NATIONAL FORUM ON MALAYSIAN STANDARDS ON LIGHT EMITTING DIODES (LEDs)

Malaysian Standards for LED Performance

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NATIONAL FORUM ON MALAYSIAN STANDARDS ON LIGHT EMITTING DIODES

Paper 6

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By: Tay Hooi Seng

WG LED Group 3

Date: 120405

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Agenda

1. Overview of coverage of MS vs LED types
2. Performance Results
3. Expectations from you
4. LED Characteristics affecting Performance
5. Conclusion
6. Appendix A - Quality Criteria as per MS/IEC
7. Appendix B - Scope of various MS

Acknowledgement

- Committee Members
  - CT Siew (Megalux)
  - Lim Choon Kim (GLOBETRONICS)
  - Hwang Yi Feng (AVAGO)
  - Geo Lim (P-Plus Lighting Sdn Bhd)
  - Roslinah Abdullah (SIRIM Product Certification)
  - Mohd Azmeer Ahmad SIRIM Electrical Testing
  - Lee Kok Chong (AMPTECH M&E SDN. BHD)

Data & Information from
- **LED Manufacturers**
  Philips, Cree, Osram
- **LIF**
- **CELMA**

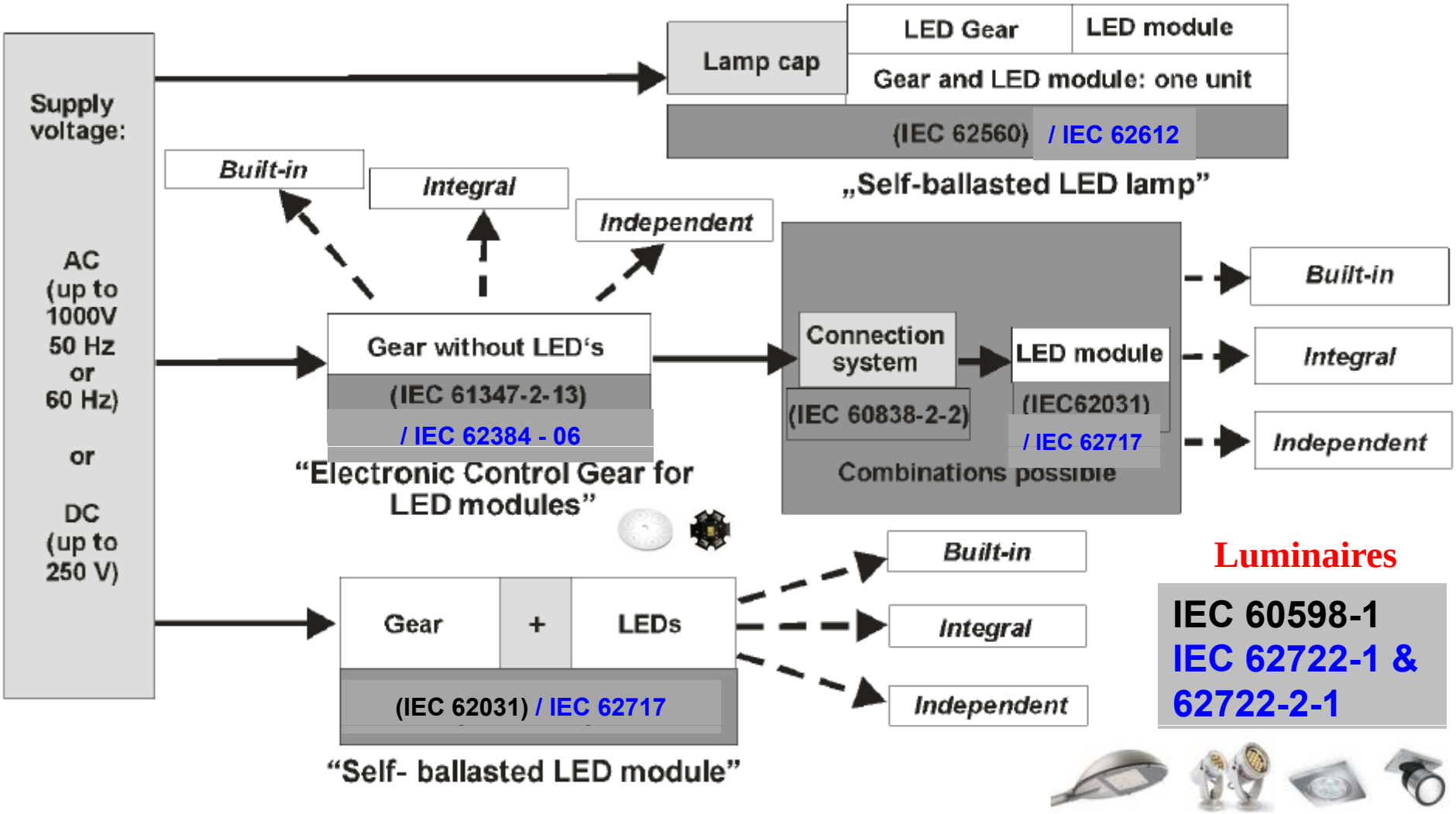
1. Overview of coverage of MS vs LED types

