

# Draft Minimum Energy Performance Standards for LED Lighting

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# Draft Minimum Energy Performance Standards for LED Lighting

This preliminary draft MEPS has been developed as part of a range of options for addressing LED lighting efficiency and performance in Australia and New Zealand. Any application of a MEPS to LED lighting in Australia and New Zealand will be subject to approval by governments following consideration of a Regulation Impact Statement (after public consultation). The draft MEPS has been developed in consultation with a technical working group of stakeholders from lighting and control supply, government programs and test laboratories, and is now issued for stakeholder comment as part of the development of these proposals. Comments or questions on the draft can be sent to [EER-Lighting@industry.gov.au](mailto:EER-Lighting@industry.gov.au) by Friday 19 August 2016. More information about the Equipment Energy Efficiency Program is available at: [www.energyrating.gov.au/](http://www.energyrating.gov.au/) with specific background on LED lighting available in the LED lighting Product Profile here: [www.energyrating.gov.au/consultation/led-lighting-product-profile-consultation](http://www.energyrating.gov.au/consultation/led-lighting-product-profile-consultation)

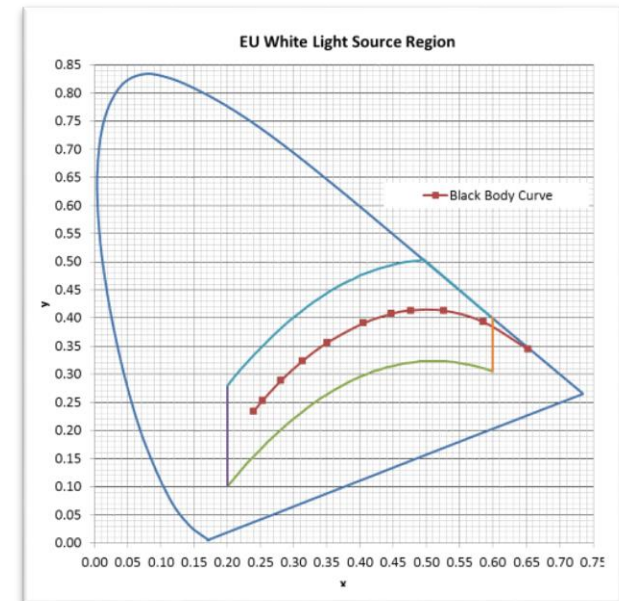
## Scope

This Draft Minimum Energy Performance Standards (MEPS) for LED Lighting is proposed to apply to the sale and commercial use of the range of LED products specified below. The MEPS is intended to specify minimum performance levels for lighting efficacy and a number of other performance parameters important in ensuring LED lighting provides an effective and efficient alternative to other less efficient lighting technologies (tables 1&2). Table 3 lists proposed package marking requirements. Where possible, the test requirements reference relevant international standards by the International Lighting Commission (CIE), International Electrotechnical Commission (IEC), and regional standards such as the Illuminating Engineering Society of North America. The MEPS levels are largely drawn from the International Energy Agency 4E Solid State Lighting Annex Product Quality and Performance Tiers (<http://ssl.iea-4e.org/>).

### All Lamp Categories

As well as the specific scope below, this MEPS applies to lamps and luminaires capable of being tuned to within the specified white region in any of their modes of operation. This includes fixed white light sources as well as tuneable sources which are capable of being tuned to within the white region specified by the chromaticity coordinates (x and y) range:

- $0,2 < x < 0,6$ ; and
- $-2,3172 x^2 + 2,3653 x - 0,28 < y < -2,3172 x^2 + 2,3653 x - 0,1$ .



### *Non-directional LED lamps (table 1)*

Lamps with LED light sources of all shapes with lamp caps B15, B22, E14, E27, E40, GU10, G9 and ELV lamp bi-pin caps G4, that emit  $\geq 100$  lm.

### *Directional LED lamps (table 1)*

Lamps with LED light sources of all shapes with lamp caps B15, B22, E14, E27, E40, GU10, G9 and R7, and ELV lamp bipin caps GU5.3, GX5.3, G6.35, GX53, that emit  $\geq 100$  lm.

### *Linear LED lamps (table 1)*

Linear LED lamps double-capped LED lamps including G5 and G13 caps, intended for replacing fluorescent lamps (as defined in IEC 60081) with the same caps (as defined in IEC 60081) or caps specific for double-capped linear LED lamps with a nominal length of 550 mm to 1500 mm.

### *Planar Luminaires, integrated battens & Troffers (table 2)*

Integrated LED fixtures (including panel form) intended as an alternative to tubular fluorescent based general purpose

- troffer/recessed luminaires (defined in AS/NZS 60598-2-2)
- batten/fixed general purpose luminaires, suspended or surface mount (defined in AS/NZS 60598-2-1)

### *Integrated LED Luminaires (small) (table 2)*

Integrated LED luminaires with a luminous flux of  $\geq 100$  lm and  $< 2,500$  lm. Note integrated includes a luminaire with remote control gear.

For decorative style integrated LED luminaires (see definition below) which have low volume sales of up to {a yet to be determined} annual units, a simplified registration may be submitted, including supply of manufacturer's datasheet, without demonstration of full compliance with MEPS.

Import/production volumes to be provided annually for duration of registration. Where this upper sales limit is exceeded, the supplier may either withdraw the product from sale; or alternately both complete product testing and complete a full product registration (demonstrating compliance with MEPS). Note - where decorative luminaires are designed with lamp holders rather than an integrated light source, any supplied lamp will be subject to MEPS (in a standard registration process) rather than the entire luminaire.

### *Integrated LED Luminaires (large) (table 2)*

Integrated LED luminaires with a luminous flux of  $\geq 2,500$  lm and  $< 50,000$  lm.

