Regional Tropical Performance Criteria

LED Lamps and Luminaires

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Light Naturally

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Aim

- To propose draft performance criteria and test methods for LED lamps in the tropics

- This will provide a better determination of the performance of residential LED lighting products under tropical climates and electrical supply conditions experienced by the communities of *lites.asia* member countries.

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Causes for Failure

The failure to achieve the claimed photometric and lifetime performance of an LED lamp can be assigned to three main categories of causes:

- Poor product design &/or fabrication
- Drive current higher than recommended by LED chip manufacturer
- Poor thermal management

Detection of Failure

- For some products any issues of product design and fabrication will be identified through testing under normal operating conditions
- but for other products issues may only manifest themselves under extreme conditions (environmental & electrical).

Current LED Performance Standards

- IEC and IESNA LED Performance Standards appear not to satisfactorily cover the extended operating conditions experienced by lighting products in tropical regions.

IEC LED Performance Standard

Annex A
(normative)

Method of measuring lamp characteristics

A.1 General

All tests shall be made in a draught-free room at an ambient temperature of (25 ± 1) °C and a relative humidity of 65 % maximum.

A.3 Photometric characteristics

A.3.1 Test voltage

The test voltage shall be the rated voltage (for tolerance, see Clause A.1). In the case of a voltage range, measurements shall be carried out at the mean value.

Limiting the cost of tropical performance criteria

- Try to utilise parts of existing Standard Test methods

  Either by

  - Adding a measurement to existing test condition, or
  - Adding additional product samples to existing test condition

Review of Standards (IEC)

- IEC/PAS 62612 - 2009 Self-ballasted LED-lamps for general lighting services – Performance requirements
- IEC/PAS 62717 – 2011 LED modules for general lighting – Performance requirements
- IEC/PAS 62722.2.1 – 2011 Luminaire performance – Part 2-1: Particular requirements for LED luminaires
- IEC 60529 2001 Degrees of protection provided by enclosures (IP Code)

Review of Standards (IESNA)

- IES LM-79 – 2008 IES approved method for the electrical and photometric performance of solid-state lighting products
- IES LM-80 – 2008 Approved method: Measuring lumen maintenance of LED light sources
- IES LM-82 – 2012 IES approved method for the characterisation of LED light engines and LED lamps for electrical and photometric properties as a function of temperature
- IES TM-21 – 2011 Projecting long term lumen maintenance of LED light sources

Proposed Extreme conditions

Parameter	Minimum	Maximum
Ambient Temperature (°C)	-10°	+45°
Relative Humidity	N/A	85%
Voltage range (Volts) (relative to rated voltage)	-30%	+10%
Weathering effects		
Corrosion	N/A	??
Ingress Protection	N/A	51
External aggregation of particulate (ie temperature increase from sand, dust, salt)	N/A	??

Criteria to test

- Initial light output reduction
- Lamp failure to operate
- Lumen maintenance reduction (i.e. accelerated drop in light output over time)

Testing impost

Need test methods which can identify effects

- Initial light output reduction
  - Relatively short term test
- Lamp failure to operate
  - Relatively short term test
- Long term greater reduction in light output
  - Long term test or short term predictive test

Criteria for performance

Compare performance under extreme conditions compared to standard conditions

Initial Light Output @ 45°C

- IES LM82 provides a test method for the characterization of LED lamps for photometric properties as a function of temperature.

- Suggested criteria

$$\frac{Initial\ light\ output\ @\ 45°C}{Initial\ light\ output\ @\ 25°C} \geq 0.95$$

Lumen Maintenance: L_{70} @45°C

Two methods proposed

- Photometric testing to 6 000 h
  - Predicts L_{70} from first 6,000h of test data
- Stabilised junction temperature test
  - Predicts L_{70} from manufacturers test results for operating temperature of the LED chip.

