content</td><td>The linear lamp shall not contain any mercury (0.0mg mercury)</td></tr>
</table>

3.2 Product information requirements

The following information shall be clearly and prominently indicated on the packaging and in all other forms of product information. Items 1,2,3 and 7 should also appear on the product label.

1) Rated power in Watts.
2) Rated voltage in Volts.
3) Rated initial luminous flux in lumen.
4) Rated efficacy in lumens per Watt (lm/W).
5) Energy level as indicated by the conformity assessment report (see Article 5).
6) Statement on control compatibility for products directly connected to the electrical supply – clearly state whether dimmable or not dimmable. If yes, then information on dimmer compatibility, or web link to this information.
7) Rated correlated colour temperature (CCT) in Kelvin (K) combined with a sliding scale on the packaging and indicated numerically on the product label.



8) For products which are exempted, under Clause 1.2, from the requirements of Clauses 3.1 and 3.2, 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 the **Product is NOT Intended for General Illumination Purposes** or by adding the below pictogram to the packaging.

Manufacturers are not required to provide a lifetime claim. However, if the manufacturer optionally decides to make a product lifetime claim on the packaging, or on other forms of product information, then:

- Lifetime [hours] claim of LED products– manufacturers shall provide evidence to the regulator that substantiates the claim according the L70F50 definition of IEC 62612.

3.3 Referenced test standards, compliance certification and surveillance testing

The metrics, referenced standards, compliance certification and surveillance testing criteria are set out in this section.

Note 1: The latest edition of the referenced measurement standards (including any amendments) applies.

Note 2: The same sample of lamps may be used for certain metrics as set out in the test sequence in Appendix A. (The first compliance check to be luminous efficacy after initial ageing to avoid unnecessary testing)

Note 3: For suppliers (i.e., importers and manufacturers), the required sample sizes and compliance criteria for compliance certification shall be the same as those set out in the requirements of the referenced measurement standards.

Note 4: For governments (i.e., market surveillance authorities) the surveillance testing criteria for verification testing are less stringent than the criteria in the Measurement Standards to allow for measurement uncertainties and manufacturing tolerances.

Note 5: The surveillance testing criteria shall not be used by the suppliers to certify compliance with the Regulation (see Note 3 above).

Note 6: Linear LED products 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.

Note 7: Linear LED products that can only operate on magnetic control gear shall be tested using an inductive reference ballast in series.

Table of referenced test standards, compliance certification and surveillance testing (ref 3.3)

Phenomena	Measurement Standards	Surveillance Testing (for government)
Luminous Efficacy Linear Luminaires	Measured luminous flux/measured power See below	Three are selected at random. The calculated luminous efficacy of each of the three units shall not be less than the required level. If one unit fails catastrophically then the supplier has the option to supply 10 more, all of which must work and one is selected at random to complete the tests.
Luminous Efficacy Linear Lamps	Measured luminous flux / measured power See below	From a sample of 11 units, 10 are selected at random. The calculated luminous efficacy of each of the 10 units shall not be less than the required level with only one out of 10 allowed under the baseline by up to 5%. If one unit fails catastrophically it is replaced with the reserve, if another fails then the product is non-compliant.
Luminous Flux in lm	IEC 62612 CIE S025 IEC 62722.2.1 IEC 62717	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.

Phenomena	Measurement Standards	Surveillance Testing (for government)
Power in W	IEC 62612 CIE S025 IEC 62722.2.1 IEC 62717	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.
Standby Power (connected product only)	IEC 63103	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.
Fundamental Power Factor	IEC 62612	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 ($R_{a)}$)	IEC 62612 CIE S 025 CIE 13.3	Sample of 10 units. The arithmetical mean of the measured CRI (R_a) of the 10 units shall not be less than the required CRI (R_a) level minus 3.
Correlated Colour Temperature (CCT)	IEC 62612 CIE S025 CIE 15	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.
Early Failure Test	See Appendix B	Sample of 10 units for linear lamps and three for linear luminaires. After 1200 cycles of 150 minutes ON and 30 minutes OFF, at least nine linear lamps or three linear luminares shall still be operational and the arithmetical mean of the luminous flux of the remaining units shall be at least 95% for linear lamps and at least 96% for luminaires of initial luminous flux (lumen maintenance).
Flicker	IEC TR 61547-1	Sample of 10 units. The arithmetical mean of the measured P_{st}^{LM} of the 10 units shall not be more than the required level plus 10%.
Stoboscopic Effect Visibility	IEC TR 63158	Sample of 10 units. The arithmetical mean of the measured SVM of the 10 units shall not be more than the required level plus 10%.
Lifetime Claim	L70F50 definition of IEC 62612	Suppliers must provide evidence (of a scientific or experimental nature) to the regulator that substantiates the lifetime claim. Lifetime claim shall not exceed the value demonstrated by the evidence.