Includes integrated LED fixtures intended as an alternative to general purpose industrial style high bay, low bay and indoor area lighting luminaires

For decorative style integrated LED luminaires (see definition below) which have low volume sales of up to {a yet to be determined} annual units, a simplified registration may be submitted, including supply of manufacturer's datasheet, without demonstration of full compliance with MEPS. Import/production volumes to be provided annually for duration of registration. Where this upper sales limit is exceeded, the supplier may either withdraw the product from sale; or both complete product testing and complete a full product registration (demonstrating compliance with MEPS). Note - where decorative luminaires are designed with lamp holders rather than an integrated light source, any supplied lamp will be subject to MEPS (in a standard registration process) rather than the entire luminaire.

### Scope Exclusions for Integrated LED luminaires

Integrated LED luminaires (Small and Large) exclude:

- Planar Luminaires, integrated battens & Troffers (including those defined in AS/NZS 60598.2.1 and AS/NZS 60598.2.2:2002)<sup>1</sup>
- Theatrical luminaires as defined in AS/NZS 60598.2.17:2006
- Light source products that are battery operated in their fundamental operating state including
  - Portable luminaires for garden use: AS/NZS 60598.2.7:2005
  - Hand lamps as defined in AS/NZS 60598.2.8:2005
- Portable (non-fixed) luminaires (e.g. desk lamps, standard lamps, Portable general purpose luminaires as defined in AS/NZS 60598.2.4:2005,
- Rope lights and string lights (as defined in AS/NZS 60598.2.20:2002)
- Non-maintained emergency escape lighting luminaires and illuminated emergency exit signs (as defined in AS/NZS 60598.2.22)

### Definition

#### ***Decorative style integrated LED luminaires***

Integrated LED luminaires which are primarily designed for their lighted as well as their unlighted appearance and aesthetic contribution to the space. Such luminaires are typically intended for use where a decorative accent or an aesthetic appearance, not a specified amount of luminaire light output, is desired. The light output of decorative luminaires is typically not intended to independently illuminate a space or a task. (Based on NEMA Lighting Systems Division & American Lighting Association Joint Document: LSD 51-2009)

Note: a photometric quantification of this definition is under investigation for small (residential) decorative luminaires and large (non-residential) decorative luminaires.

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<sup>1</sup> As these are encompassed in the Planar Luminaires, integrated battens & Troffers category

## Performance requirements

### Table 1 - Lamps

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method												
		Non-directional lamps	Directional lamps	Linear LED (tube)															
<b>Energy Efficiency &amp; Photometric</b>																			
1	Efficacy	$\geq 65$ lm/W $\geq 85$ lm/W (2020) $\geq 100$ lm/W (2023)		$\geq 100$ lm/W $\geq 110$ lm/W (2020) $\geq 120$ lm/W (2023)	10	Average $\geq$ value specified	CIE S025												
2	Replacement Lamp Equivalence	Minimum Lumen output required when claiming equivalence to a specified GLS Tungsten Filament lamp <sup>2</sup>  10W = 100 lm 15W = 150 lm 25W = 250 lm 30W = 350 lm 40W = 500 lm 60W = 800 lm 75W = 1000 lm 100W = 1500 lm 125W = 2000 lm 150W = 2500 lm 175W = 3000 lm 200W = 3500 lm	Minimum lumen output (as a percentage of GLS lamp equivalences of same wattage) required for claimed equivalent wattage reflector filament lamps of stated lamp shapes <sup>3</sup> <table border="1" data-bbox="893 874 1162 1193"> <tbody> <tr> <td>MR11</td> <td>100%</td> </tr> <tr> <td>MR16</td> <td>110%</td> </tr> <tr> <td>AR-111</td> <td>75%</td> </tr> <tr> <td>R</td> <td>50%</td> </tr> <tr> <td>PAR</td> <td>65%</td> </tr> <tr> <td>R7 (forward lumens)</td> <td>60%</td> </tr> </tbody> </table>	MR11	100%	MR16	110%	AR-111	75%	R	50%	PAR	65%	R7 (forward lumens)	60%	ONLY IF CLAIMING Minimum lumen output required for claimed equivalence to linear fluorescent lamp.  Bare lamp <sup>4</sup> L $\leq$ 600mm: 800 lm  *600 < L $\leq$ 900mm: 1200 lm  900 < L $\leq$ 1200mm:1600 lm  *1200 < L $\leq$ 1500mm:2000 lm  [Based on Design Lights Consortium DLC requirements with * extension]	10  3 (Linear LED)	Average Luminous flux $\geq$ the specified minimum light output (lm) of the claimed Equivalent wattage	CIE S025
MR11	100%																		
MR16	110%																		
AR-111	75%																		
R	50%																		
PAR	65%																		
R7 (forward lumens)	60%																		

<sup>2</sup> All lumen values (except >125W) align with IEC62612 amd 1:2015 section 9.1 preferred rated luminous flux values

<sup>3</sup> Based on IEA 4 E SSL averaged values for directional lamps

<sup>4</sup> Based on Design Lights Consortium DLC requirements with \* extension