L_{70} @ 45°C criteria for lamps

- IEA Tier 1, $L_{70} \geq 15{,}000$ h
- Energy Star, $L_{70} \geq 25{,}000$ h (residential)
- Propose $L_{70} \geq 15{,}000$ h

L_{70} @45°C - photometric test

Test Method

- IES LM-80-08 modified.
  - modification: lamp operation within an environment chamber with a maintained ambient temperature of 45°C (and RH = 85% (?))
- IES LM-79-08

Data analysis

- IES TM-21-11

L_{70} @45°C - photometric test

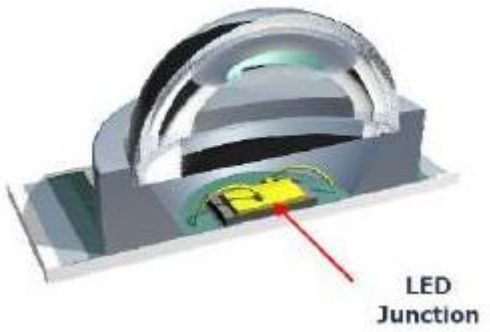
Approval

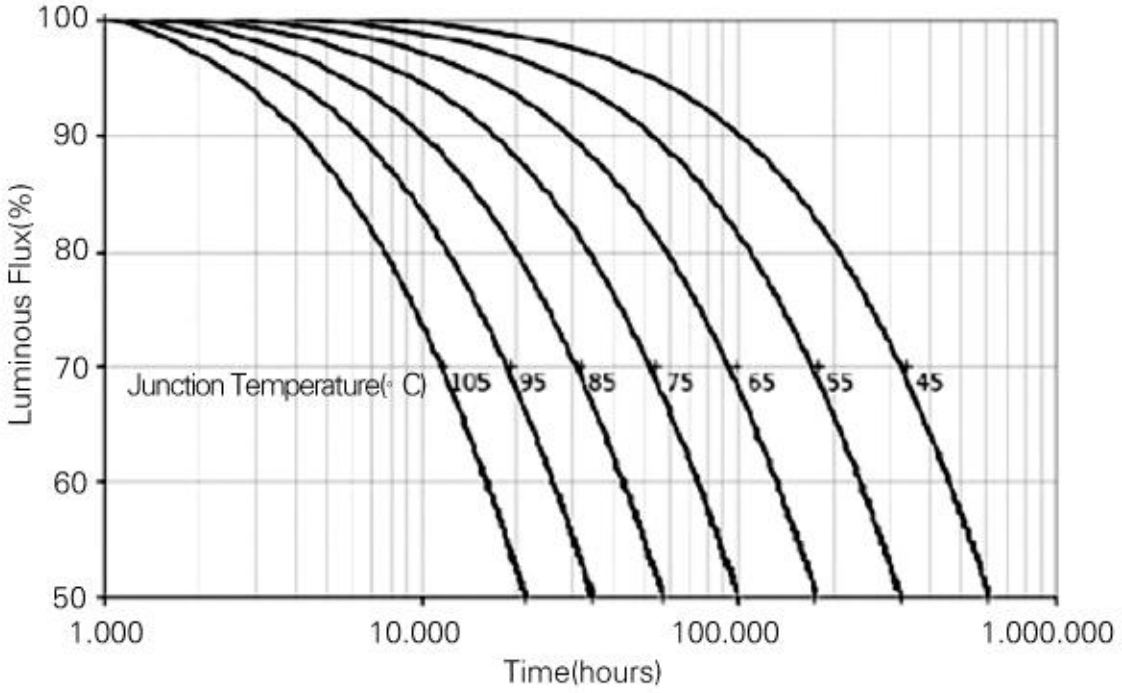
- Provisional approval gained through predicted compliance reported at:
  - 2000 hrs testing

  then retained based on
  - satisfactory 3000 hrs reporting, and
  - final approval at 6000 hrs where

$$L_{70} \text{ (@ } 45°C_{ambient}) \geq 15{,}000 \text{ hrs.}$$

Junction temperature effects





http://www.unionledlight.com/ewebeditor/UploadFile/201142217859501.jpg

http://www.ec.hc360.com/daquan2009/english/secondmenu/UserFiles/17/079.jpg

Link to lamp temperature

Case temperature at Temperature Measurement Point (TMP)

Junction temperature

A lamp manufacturer needs to determine the relationship between the case & junction temperature

https://encrypted-tbn1.google.com/images?q=tbn:ANd9GcRMVi1U1fY8Rl4xCdpLMXKgJFsCf_fS_8kapqoyCXSWT0q2b7PO