1. **LED light source**
   The LED die (or chip) is contained in a suitable package allowing simplified electrical connection or assembly;

2. **LED module**
   The LED die (or chip) together with mechanical and optical components making a replaceable item for use in a luminaire;

3. **LED luminaire**
   The complete system consisting of the LED light source or LED module including the electronics, materials, housing, wiring, connectors, seals, and so on.

Overview of Systems composed of LED & Control Gears Performance



Standards

Product type	Safety Standard	Performance Standard
LED lamps	IEC 62560 Edition 1 Publication expected 2010	IEC 62612/PAS Publicly Available Specification
LED Drivers	IEC 61347-2-13 Published 2006	IEC 62384 Published 2006
LED Modules	IEC 62031 Edition 1 Publication 2008	IEC 62717/PAS
LED Luminaires	IEC 60598-1	IEC 62722-1 & 62722-2-1
LED products	IEC TS 62504 Terms and Definitions for LED‟s and LED	

MS for LED Performance

1. MS 62504:2012 (P), General lighting - LEDs and LED modules - Terms and definitions
2. MS 62612:2012 (P), Self-ballasted LED-lamps for general lighting services - Performance requirements
3. MS 62717:2012 (P), LED modules for general lighting - Performance requirements
4. MS 62722-1:2012 (P), Luminaire performance - Part 1: General requirements
5. MS 62722-2-1(P), Luminaire performance - Part 2-1: Particular requirements for LED luminaires

2. Quality Criteria / Performance Results from MS standards

2. Quality Criteria / Performance Results from MS standards

- The MS documents suggest the following list of quality criteria to be considered when evaluating manufacturer's claims:
- a) Rated input power
- b) Rated luminous flux
- c) LED luminaire efficacy
- d) Luminous intensity distribution
- e) Photometric code
- f) Correlated Colour Temperature (CCT)
- g) Rated Colour Rendering Index (CRI)
- h) Rated chromaticity co-ordinate values both initial and maintained
- i) Lumen maintenance code
- j) Rated life (in h) of the LED module and the associated rated lumen maintenance (Lx)
- k) Failure fraction (Fy), corresponding to the rated life of the LED module in the luminaire
- l) Ambient temperature (tq) for a luminaire

2. Quality Criteria / Performance Results from MS standards

- Some of these parameters, rated life in particular, are difficult to measure accurately now, as the technology is relatively new and the lifetime of LED products is expected to be much longer than that of other types of lighting system. Consequently, verification of manufacturer's life time claims cannot be made in a sufficiently confident way. For that reason the acceptance or rejection of a manufacturer's life time claim, past 25 % of rated life (with a maximum of 6.000 hours), is out of the scope of both the IEC/PAS documents. In order to validate a life time claim, an extrapolation of test data is needed. A general method of projecting measurement data beyond limited test time is under consideration.
- IEC/PAS performance requirements documents provide
  - the definition of a set of quality criteria related to the initial specifications of a product;
  - a standardised description on how to measure these quality criteria.
- This makes manufacturers claims of initial specifications of LED modules and luminaires comparable. Be aware that the acceptance or rejection of a manufacturers lifetime claim is out of the scope!