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Non-directional lamps	Directional lamps	Linear LED (tube)			
			(use linear interpolation between GLS wattage values listed)				
3	Centre beam luminous intensity	N/A	<p>For MR or PAR lamps with a beam angle &lt;65°, centre beam intensity should meet equivalent levels using the online tool:  <a href="http://www.energystar.gov/ipa/products/lighting/iledl/IntlampCenterBeamTool.zip">http://www.energystar.gov/ipa/products/lighting/iledl/IntlampCenterBeamTool.zip</a></p> <p>For others lamps: ONLY IF CLAIMING  Centre beam luminous intensity ≥ declared value</p>	N/A	10	<p>For MR or PAR lamps:  Average ≥ equivalent level</p> <p>For other lamps:  Average ≥ declared value</p>	CIE S025
4	Light distribution	<p>ONLY IF CLAIMING</p> <p>Omnidirectional equivalence</p> <p>No less than 5% of total flux (zonal lumens) shall be emitted in the 130° to 180° zone.</p> <p>No less than 35% of total flux (zonal lumens) shall be emitted in the 90° to 180° zone.</p>	<p>Beam angle is ± 25% of declared beam angle</p> <p>and</p> <p>50% of flux shall be in declared beam angle</p>	<p>Beam angle is ± 25% of declared beam angle</p> <p>and</p> <p>50% of flux shall be in declared beam angle</p>	10  3 (Linear LED)	No less than 8 lamps (or 3 for linear LED lamps) meet the specified requirements	CIE S025

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Non-directional lamps	Directional lamps	Linear LED (tube)			
<b>Energy conservation</b>							
5	Standby Power (For lamps with Standby mode only)		< 0.5W < 0.3W (2023)		5  3 (Linear LED)	All samples ≤ value specified	AS/NZS IEC 62301 (or IEA 4E SSL Task 7 2016 draft publication)
6	Ratio of Standby Power to On power (For lamps with Standby mode only)		$P_{\text{STANDBY}}/P_{\text{ON}} \leq 5\%$		5  3 (Linear LED)	Average ≥ value specified	AS/NZS IEC 62301  (or IEA 4E SSL Task 7 2016 draft publication)
7	Smart Lighting: on-demand power consumption feature (smart lamps only)	To be considered following the outcomes of investigations by the IEA 4E SSL and G20 working groups			1	Require device to provide energy consumption reporting that is accessible by owner	Energy Star Lamps v2 Section 12.9
<b>Colour</b>							
8	Colour Rendering		$R_a \geq 80$		10	Average ≥ value specified	CIE S025 (refers to CIE 13.3)

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method																																			
		Non-directional lamps	Directional lamps	Linear LED (tube)																																						
9	Colour Appearance	Lamp must have one of the following nominal CCTs consistent with the 7-step chromaticity quadrangles and Duv tolerances below. <sup>5</sup>			10	All samples shall have Chromaticity values that fall into the rated nominal CCT quadrangle	CIE S025 (refers to CIE S015)																																			
		<table border="1"> <thead> <tr> <th>Nominal CCT (K)</th> <th>Target CCT and Tolerance (K)</th> <th>Target Duv</th> <th>Duv Tolerance Range</th> </tr> </thead> <tbody> <tr> <td>2200</td> <td>2238 ± 102</td> <td>0.0000</td> <td rowspan="10"> <math>T_x</math>: CCT of the source            For <math>T_x &lt; 2870\text{K}</math>  <math>0.000 \pm 0.0060</math>            For <math>T_x \geq 2870\text{K}</math>  <math>D_{uv}(T_x) \pm 0.0060</math>            where  <math>D_{uv}(T_x) = 57700 \times (1/T_x)^2 - 44.6 \times (1/T_x) + 0.00854</math> </td> </tr> <tr> <td>2500</td> <td>2460 ± 120</td> <td>0.0000</td> </tr> <tr> <td>2700</td> <td>2725 ± 145</td> <td>0.0000</td> </tr> <tr> <td>3000</td> <td>3045 ± 175</td> <td>0.0001</td> </tr> <tr> <td>3500</td> <td>3465 ± 245</td> <td>0.0005</td> </tr> <tr> <td>4000</td> <td>3985 ± 275</td> <td>0.0010</td> </tr> <tr> <td>4500</td> <td>4503 ± 243</td> <td>0.0015</td> </tr> <tr> <td>5000</td> <td>5029 ± 283</td> <td>0.0020</td> </tr> <tr> <td>5700</td> <td>5667 ± 355</td> <td>0.0025</td> </tr> <tr> <td>6500</td> <td>6532 ± 510</td> <td>0.0031</td> </tr> </tbody> </table>			Nominal CCT (K)	Target CCT and Tolerance (K)	Target Duv	Duv Tolerance Range	2200	2238 ± 102	0.0000	$T_x$ : CCT of the source For $T_x < 2870\text{K}$ $0.000 \pm 0.0060$ For $T_x \geq 2870\text{K}$ $D_{uv}(T_x) \pm 0.0060$ where $D_{uv}(T_x) = 57700 \times (1/T_x)^2 - 44.6 \times (1/T_x) + 0.00854$	2500	2460 ± 120	0.0000	2700	2725 ± 145	0.0000	3000	3045 ± 175	0.0001	3500	3465 ± 245	0.0005	4000	3985 ± 275	0.0010	4500	4503 ± 243	0.0015	5000	5029 ± 283	0.0020	5700	5667 ± 355	0.0025	6500	6532 ± 510	0.0031			
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10	Colour maintenance	The shift in chromaticity co-ordinates after 6000 hours of operation, $\Delta u', v'$ (6000 hours), $\leq 0.007$			3	All samples satisfy conditions of the test method.	ISTMT (UL 1598 Clause 14) & IESNA LM80 (test includes lens and phosphors) or IESNA LM84																																			

<sup>5</sup> As per ANSI C78.377: 2015 Specifications for the Chromaticity of Solid State Lighting Products



Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Non-directional lamps	Directional lamps	Linear LED (tube)			
<b>Life</b>							
11	Premature lamp failure rate	No failures at 3,000 hours or $\leq 10\%$ early failures at 6000 hours			10	No more than 1 of the samples shall fail to operate before the end of the test duration	IESNA LM84
12	Endurance	Must survive one switching cycle for every 2 hours of rated life			10	Satisfy conditions of the test method.	IEC 62612: 2013 Section 11.3.3
13	Lumen maintenance	Lumen maintenance @ 6000 hrs $L_{x,6k} \geq 86.7\%$ (based on $L_{70}B_{50} \geq 15,000h$ )		Lumen maintenance @ 6,000h $L_{x,6k} \geq 91.8\%$ (based on $L_{70}B_{50} \geq 25,000h$ )	10	Average $L_{x,6k} \geq$ value specified	IESNA LM80/TM21 & ISTMT (IEC 60598.1 Section 12.4.1 or UL 1598 Clause 14) or IESNA LM84/TM28
14	Rated Life Declaration	Declaration of a minimum lifetime of 15,000 hours		Declaration of a minimum lifetime of 25,000 hours	N/A	Declaration Only	N/A

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Non-directional lamps	Directional lamps	Linear LED (tube)			
15	Minimum Rated Life, F <sub>50</sub>	< 50% at 15,000 hours  Not to be applied until a practical test method becomes available		< 50% at 25,000 hours  Not to be applied until a practical test method becomes available	To be determined	Average ≤ value specified	To be determined
16	Warranty duration <sup>6</sup>	Minimum 2 years plus additional 1 year for every 15,000 hours or part thereof beyond the minimum rated life declaration of:			N/A	Declaration Only	N/A
		15,000 hours		25,000 hours			
<b>Electrical</b>							
17	Power Factor	< 25W: PF > 0.50 ≥ 25W: PF > 0.90		PF > 0.90	10 3 (Linear LED)	Average power factor ≥ value specified	IEC 61000-3-2 (2014)
18	Harmonics	For products 5W < P ≤ 25W: <i>{text here is pending final approval of amendment to 61000-3-2}</i>  One of the following three requirements: 1. the harmonic currents shall not exceed the power-related limits of Table 3, column 2,			1	Comply with the requirements of IEC61000-3-2	IEC 61000-4-7

<sup>6</sup> Note the legal feasibility of a specified warranty duration is being investigated.

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method																								
		Non-directional lamps	Directional lamps	Linear LED (tube)																											
		<b>Table 3 – Limits for Class D equipment</b>																													
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		<p style="text-align: right;">or:</p> <ol style="list-style-type: none"> <li>the third harmonic current, expressed as a percentage of the fundamental current, shall not exceed 86 % and the fifth harmonic current shall not exceed 61 %. Also, the waveform of the input current shall be such that it reaches the 5 % current threshold before or at 60°, has its peak value before or at 65° and does not fall below the 5 % current threshold before 90°, referenced to any zero crossing of the fundamental supply voltage. The current threshold is 5 % of the highest absolute peak value that occurs in the measurement window, and the phase angle measurements are made on the cycle that includes this absolute peak value (see Figure 2). Components of current with frequencies above 9 kHz shall not influence this evaluation. or:</li> <li>the THD shall not exceed 70%. The third order harmonic, expressed as a percentage of the fundamental current, shall not exceed 35%, the fifth order shall not exceed 25%, the seventh order shall not exceed 30%, the ninth and eleventh order shall not exceed 20% and the second order shall not exceed 5%.</li> </ol> <p>If the lighting equipment includes means for control (e.g. dimming, colour), or is specified to drive multiple loads, then the measurement is made only at the control setting and the load of lamps that gives the maximum active input power.</p> <p>NOTE The preceding requirement is based on the assumption that, for lighting equipment using control other than phase control, the THC decreases when the input power is reduced.</p>																													

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method														
		Non-directional lamps	Directional lamps	Linear LED (tube)																	
		<p>For lighting equipment containing a control module with an active input power <math>\leq 2</math> W, the contribution of the control module to the harmonic current of the lighting equipment is disregarded e.g. by testing the equipment with control module fed by a separate mains supply.</p> <p>For products <math>&gt;25</math>W<sup>7</sup>:</p> <table border="1"> <thead> <tr> <th>Harmonic Order n</th> <th>Maximum permissible harmonic current expressed as a percentage of the input current at the fundamental frequency (%)</th> </tr> </thead> <tbody> <tr> <td>2</td> <td>2</td> </tr> <tr> <td>3</td> <td>30 - CPF *</td> </tr> <tr> <td>5</td> <td>10</td> </tr> <tr> <td>7</td> <td>7</td> </tr> <tr> <td>9</td> <td>5</td> </tr> <tr> <td>11 ≤ n ≤ 39 (odd harmonics only)</td> <td>3</td> </tr> </tbody> </table> <p>* CPF is the circuit power factor</p> <p><b><i>{text below is pending final approval of amendment to 61000-3-2}</i></b></p> <p>For the other types of lighting equipment that includes means for control (e.g. dimming, colour), the following conditions apply:</p> <ol style="list-style-type: none"> <li>the harmonic current values for the maximum active input power condition derived from the percentage limits given in Table 2 shall not be exceeded;</li> <li>at control settings leading to an active input power less than the maximum input power condition, the harmonic currents shall not exceed the limits based on the maximum active input power of: <ul style="list-style-type: none"> <li>below 50W: no limits below 5 W;</li> <li>50 W - 250 W: no limits below 10% of maximum active input power;</li> <li>above 250 W: no limits below 25 W.</li> </ul> </li> </ol>			Harmonic Order n	Maximum permissible harmonic current expressed as a percentage of the input current at the fundamental frequency (%)	2	2	3	30 - CPF *	5	10	7	7	9	5	11 ≤ n ≤ 39 (odd harmonics only)	3			
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<sup>7</sup> IEC 61000-3-2, Table 2, Limits for Class C equipment