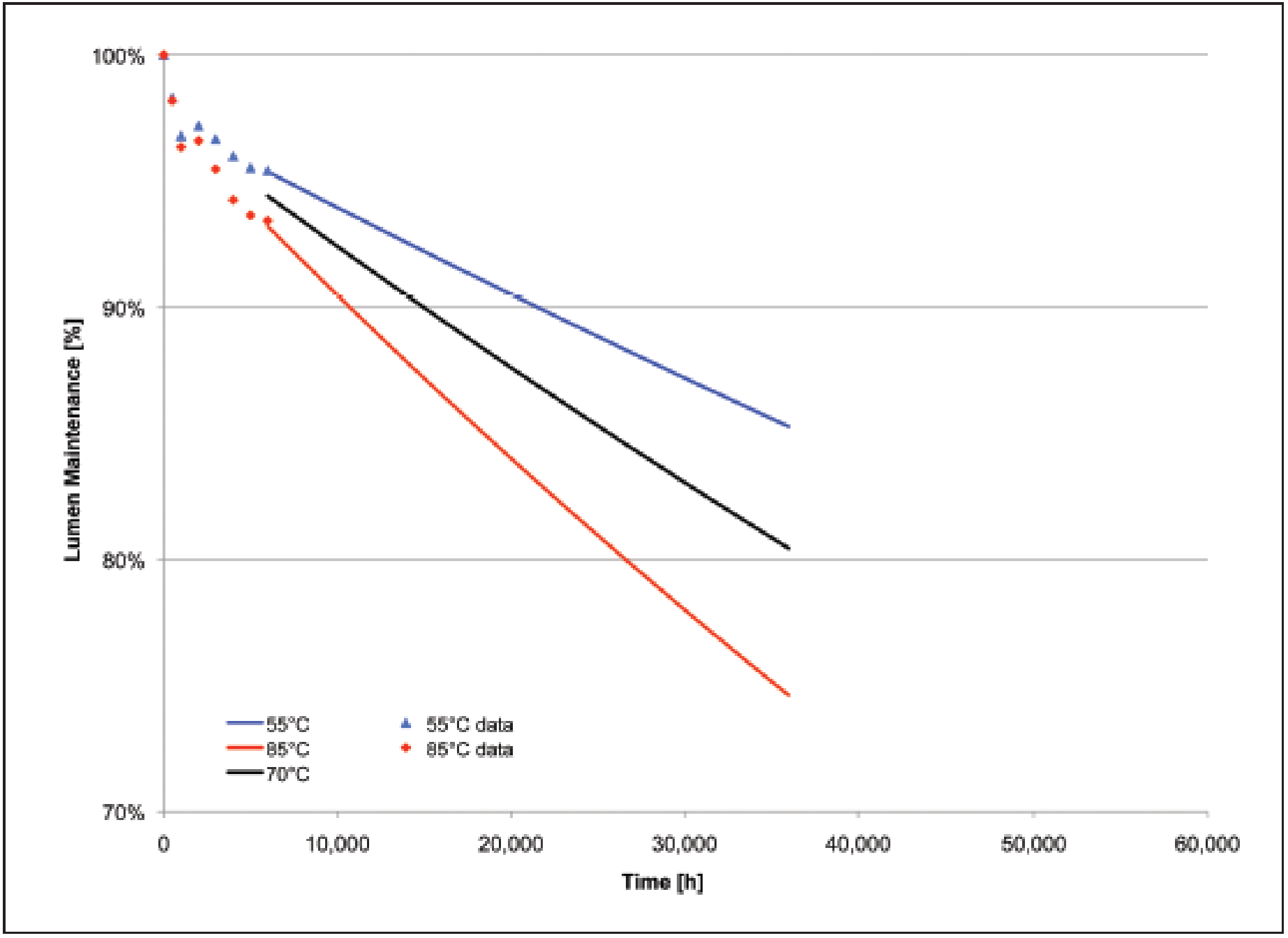


Figure E1. Graphic representation of lumen maintenance life projection using 6000 hours of LM-80-08 data

L_{70} @45°C - Junction temperature

Test method

- The package(s)/module(s)/array(s) stabilised temperature is measured *in situ*, at the TMP while operating at the specified drive current in a draft free environment at ambient temperature of 45°C

L_{70} @45°C - Junction temperature

Criteria

1. The package(s)/module(s)/array(s) temperature measured *in situ*, at the TMP is less than or equal to the temperature(s) specified in the LM-80 test report for the corresponding drive current or higher, and is within the manufacturer's specified operating current range.

2. The drive current measured in the fixture is less than or equal to the drive current specified in the LM-80 test report at the corresponding temperature or higher.