Article 4. Entry into Force

The product and information requirements set out in Article 3 shall take effect from the date indicated in the table below which vary by the Article 1.1 product category as indicated. The date shall be no later than that in Column B in any case, and preferably earlier, in line with the date in Column A.

Effective Date of Regulation by Category, Column A or B whichever comes first		
Product Category	**Column A Earliest Date**	**Column B Latest Date**
Luminaires & T12 category	1 year after publication	1/1/2023
T8 category	2 years after publication	1/1/2024
T5 category	3 years after publication	1/1/2025

Article 5. Declaration of Conformity

The compliance with the requirements of article 3 should be demonstrated through a Conformity Assessment Report (CAR), which shall:

(1) demonstrate that the product model fulfils the requirements of of this Regulation,

(2) provide any other information required to be present in the technical documentation file,

(3) specify the reference setting and conditions in which the product complies with this Regulation.

The CAR shall be submitted to [*agency name*] for review prior to making the product available for sale. If the CAR for the designated model is approved, which is confirmed by written correspondence from [*agency name*] and listing of the product on [*product registration system*], the model may be sold in the market. A CAR is valid for the designated model for 24 months. If a CAR is rejected, a written explanation will be provided to the submitter. All aspects identified in the written explanation must be addressed in a revised CAR. Until the CAR is approved, the product is ineligible for sale in the market. An updated CAR must be submitted to [*agency name*] at least 90 days prior to the expiration of the current CAR.

Article 6. Market Surveillance

6.1 Introduction

The designated authority implementing this Regulation shall develop a programme to check compliance with this standard and monitor the market for noncompliance. The programme should include details on sample size, laboratory accreditation requirements (ISO/IEC 17025 certified), and a challenge process that manufacturers can utilize if the initial testing of their product is found to be out of compliance.

[*Agency name*] will be responsible for enforcement activities that include potential assessment of fines and barring the ongoing sale of non-compliant products in the country. [*Agency name*] shall establish written policies that clearly spell out its authority, procedures, and penalty structure. All testing carried out for compliance and market surveillance testing purposes shall be in accordance with the measurement and calculation methods set out in this Regulation.

6.2 Outline procedure

In the context of verifying compliance of a product model with the requirements laid down in this Regulation, the government authorities shall apply the following procedure:

(1) The government authorities shall test samples of the same model from the same manufacturer, randomly selected in line with the table in Clause 3.3 and following the test sequence in Appendix A.

(2) The model shall be considered to comply with the applicable requirements if:
   a. all measured parameters as defined in Clause 3.3 and the values calculated from these measurement(s) are within the respective verification tolerances,
   b. the supplied technical documentation file provides sufficient evidence of the lifetime to substantiate the claim made by the manufacturer,
   c. the product information meets the requirements of Clause 3.2 including:
      i. the required statement on control compatibility and if compatibility is claimed then it is stated on the product label and packaging with further information provided qualifying this in instruction sheets or online.

(3) If the results referred to in Points 2 (a), 2 (b) and 2 (c) above are not achieved, the model shall be considered not to comply with this Regulation.

(4) If a decision of non-compliance is taken according to Point 2 against a manufacturer, the government authority may inform other government authorities in the region within a reasonable time period (normally one month) of the decision being taken to help protect against the widespread sale of the same model.

Government authorities shall use the measurement and calculation methods set out in this Regulation and shall only apply those verification tolerances set out in Article 3, and the procedure described in this article (Article 6), Points 1 to 4 inclusive. No other tolerances, such as those set out in harmonised standards or in any other measurement method, shall be applied.