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Non-directional lamps	Directional lamps	Linear LED (tube)			
<b>Operation</b>							
19	Dimmer compatibility	<p>Dims smoothly to 30% of light output with no observable flicker and no audible noise. When dimmer is set to 100%, light output <math>\geq</math> 90% of lamp without dimmer. For dimmable products, the manufacturer shall:</p> <p>(a) declare the conditions under which the lamp will dim            (b) provide a webpage address that lists compatible dimmer makes and models including (for ELV lamps) compatible makes and models of ELVCs available in the local market; and            (c) for each compatible dimmer, the number of luminaires that can be dimmed and the range of luminous flux levels a given dimmer-lamp combination can achieve.</p>	N/A	3 lamps 2 dimmers  (1 ELVC model if required)	All lamp/dimmer/ (ELVC, if required) combinations where compatibility claimed satisfy conditions of the test method.	To be developed <sup>8</sup>	
20	ELV converter compatibility  (For ELV Lamps only)	<p>In combination with ELV converter shall operate in a stable manner without observable flicker, light fluctuation or audible noise            Also the manufacturer shall:</p> <p>(a) declare which ELV conditions (e.g. minimum/maximum number of lamps connected to ELVC) under which the lamp will operate            (b) provide a webpage address that lists compatible ELV converter makes and models including ELVCs available in the local market.</p>	N/A	3 lamps 3 ELVCs	All lamp/ELVC combinations where compatibility claimed satisfy conditions of the test method.	To be developed	

<sup>8</sup> IEC Joint Working Committee TC 34 & 23B on the interoperability of dimmers and LED products 34/305/DTR may provide reference Also IEC TC document 34C/1187/DC on in-rush current may provide reference

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method								
		Non-directional lamps	Directional lamps	Linear LED (tube)											
<b>Health</b>															
21	Photo-biological Safety	Blue Light & UV hazards shall be either RG0 or RG1 unlimited <sup>9</sup>			1	Satisfy conditions of the test method.	IEC 62471 / CIE S009								
22	Flicker	Maximum flicker modulation (based on the flicker frequency) <sup>10</sup>			1	Satisfy conditions of the test method.	IEEE 1789								
		<table border="1"> <thead> <tr> <th>f: Flicker frequency (Hz)</th> <th>FM: Flicker modulation (%)</th> </tr> </thead> <tbody> <tr> <td>f ≤ 90Hz</td> <td>FM ≤ (0.025 × f)</td> </tr> <tr> <td>90Hz ≤ f ≤ 1250Hz</td> <td>FM ≤ (0.08 × f)</td> </tr> <tr> <td>f &gt; 1250Hz</td> <td>No FM requirement</td> </tr> </tbody> </table>		f: Flicker frequency (Hz)	FM: Flicker modulation (%)	f ≤ 90Hz	FM ≤ (0.025 × f)	90Hz ≤ f ≤ 1250Hz	FM ≤ (0.08 × f)	f > 1250Hz	No FM requirement				
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23	Glare	N/A		When the gamma (γ) angle exceeds 60 degrees, the light source luminance is no more than 10,000 candela/m <sup>2</sup> in C <sub>0</sub> , C <sub>45</sub> and C <sub>90</sub> planes	3	All lamps satisfy requirements	CIE S025								

<sup>9</sup> Based on IEC 62471/CIE S009. Guidance is provided in IEC/TR 62778:2014: Application of IEC 62471 for the assessment of blue light hazard to light sources and luminaires

<sup>10</sup> Based on IEEE 1789:2015

**Table 2 – Integrated LED luminaires**

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Small	Large	Planar, Battens & Troffers (P/B/T)			
<b>Energy Efficiency &amp; Photometric</b>							
1	Efficacy	≥ 65 lm/W ≥ 85 lm/W (2020) ≥100 lm/W (2023)		≥ 90 lm/W ≥ 110 lm/W (2020) ≥ 120 lm/W (2023)	4 (Small)  2 (Large & P/B/T)	Average ≥ value specified	CIE S025
2	Replacement Lamp Equivalence	Where claiming replacement equivalence to a specific lamp based fixture the luminaire must meet minimum lumen output provided in the lamp tables. (eg for halogen downlights replacements, use equivalence of GX5.3, GU10 directional lamps)	None provided	Luminaire lumens (per lamp) for claimed number of tubular fluorescent lamp equivalents must meet minimum lumen output provided in the lamp table.	3 (Small)  1 (P/B/T)	Average Luminous flux ≥ Claimed Equivalent wattage specified minimum light output (lm)	CIE S025
3	Centre beam luminous intensity	For luminaires claiming equivalence to MR or PAR lamps with a beam angle <65°, centre beam intensity should meet equivalent levels using the online tool: <a href="http://www.energystar.gov/ia/products/lighting/iledl/IntlampCenterBeamTool.zip">http://www.energystar.gov/ia/products/lighting/iledl/IntlampCenterBeamTool.zip</a>  ONLY IF CLAIMING	ONLY IF CLAIMING  Centre beam luminous intensity ≥ declared value	N/A	3 (Small)  1 (Large)	For MR or PAR lamp claimed equivalence:  Average ≥ of equivalent level  For other lamps:  Average ≥ of declared value	CIE S025

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Small	Large	Planar, Battens & Troffers (P/B/T)			
		Centre beam luminous intensity $\geq$ declared value					
4	Light distribution	ONLY for Directional luminaires: Beam angle is $\pm 25\%$ of declared beam angle  and  50% of flux shall be in declared beam angle	None provided		3	All samples meet the specified requirements	CIE S025
<b>Energy conservation</b>							
5	Standby Power (For luminaires with Standby mode only)		$< 0.5W$ $< 0.3W$ (2023)		3 (Small)  1 (Large & P/B/T)	All samples $\leq$ value specified	AS/NZS IEC 62301 (or IEA 4E SSL Task 7 2016 draft publication)
6	Ratio of Standby Power to On power (For luminaires with Standby mode only)	$P_{\text{STANDBY}}/P_{\text{ON}} \leq 5\%$	None provided		3 (Small)	Average $\geq$ value specified	AS/NZS IEC 62301  (or IEA 4E SSL Task 7 2016 draft publication)



Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Small	Large	Planar, Battens & Troffers (P/B/T)			
7	Smart Lighting – controlled variations in power consumption (smart luminaires only)	To be considered following the outcomes of investigations by the IEA 4E SSL and G20 working groups			1	Require device to provide energy consumption reporting that is accessible by owner	Energy Star Lamps v2 Section 12.9
<b>Colour</b>							
8	Colour Rendering	Ra ≥80			3 (Small) 1 (Large & P/B/T)	Average ≥ value specified	CIE S025 (refers to CIE 13.3)
9	Colour Appearance	Lamp must have one of the following nominal CCTs consistent with the 7-step chromaticity quadrangles and Duv tolerances below. <sup>11</sup>			3 (Small) 1 (Large & P/B/T)	All samples shall have chromaticity values that fall into the rated nominal CCT quadrangle	CIE S025 (refers to CIE S015)

<sup>11</sup> As per ANSI C78.377: 2015 Specifications for the Chromaticity of Solid State Lighting Products

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method																																			
		Small	Large	Planar, Battens & Troffers (P/B/T)																																						
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10	Colour maintenance	The shift in chromaticity co-ordinates after 6000 hours of operation, $\Delta u', v'$ (6000 hours), $\leq 0.007$			3	All samples satisfy conditions of the test method.	ISTMT (IEC 60598.1 Section 12.4.1 or UL 1598 Clause 14) & IESNA LM80 (acceptable where module tested includes lens and phosphors) or IESNA LM84																																			

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Small	Large	Planar, Battens & Troffers (P/B/T)			
<b>Life</b>							
11	Premature luminaire failure rate	No failures at 3,000 hours or ≤ 1 early failures at 6000 hours			10 (Small) 3 (Large & P/B/T)	No more than 1 of the samples shall fail to operate before the end of the test duration	IESNA LM84
12	Endurance	Must survive one switching cycle for every 1 hours of rated life <sup>12</sup>			3 (Small) 1 (Large & P/B/T)	Satisfy conditions of the test method.	IEC 62722.2.1: 2011 Section 10.3
13	Lumen maintenance	Lumen maintenance @ 6,000h  $L_{x,6k} \geq 93.1\%$  (based on $L_{70}B_{50} \geq 30,000h$ )	Lumen maintenance @ 6,000h ( $L_{x,6k}$ ) $\geq 95.4\%$ of initial  (based on $L_{70}B_{50} \geq 45,000h$ )	3	Average $L_{x,6k} \geq$ value specified	IESNA LM80/TM21 & ISTMT (IEC 60598.1 Section 12.4.1 or UL 1598 Clause 14) or IESNA LM84/TM28	
14	Rated Life Declaration	Declaration of a minimum of 30,000 hours	Declaration of a minimum of 45,000 hours	N/A	Declaration Only	N/A	
15	Minimum Rated Life, $F_{50}$	< 50% at 30,000 hours	< 50% at 45,000 hours	To be determined	Average ≤ value specified	To be determined	

<sup>12</sup> Note: twice requirement of IEC 62722.2.1

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Small	Large	Planar, Battens & Troffers (P/B/T)			
		Not to be applied until a practical test method becomes available	Not to be applied until a practical test method becomes available				
16	Warranty duration	Minimum 2 years plus additional 1 year for every 15,000 hours or part thereof beyond the minimum rated life declaration of:			N/A	Declaration Only	N/A
		30,000 hours	45,000 hours				
<b>Electrical</b>							
17	Power Factor	> 0.90			3 (Small) 1 (Large & P/B/T)	Average power factor $\geq$ value specified	IEC 61000-3-2 (2014)
18	Harmonics	For products $5W < P \leq 25W$ : <i>{text here is pending final approval of amendment to 61000-3-2}</i>			1	Comply with the requirements of IEC61000-3-2	IEC 61000-4-7
		One of the following three requirements: 1. the harmonic currents shall not exceed the power-related limits of Table 3, column 2,					

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method																								
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		<b>Table 3 – Limits for Class D equipment</b> <table border="1" style="margin: auto;"> <thead> <tr> <th>Harmonic order</th> <th>Maximum permissible harmonic current per watt</th> <th>Maximum permissible harmonic current</th> </tr> <tr> <th><i>n</i></th> <th>mA/W</th> <th>A</th> </tr> </thead> <tbody> <tr> <td>3</td> <td>3,4</td> <td>2,30</td> </tr> <tr> <td>5</td> <td>1,9</td> <td>1,14</td> </tr> <tr> <td>7</td> <td>1,0</td> <td>0,77</td> </tr> <tr> <td>9</td> <td>0,5</td> <td>0,40</td> </tr> <tr> <td>11</td> <td>0,35</td> <td>0,33</td> </tr> <tr> <td>13 ≤ <i>n</i> ≤ 39 (odd harmonics only)</td> <td><math>\frac{3,85}{n}</math></td> <td>See Table 1</td> </tr> </tbody> </table>			Harmonic order	Maximum permissible harmonic current per watt	Maximum permissible harmonic current	<i>n</i>	mA/W	A	3	3,4	2,30	5	1,9	1,14	7	1,0	0,77	9	0,5	0,40	11	0,35	0,33	13 ≤ <i>n</i> ≤ 39 (odd harmonics only)	$\frac{3,85}{n}$	See Table 1			
Harmonic order	Maximum permissible harmonic current per watt	Maximum permissible harmonic current																													
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13 ≤ <i>n</i> ≤ 39 (odd harmonics only)	$\frac{3,85}{n}$	See Table 1																													
		<p style="text-align: right;">or:</p> <p>2. the third harmonic current, expressed as a percentage of the fundamental current, shall not exceed 86 % and the fifth harmonic current shall not exceed 61 %. Also, the waveform of the input current shall be such that it reaches the 5 % current threshold before or at 60°, has its peak value before or at 65° and does not fall below the 5 % current threshold before 90°, referenced to any zero crossing of the fundamental supply voltage. The current threshold is 5 % of the highest absolute peak value that occurs in the measurement window, and the phase angle measurements are made on the cycle that includes this absolute peak value (see Figure 2). Components of current with frequencies above 9 kHz shall not influence this evaluation. or:</p> <p>3. the THD shall not exceed 70%. The third order harmonic, expressed as a percentage of the fundamental current, shall not exceed 35%, the fifth order shall not exceed 25%, the seventh order shall not exceed 30%, the ninth and eleventh order shall not exceed 20% and the second order shall not exceed 5%.</p> <p>If the lighting equipment includes means for control (e.g. dimming, colour), or is specified to drive multiple loads, then the measurement is made only at the control setting and the load of lamps that gives the maximum active input power.</p> <p>NOTE The preceding requirement is based on the assumption that, for lighting equipment using control other than phase control, the THC decreases when the input power is reduced.</p>																													