Note: Criteria 1 & 2 are conditions set out in Energy Star SSL Luminaires v1.3

L_{70} @45°C - Junction temperature

Data analysis

- IES TM-21-11

Conditional Approval

- L at 2000 hrs ≥ 95.4%
- L at 3000 hrs ≥ 93.1%

Final Approval

- L at 6000 hrs ≥ 86.7%

- L_{70} (@ 45°$C_{ambient}$) ≥ 15,000 hrs

L_{70} @ 45°C criteria for downlights

- IEA Tier 1, $L_{70} \geq 30{,}000$ h
- Energy Star, $L_{70} \geq 35{,}000$ h (commercial)
- Propose $L_{70} \geq 30{,}000$ h

L_{70} @ 45°C criteria for downlights

Same 2 test options as lamps

- Photometric test

  Conditional Approval

  - L at 2000 hrs ≥ 97.7%
  - L at 3000 hrs ≥ 96.5%

  Final Approval

  - L at 6000 hrs ≥ 93.1%

  - L_{70} (@ 45°$C_{ambient}$) ≥ 15,000 hrs

- Junction temperature test

Supply over-voltage

Test method

- IEC/PAS 62612 2009 section 10.2.1 b) modified
- modification: Operate the lamp at 10% above the rated voltage (or top of the rated voltage range) , switching on and off at 30 second intervals. Repeat the cycling for one tenth of the number equal to half of the rated lamp life in hours.

Supply over-voltage

Approval

- At the end of the test, the lamp shall operate and remain alight for 15 minutes.

Supply under-voltage (?)

Test method

- Operate the lamp at 30% under the rated voltage (or bottom of the rated voltage range).

Approval

- The lamp shall operate and remain alight for 15 minutes.

Accelerated Humidity Test

Test method

- IES LM-79-08

Criteria

- The initial luminous flux shall be measured (under standard conditions)
- The non-energised lamp shall be placed in an environment chamber with a maintained ambient temperature of 85°C (+5°C) and Relative Humidity of 85% (+5%) for 500 hours.
- The 85°C/85%RH@500hrs luminous flux shall be measured (under standard conditions)

Accelerated Humidity Test

Data analysis

- Calculate the ratio of the luminous flux after 85°C/85%RH@500hrs and the initial luminous flux

Approval

$$\frac{Light\ output_{\ 85°C/85\%RH@500hrs}}{Light\ Output_{\ initial}} \geq 0.90$$

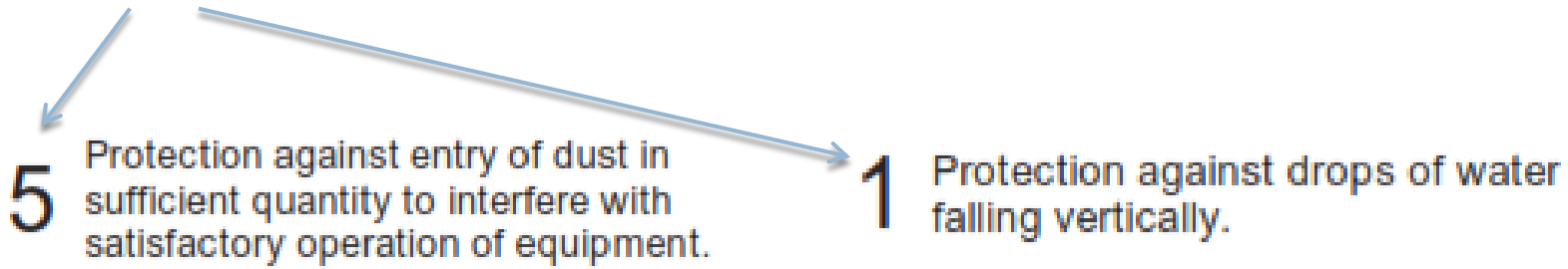
Ingress Protection

Test method

- IEC 60529 2001 Degrees of protection provided by enclosures (IP Code)

Approval

- IP51 or greater



Heatsink Maintenance

Test method

- Insect and dust build-up susceptibility

To be discussed

Corrosion

- Too difficult to test

- AS 60355-2004: An appraisal of the problems of accelerated testing for atmospheric corrosion

In Summary

Efforts have been made to:

- Use existing test methods where possible
- Provide options on predictive or measured performance

Your thoughts and comments...