2. Quality Criteria / Performance Results from MS standards

LED DATA

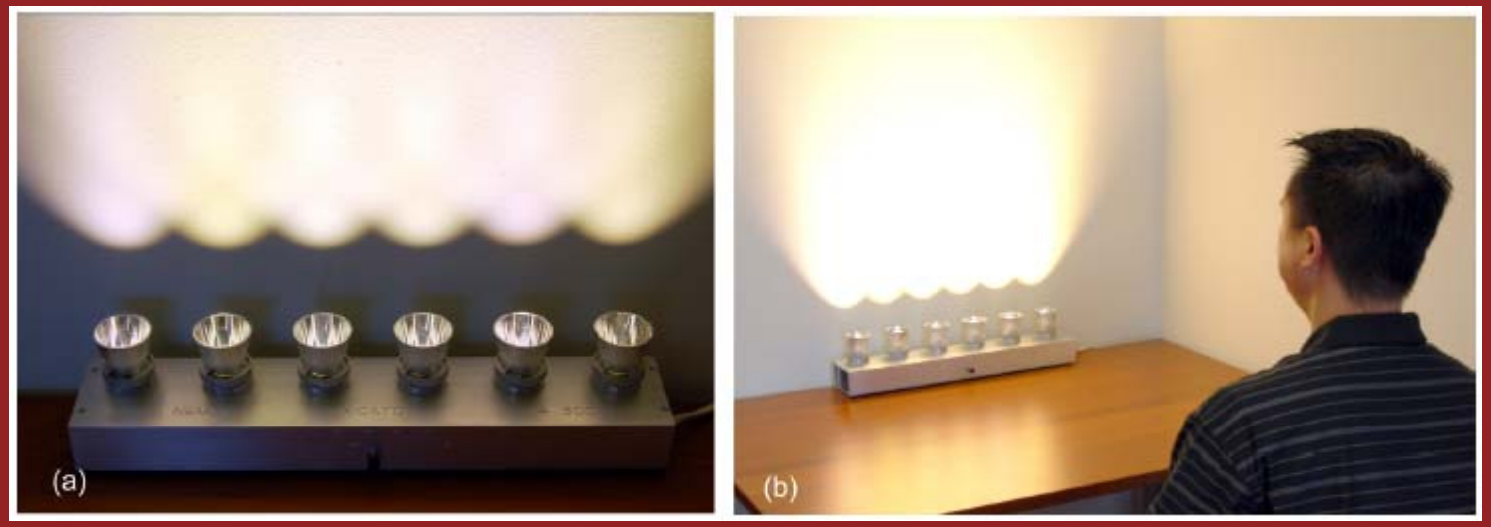
- Manufacturer of the LED package
- Depreciation curves for the LED package at an ambient temperature of 25 °C

LUMINAIRE DATA at an ambient of 25°C

- The board temperature T_{board} of the LED package
- Correlated Colour Temperature, CCT (+ shift over life)
- Colour rendering index, CRI (+ shift over life)
- Luminaire lumen output
- Luminaire power
- Luminaire efficacy
- Luminaire Life which should always be qualified by:
  - Lumen depreciation / maintenance (eg L_{80})
  - Failures over life (eg F_{10})
  - Real hours used to calculate life

Reputable LED luminaire manufacturer that publishes product specifications that are measured in compliance with the MS performance requirements.

3. Expectations from you



LED lighting is driving a significant transformation of the lighting industry.

LEDs can provide a palette of millions of colors and dynamic effects that conventional lighting cannot match in terms of design, scene-setting and ambience. Thanks to their miniaturized dimensions and low heat radiation, they can be embedded almost anywhere. And being digital, they are programmable, offering unlimited scope for creative use and effective management. Last but not least, they offer long lifetime and energy and maintenance savings, making them potentially an efficient solution.

In recent years the lighting market has been flooded by a vast number of new and unproven entrants. Some are making dubious claims about their products' performance that are too good to be true, and not supported on a technical basis. All stakeholders such as lighting specifiers and designers need to know how long an LED luminaire will retain a meaningful percentage of its initial light output over their years of operation, color consistencies over lifetime etc.