Article 7. Revision

It is recommended that this Regulation be reviewed regularly every three years to take into account technological progress and to address any unforeseen loopholes being exploited. The review shall consider not only energy efficiency requirements but also those related to light quality, as well as enviromentally conscious deign (see Article 9). This shall include but not limited to the following topics:

- setting more stringent energy efficiency requirements for all light source types,
- removing any apparent loopholes,
- substituting the CRI and CCT metrics by a more adequate metrics,
- setting requirements on dimming, including the interaction with flicker,
- combining this Regulation with other lighting-related Regulations.

Article 8. Benchmark Models (Best Available Technology)

The best available technology on the market, at the time of entry into force of this Regulation, for the environmental aspects that were considered significant and are quantifiable, is indicated below.

> The most efficient linear light sources are LEDs with an efficacy of: 165-185 lm/W
> Based on useful luminous flux at a CRI of Ra 80 with a fixed CCT above 3500K

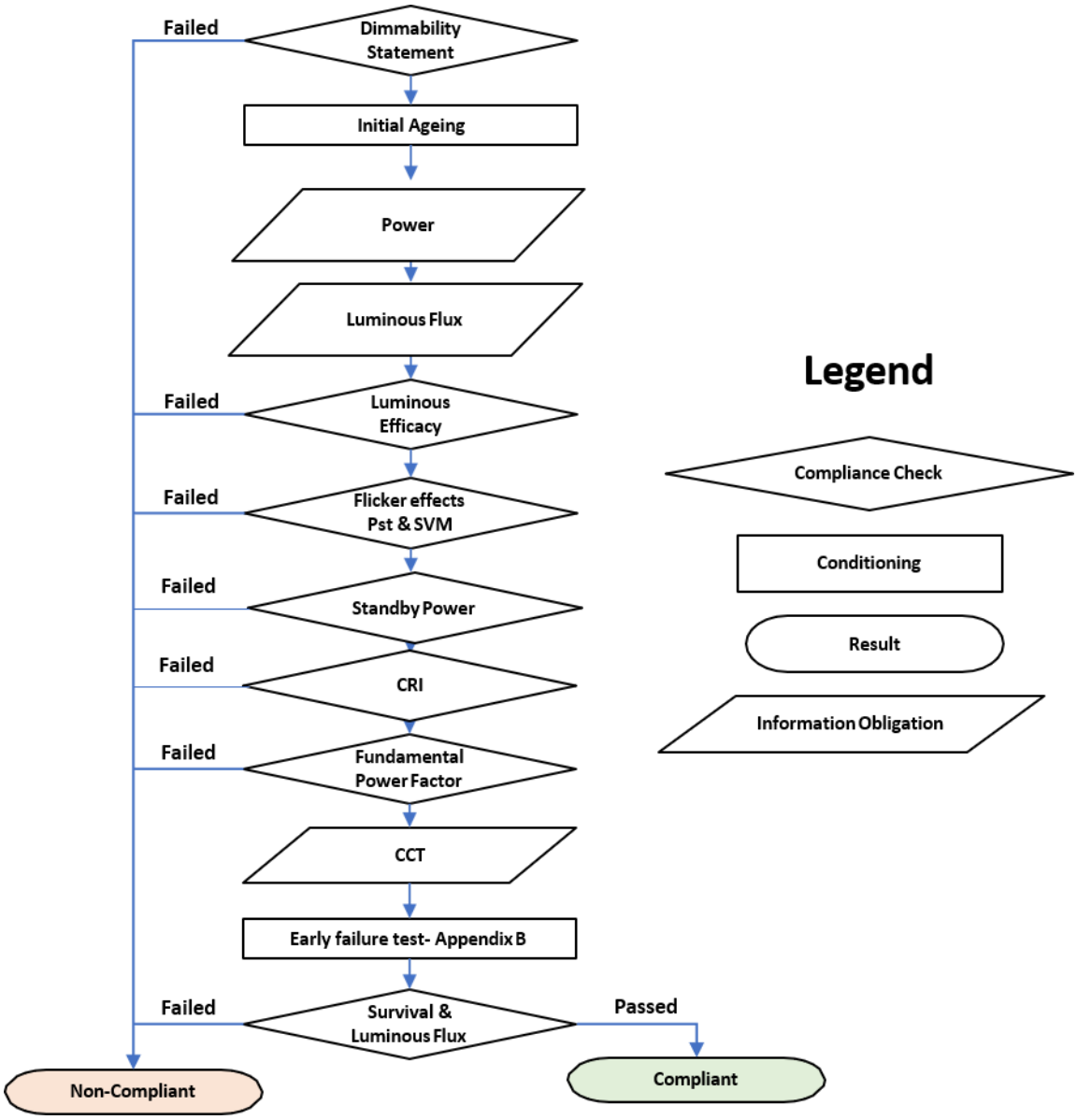
Luminaires are not quoted separately because they have many and varied optical components which trade off higher efficacy levels for optical control on such things as lower glare and higher quality lighting. The best available LED sources within the luminares will have a similar efficiacy.

