Participating Countries:
Australia, China, Denmark, France, Japan, The Netherlands,
Sweden, The United Kingdom, The United States of America

Contacts:
Operating Agent: Marc FONTOYNONT (mrf.lights@gmail. com)
Program Associate: Ku'uipo CURRY (kuuipocurry@gmail.com)
Task Leader: Georges ZISSIS (georges.zissis@laplace.univ-tlse.fr)

Draft performance tiers' criteria items: explanations, rationale for inclusion and importance

The Annex recognizes the work of the CIE, IEC or IES for official technical definitions. The Annex has created this document to provide easy-to-understand explanations for the terms used in the IEA 4E SSL Annex Performance Tiers, and explain to less-technical users why each criteria item was included in the Draft Performance Tiers. In addition, the importance of each criteria item is characterized as very high, high, medium or low based on the interests of the Annex's member countries. The explanations of technical terms contained in this document are neither official CIE, IEC or IES definitions nor are not meant to be new official definitions of terms.

Criteria Item	What is it?	Why was this included in the Performance Tiers?	Importance
Minimum light output (lm) and equivalent wattage	The luminous flux (lm) quantifies the total amount of light emitted by a light source or product. The minimum light output requirement ensures that the SSL product's total light output is at least the same as the light output from an incandescent light source. These levels will also assist in evaluating manufacturer claims that a given SSL product is an equivalent replacement for a typical wattage incandescent light product.	Acceptable light output levels are of highest importance for safe working and living conditions. Accurate equivalency comparison with the products that are being replaced is also important. This importance will diminish over time as manufacturers stop selling products according to claimed equivalencies and consumers select lamps on the basis of light output (lumens) rather than wattage.	Very High
Minimum lamp luminous efficacy (lm/watt)	The ratio of the total light output of a lamp compared to power consumed (lm/watt). The higher the efficacy value, the more energy-efficient the lighting product.	This criteria item is of highest importance for the consumer and society to save energy and money.	Very High

Criteria Item	What is it?	Why was this included in the Performance Tiers?	Importance
Minimum fixture luminous efficacy (lm/watt)	The ratio of the total light output of an entire fixture compared to the power consumed (lm/watt).	This is a very important criteria item. If a very efficient light source is installed in an inefficient light fixture, a large part of the light will be lost inside the fixture. As a result, even with a very efficient light source, there will be no efficiency gains or energy saved.	Very High
Target Correlated Color Temperature (CCT) in degrees Kelvin (K)	The temperature of the lighting product in relation to the Planckian (black body) locus. CIE 15:2004 defines how to measure this parameter. ANSI C78.377 defines the target color temperatures and allowable tolerances.	The CCT metric helps consumers select the appropriate product depending on their light color preference and match lights' color across different manufacturers' lighting products. This way, when different manufacturers' light products are used in the same space there is not an unintended mix of cool-white lighting with warm-white lighting.	Very High
Color Rendering Index (CRI)	Color rendering is a measure of how similar object colors appear under one light source as compared to the object colors under a reference light source (usually an incandescent light or daylight.)Color rendering index is defined in CIE 13.3-1995.	Color rendering is very important for consumer satisfaction with a lighting product. Often, a CRI of 80 is required for office work, and recommended for use in residential applications. A CRI of 90 is recommended for tasks that require high color discrimination.	Very High
Safety marking	This criteria item specifies that a product meets electrical safety requirements and marking requirements.	All products must meet all safety regulations in an economy.	Very High

Criteria Item	What is it?	Why was this included in the Performance Tiers?	Importance
Minimum Rated Lamp lifetime (B_{50})	Lamp lifetime is typically defined as the amount of time that it takes for 50% of a statistically significant sample of lamps to fail.	It is unrealistic to measure very long lifetimes for SSL products. Having a credible B_{50} estimation is very important, as LED lighting products must have longer lifetimes to justify the high initial cost of LED lighting. If SSL products are able to meet their lifetime claims, they will be able to cut long-term energy consumption and save the consumer money.	Very High
Minimum Lumen Maintenance (time to L_{70})	A lighting product's time to L70 indicates the amount of time it takes for a lighting product's total light output to degrade to 70% of the light product's initial total light output.	Lumen Maintenance helps the consumer determine how long it will take a lighting product to degrade to the point that it is no longer useable. High lumen maintenance over time helps to justify the higher initial cost of SSL lighting products.	Very High
RoHS Compliant	The RoHS Directive prevents the use of certain hazardous materials in new electrical and electronic equipment placed on the European market after 1 July 2006.	This criteria item requires products meet requirements that limit the use of certain hazardous materials when sold in the EU. Non-EU countries may use other, similar requirements.	Very High
Photobiological hazard class (UV & blue light)	These hazard classes have been defined in IEC 62471 and this criteria item specifies the allowable amount of high frequency "blue light" (ultra violet light) that a SSL product shall emit.	This criteria item is very important for consumer safety. High frequency blue light can cause irreparable damage to eyesight. Products need to be evaluated to determine their appropriate photo-biological hazard class.	Very High