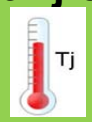
Expectations from you… **Good lighting MS ISO 8995**

- Good lighting will create a
  - visual environment that enables people to see,
  - to move about safely
  - to perform visual tasks efficiently, accurately and safely without causing undue visual fatigue and discomfort
- which can be achieved via **Design criteria**

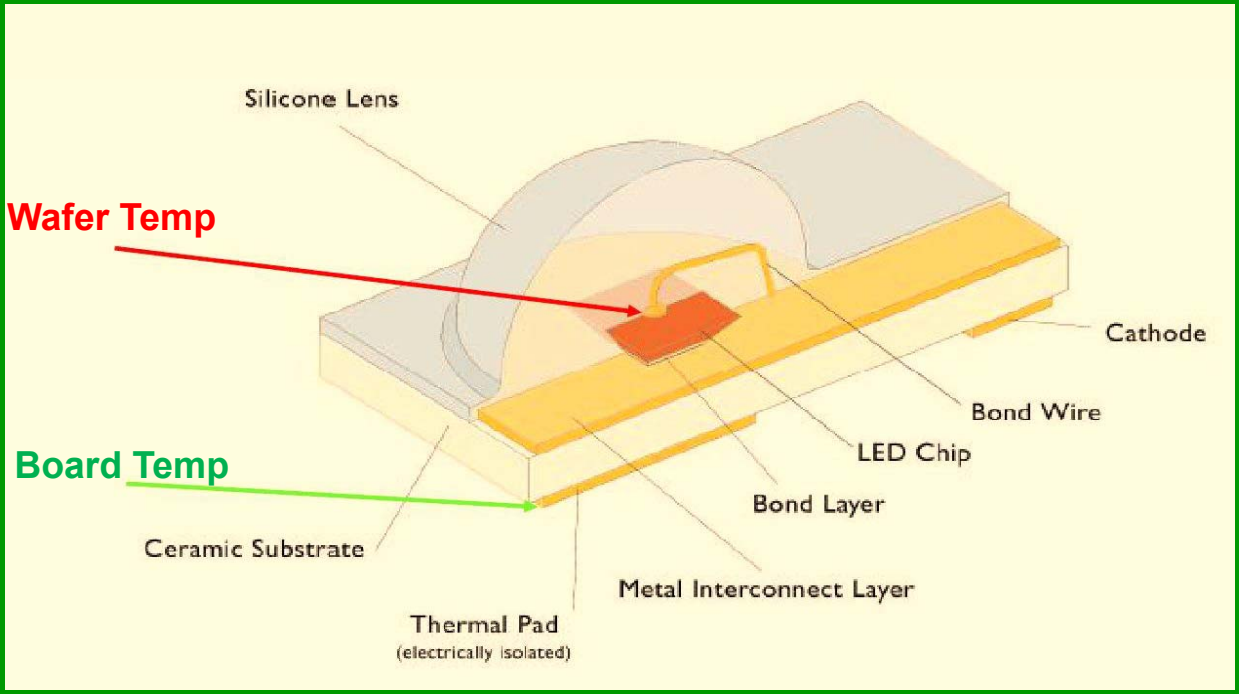
- **Lighting environment**
  - **Luminous environment**
  - **Luminance distribution**
  - **Illuminance levels**
- **Maintenance factor**
- **Glare (Direct & Indirect)**
- **Directionality**
- **Colour aspects**
- **Energy considerations**
- **Daylight**
- **Maintenance**
- **Emergency lighting**

Expectations from you… **Good lighting**

Lighting Design Criteria	Expectations/ Concerns	Light Quality

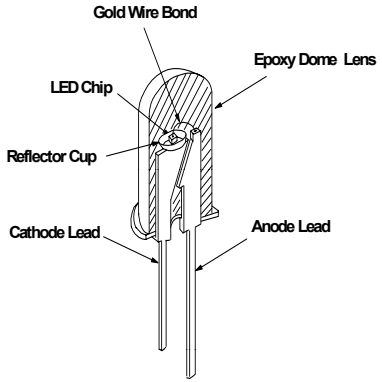
• Lighting environment
  • Luminous environment
  • Luminance distribution
  • Illuminance levels
• Maintenance factor
• Glare (Direct & Indirect)
• Directionality
• Colour aspects
• Energy considerations
• Daylight
• Maintenance
• Emergency lighting
	• Lighting environment
	  • Illuminance levels
	• Maintenance factor
	• Glare (Direct & Indirect)
	• Colour Consistencies
	• Energy considerations
	• Lifetime
		1. Light Output Ratio
		2. Light output at Tj of 25/85°
		 