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method																
		Small	Large	Planar, Battens & Troffers (P/B/T)																			
		<p>For lighting equipment containing a control module with an active input power <math>\leq 2</math> W, the contribution of the control module to the harmonic current of the lighting equipment is disregarded e.g. by testing the equipment with control module fed by a separate mains supply.</p> <p>For products <math>&gt;25</math>W<sup>13</sup>:</p> <table border="1"> <thead> <tr> <th>Harmonic Order</th> <th>Maximum permissible harmonic current expressed as a percentage of the input current at the fundamental frequency (%)</th> </tr> </thead> <tbody> <tr> <td>n</td> <td>(%)</td> </tr> <tr> <td>2</td> <td>2</td> </tr> <tr> <td>3</td> <td>30 - CPF *</td> </tr> <tr> <td>5</td> <td>10</td> </tr> <tr> <td>7</td> <td>7</td> </tr> <tr> <td>9</td> <td>5</td> </tr> <tr> <td>11 ≤ n ≤ 39 (odd harmonics only)</td> <td>3</td> </tr> </tbody> </table> <p>* CPF is the circuit power factor</p> <p><b><i>{text below is pending final approval of amendment to 61000-3-2}</i></b></p> <p>For the other types of lighting equipment that includes means for control (e.g. dimming, colour), the following conditions apply:</p> <ol style="list-style-type: none"> <li>the harmonic current values for the maximum active input power condition derived from the percentage limits given in Table 2 shall not be exceeded;</li> <li>at control settings leading to an active input power less than the maximum input power condition, the harmonic currents shall not exceed the limits based on the maximum active input power of: <ul style="list-style-type: none"> <li>below 50W: no limits below 5 W;</li> <li>50 W - 250 W: no limits below 10% of maximum active input power;</li> <li>above 250 W: no limits below 25 W.</li> </ul> </li> </ol>			Harmonic Order	Maximum permissible harmonic current expressed as a percentage of the input current at the fundamental frequency (%)	n	(%)	2	2	3	30 - CPF *	5	10	7	7	9	5	11 ≤ n ≤ 39 (odd harmonics only)	3			
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<sup>13</sup> IEC 61000-3-2, Table 2, Limits for Class C equipment

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Small	Large	Planar, Battens & Troffers (P/B/T)			
<b>Operation</b>							
19	Dimmer compatibility	<p>Dims smoothly to 30% of light output with no observable flicker and no audible noise. When dimmer is set to 100%, light output <math>\geq</math> 90% of lamp without dimmer. For dimmable products, the manufacturer shall:</p> <p>(a) declare the conditions under which the lamp will dim</p> <p>(b) provide a webpage address that lists compatible dimmer makes and models including (for ELV lamps) compatible makes and models of ELVCs available in the local market; and</p> <p>(c) for each compatible dimmer, the number of luminaires that can be dimmed and the range of luminous flux levels a given dimmer-lamp combination can achieve.</p>	N/A		<p>1 luminaire</p> <p>1 dimmer</p>	Satisfy conditions of the test method.	To be developed <sup>14</sup>

<sup>14</sup> IEC Joint Working Committee TC 34 & 23B on the interoperability of dimmers and LED products 34/305/DTR may provide reference Also IEC TC document 34C/1187/DC on in-rush current may provide reference

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method								
		Small	Large	Planar, Battens & Troffers (P/B/T)											
<b>Health</b>															
20	Photo biological Safety	Blue Light & UV hazards shall be either RG0 or RG1 unlimited <sup>15</sup>			1	Satisfy conditions of the test method.	IEC 62471 / CIE S009								
21	Flicker	Maximum flicker modulation (based on the flicker frequency) <sup>16</sup> <table border="1" data-bbox="577 608 1133 794"> <thead> <tr> <th>f: Flicker frequency (Hz)</th> <th>FM: Flicker modulation (%)</th> </tr> </thead> <tbody> <tr> <td><math>f \leq 90\text{Hz}</math></td> <td><math>FM \leq (0.025 \times f)</math></td> </tr> <tr> <td><math>90\text{Hz} \leq f \leq 1250\text{Hz}</math></td> <td><math>FM \leq (0.08 \times f)</math></td> </tr> <tr> <td><math>f &gt; 1250\text{Hz}</math></td> <td>No FM requirement</td> </tr> </tbody> </table>			f: Flicker frequency (Hz)	FM: Flicker modulation (%)	$f \leq 90\text{Hz}$	$FM \leq (0.025 \times f)$	$90\text{Hz} \leq f \leq 1250\text{Hz}$	$FM \leq (0.08 \times f)$	$f > 1250\text{Hz}$	No FM requirement	1	Satisfy conditions of the test method.	IEEE 1789
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$f > 1250\text{Hz}$	No FM requirement														
22	Glare	When the gamma ( $\gamma$ ) angle exceeds 60 degrees, the light source luminance is no more than 10,000 candela/m <sup>2</sup> in C <sub>0</sub> , C <sub>45</sub> and C <sub>90</sub> planes			3	All lamps satisfy requirements	CIE S025								