Criteria Item	What is it?	Why was this included in the Performance Tiers?	Importance
Minimum Power Factor	Power factor is the ratio of the real power flowing to the load over the apparent power of the circuit.	For the Electrical power supplier, this is of very high importance. However, for residential customers there has not been established any significant relation between the power factor of small electronic loads like SSL and the grid power factor.	High
Harmonic distortion	Harmonic distortion measures how the lighting product will affect the quality of the electrical utility's grid. Harmonic distortion is the mathematic ratio of the sum of the powers of all harmonic components to the power of the fundamental frequency.	The total harmonic distortion important to maintain the quality of the electrical grid. High harmonic distortion may cause a loss of reliability of switch pulse information.	High
Dimmer compatibility	This criteria item evaluates whether a SSL light source will operate well with installed dimmers used for incandescent light sources.	Dimmer compatibility is of high importance for the consumer as many SSL products are often not completely compatible with commonly available dimmers. As manufacturers are still trying to define and adopt a new dimming standard, the dimmer compatibility of SSL products is likely to continue to be a problem.	High
Chromaticity tolerance (Du'v')	This criteria item specifies the allowable deviation in light's color. Technically, it is the distance of a light's chromaticity from the Planckian (black body) locus. Chromaticity allowances follow those in ANSI C78.377.	This criteria item is of high importance to ensure that the light from an LED product does not have an unacceptable pink or green tint. This criteria item attempts to ensure that all lamps of the same claimed color temperature appear to be the same color when installed.	High

Criteria Item	What is it?	Why was this included in the Performance Tiers?	Importance
Color Spatial Uniformity	This criteria item specifies a maximum allowable variation in the color of light emitted at different angles. (The metric used is a chromaticity tolerance over an angular range).	It is of high importance to ensure that there are not extreme, perceptible color variations in the light output of a lamp. For directional lamps, it is often possible to see blotches of different colored light within a beam.	High
Flicker (Flicker index)	This criteria item measures the perceived photometric "flicker" of a light source.	This is an important item for both consumer satisfaction and consumer acceptance of SSL products. Some consumers may have severe health reactions to flickering light sources of certain frequencies ranging from low-grade headaches to extreme seizures. Flicker can also make rapidly moving objects seem like they are standing still, or leave after images of bright points in the visual field. The requirements minimize these stroboscopic effects.	High
Luminous intensity distribution 0-360°	This criteria item describes the measured distribution of light of a lighting product.	It is of high importance to measure this as many LED products being sold now poorly approximate the light distribution of the conventional products they claim to replace.	High
Center beam luminous intensity	This is a measurement of the intensity of the light on the optical beam axis for reflector/directional lamps or fixtures with beam angles < 65° that have a light output distribution pattern that is very high at the center of the beam of light emitted from the lamp/product.	This is an important criteria item to evaluate the performance of directional lamps/products (Reflector replacement lamps like an "MR" or "PAR" lamp or downlight fixture).	High (only for directional lamps)

Criteria Item	What is it?	Why was this included in the Performance Tiers?	Importance
Glare Luminance (cd/m2)	This performance criteria item defines the total luminance level where the visual contrast between task and light source are so high that the task cannot be distinguished. Alternatively, it is when the amount of light becomes physically painful to experience or makes it difficult to work.	High importance for the consumer's security, health, productivity and comfort.	High
Recyclability (%)	This criteria item defines how much of the SSL product must be recyclable.	This criteria item is important to manage electronic equipment waste and reduce the environmental burden of these products. Ideally, products would be designed to be easily recycled when they fail.	High
Warranty Duration	This criteria item specifies the duration in years from the date of manufacture of a SSL product.	It is very important that consumers have a guarantee that SSL products will perform as claimed.	High
Lag start time (ms)	This performance item measures the amount of time for a lighting product to begin emitting light after power is turned on.	For all applications, it is very important that the starting time of a lighting product is very short, both for emergency situations, but also for consumer acceptance.	Medium
Color Maintenance (Δ u',v' at 6,000h)	This criteria item specifies the allowable shift of the light color of a SSL product as it ages.	This criteria item ensures that as a light product ages, the perceived color of light does not shift from warm-white to cool-white or develop a green or pink tint. If a light product in a large installation is replaced by a new light product, this criteria ensures that the new product's light color will be similar in color to the other lights installed in the same space.	Medium

Contacts:
Operating Agent: Marc FONTOYNONT (mrf.lights@gmail. com)
Program Associate: Ku'uipo CURRY (kuuipocurry@gmail.com)
Task Leader: Georges ZISSIS (georges.zissis@laplace.univ-tlse.fr)

Criteria Item	What is it?	Why was this included in the Performance Tiers?	Importance
Rapid Cycling	This criteria item requires that a SSL product is rapidly switched on and off to simulate how a product will be used over its lifetime.	This criteria item requires that a test is carried out to stress a SSL product over a short period of time to determine the failure rates of a product. Often, if one electronic subcomponent in a SSL product fails, the whole product fails. A stress test like this one can help verify that an SSL product will not fail when installed and used in a consumer application.	Low