Article 9. Environmentally Conscious Design (ECD)

National Authorities are recommended to consider this when registering products and to introduce a scheme to recoginse manufacturers who follow the IEC 109 guidelines (Appendix C has the checklist for reference). This is under constant revision so the latest Information from the IEC should be referred to.

Appendix A. Test Sequence

Note: Mercury containing products such as fluorescent lamps cannot comply with the Regulation so this should be checked first.



Appendix B. Combined Tests for Early Failure and Lumen Maintenance

The combined test for LED linear products shall be conducted using a sample of 10 units for linear lamps and three for linear luminaires. For linear lamps, if more than one unit fails before the end of the test then both tests have failed and the test has failed and is stopped. For luminaires if one unit fails the test has failed and is stopped. If not then the test continues until 3000 test hours is reached and at that point the arithmetical mean of the measured luminous flux of the remaining products shall be at least 96% for luminaires and 95% for lamps of the arithmetical mean of their initial luminous flux. (i.e. lumen maintenance). The testing shall be conducted:

a) In a room with an ambient temperature in the range of 15°C to 40°C where vibration and shock are minimized and the lamps under test are not subject to supplemental ventilation or cooling (e.g. blowing air from a fan or air conditioner directly onto the area where the testing racks and lamps are located).
b) With the LED products operated in free air in a horizontal position.
c) At the LED product's rated voltage and frequency if a single value is declared. If the rated voltage is a range, the LED product shall be tested at the mean voltage of that range. For dual-voltage LED products, for example those intended for operation at 110 V to 130 V and 220 V to 240 V, ageing and testing shall be conducted at the mean voltage of each voltage range. The test voltage supply shall have a tolerance within 2%. The total harmonic content of the supply voltage shall not exceed 3%. The harmonic content is defined as the root mean square (RMS) summation of the individual harmonic components using the fundamental as 100%. IEC 61000-3-2, Annex A, provides guidance on the supply voltage source.
d) With the LED products operating for 1200 cycles. A cycle is defined as a repeatedly switching cycle of 150 minutes ON followed by 30 minutes OFF. The hours of operation recorded (i.e. 3000 hours) shall only include the periods of the cycle when the lamp was switched ON.

Note 1: Luminous flux of each LED product under test should be measured at time t = 0 (initial luminous flux prior to any cycling) and at the completion of 1200 cycles (150 minutes ON, 30 minutes OFF).

Note 2: Linear LED products 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.

Note 3: Linear LED products that can only operate on control gear shall be tested using an inductive reference ballast in series.

Appendix C. IEC Guide 109 – advisory checklist

Consideration of environmental aspects in product regulations

As far as possible provisions in product regulation should support or at least not hamper the environmental objectives that are specified in the following check list.

Resource conservation

- Minimal material content in the product
- Minimal material content in the packaging
- Minimal number of different materials
- Maximum separability of different materials
- Maximum recyclability of used materials
- Reusability of product parts and components
- Reusability and upgradability of the product as a whole
- Possibility of using recycled materials
- Possibility of using refurbished product parts and components
- Minimal size of product
- Minimal mass of product

Energy conservation

- Minimal energy consumption during the product´s operation
- Power management, e.g. automatic change to standby mode

Pollution prevention

- Avoidance of hazardous substances
- Avoidance of substance emissions into the environment (air, water, soil)
- Avoidance of other releases, e.g. radiation, noise, dust

Avoidance of waste

- Modularity allowing multiple use of components

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