<sup>15</sup> Based on IEC 62471/CIE S009. Guidance is provided in IEC/TR 62778:2014: Application of IEC 62471 for the assessment of blue light hazard to light sources and luminaires

<sup>16</sup> Based on IEEE 1789:2015



**Table 3: Proposed product package marking requirements<sup>17</sup>**

Ref	Attribute	Product	Package	Spec Sheet /website	Marked Value Criterion
1	Lumens	X	X	X	<p><u>Non-directional LED lamps:</u>                      The rated luminous flux should preferably<sup>18</sup> be one of the following values: 100 lm, 150 lm, 250 lm, 350 lm, 500 lm, 800 lm, 1000 lm, 1500 lm, 2000 lm, 3000 lm.<sup>19</sup></p> <p>The initial luminous flux of each individual LED lamp in the measured sample shall not be less than the rated luminous flux by more than 10 %, and not be more than the rated luminous flux by more than <del>10% unless, if the rated value is one of the preferred values listed above, then</del><sup>20</sup>20%.</p> <p>The average initial luminous flux of the LED lamps in the measured sample shall not be less than the rated luminous flux by more than 7.5 %.</p> <p><u>Directional lamps:</u>                      The initial luminous flux of each individual LED lamp/luminaire in the measured sample shall not be less than the rated luminous flux by more than 10 % and not be more than the rated luminous flux by more than 10%. The average initial luminous flux of the LED lamps in the measured sample shall not be less than the rated luminous flux by more than 7.5 %.</p> <p><u>Luminaires:</u></p>

<sup>17</sup> Note that the allowed variations between tested and rated values specified below do not apply to compliance with minimum performance requirements.

<sup>18</sup> Stakeholder input sought on whether these values should be mandatory or only encouraged.

<sup>19</sup> Note these lumen values (except for the 150W which doesn't exist) align with the IEC62612 and 1:2015 section 9.1 preferred rated luminous flux values

<sup>20</sup> The strike-through text here would be included if the preferred luminous flux values were not mandatory.

Ref	Attribute	Product	Package	Spec Sheet /website	Marked Value Criterion
					The initial luminous flux of each individual LED luminaire sample shall not be less than the rated luminous flux by more than 10 % and not be more than the rated luminous flux by more than 10%.
2	Efficacy (lumens per Watt)		X	X	The initial efficacy of each individual LED lamp or luminaire in the measured sample shall be no less than the rated efficacy by more than 10 %. The average efficacy of the LED lamps in the measured sample shall be no less than the rated efficacy by more than 7.5 %.
3	Watts (must be in a smaller font than efficacy on package)	X	X	X	The initial power consumed by each individual LED lamp in the measured sample shall not exceed the rated power by more than 5 %.
4	Replacement Lamp Equivalence (directional and non-directional lamps)		X	X	Statement of equivalence to a filament lamp. Minimum lumen output required when claiming as specified in Table 1 above.
5	Lifetime		X	X	Must be equal or above the specified minimum rated life
6	Correlated colour temperature	X	X	X	
7	Beam Angle (for directional lamps & small luminaires)	X	X	X	
8	Dimmable	X	X	X	
9	Dimmer compatibility information and weblink		X	X	
10	ELVC converter compatibility information and weblink		X	X	

Ref	Attribute	Product	Package	Spec Sheet /website	Marked Value Criterion
11	Ballast compatibility information and weblink (for Linear LED lamps)	X	X	X	
12	Website link for disposal information		X	X	
13	Standby energy use		X	X	
14	Product identification number as used for product registration		X	X	

**Table 4: Proposed test conditions**

Ref	Attribute	Test method
1	Efficacy	CIE S025
2	Replacement Lamp Equivalence	CIE S025
3	Standby Power (smart lamps only)	AS/NZS IEC 62301 (or IEA 4E SSL Task 7 2016 draft publication)
4	Smart Lighting – controlled variations in power consumption (smart lamps only)	Energy Star Lamps v2 Section 12.9
5	Colour Appearance	CIE S025 (refers to CIE S015)
6	Colour Rendering	CIE S025 (refers to CIE 13.3)

Ref	Attribute	Test method
7	Lumen maintenance	IESNA LM80/TM21 & ISTMT (IEC 60598.1 Section 12.4.1 or UL 1598 Clause 14) Or IESNA LM84/TM28
8	Premature lamp failure rate	IESNA LM80 Or IESNA LM84
9	Power Factor	IEC 61000-3-2 (2014)
10	Harmonics	IEC 61000-4-7
11	Dimmer compatibility	To be developed
12	ELV converter compatibility	To be developed
13	Photo biological Safety	IEC 62471/CIE S009
14	Endurance	Lamps IESNA LM80: 2013 Luminaires IESNA LM84: 2011
15	Flicker	IEEE 1789
16	Centre beam luminous intensity (directional lamps only)	CIE S025
17	Beam Angle	CIE S025
18	Colour maintenance	ISTMT (IEC 60598.1 Section 12.4.1 or UL 1598 Clause 14) & IESNA LM80 (acceptable where module tested includes lens and phosphors) Or IESNA LM84