		3.Color
		• Consistency
		• Color Rendering
		4. Life

4. LED Characteristics affecting Performance

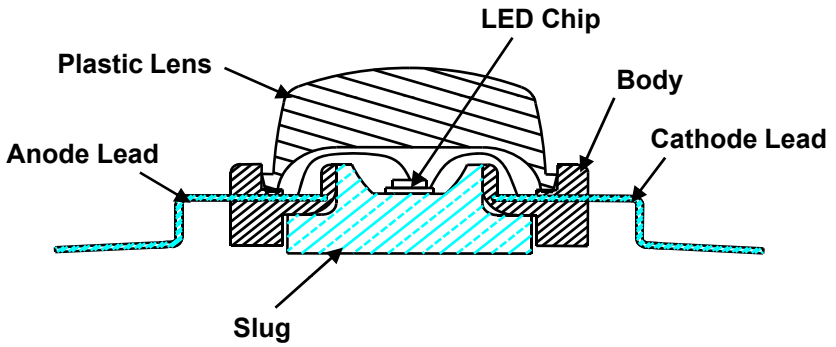


What is an LED?

- A compound semiconductor device that converts electrical energy directly into a discrete wavelength (colour) of light
- Manufactured in chip fabrication plants

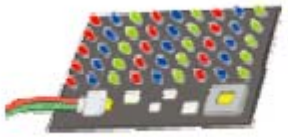


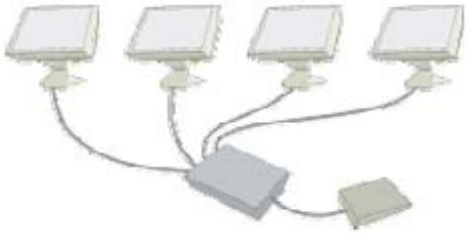
eg. Luxeon



LED System Components is built up of

- LED die
- LED Package
  - Thermal management, optics, mechanics
- PCB
- Optics
- Fixture
- Driver
- Controls





LED Luminaire Efficacy – It's a SYSTEM

LED source Efficacy lm/W to Luminaire System Efficacy lm/W

LED	LED array	Optics	Driver	Fixture
• Color temp/CRI • Temperature (Tj) • Single best bin • Drive current	• Thermal losses (higher Tj)	• Optical losses	• Driver losses	
	-5-10%	*-5-10%*	*-6%-20%*	

114lm/W

= System efficacy

Same holds for system reliability!!

Could be 139lm/W Less up to 40% Or 68lm/W

Light Quality

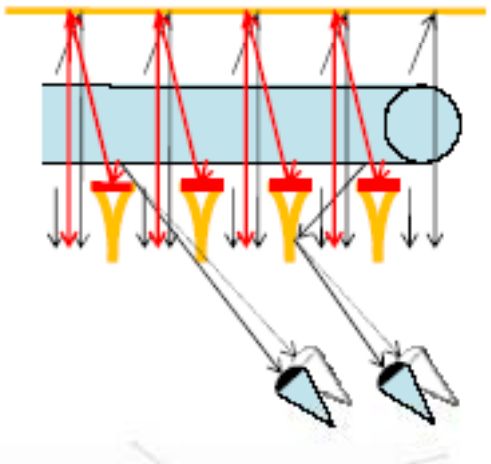
Light Quality

1. **Light Output Ratio**
2. Light output at Tj of 25/85°

3.Color
- Consistency
- Color Rendering

4. Life

LOR = Light Output Ratio



Accounts for absorption/wastage in luminaire

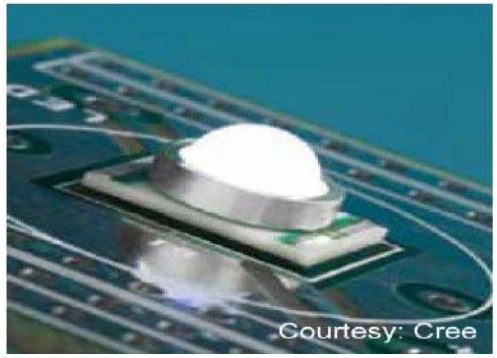
$$\text{LOR} = \frac{\text{Light output from luminaire}}{\text{Light output from lamp}}$$

ULOR = Upward Light Output Ratio

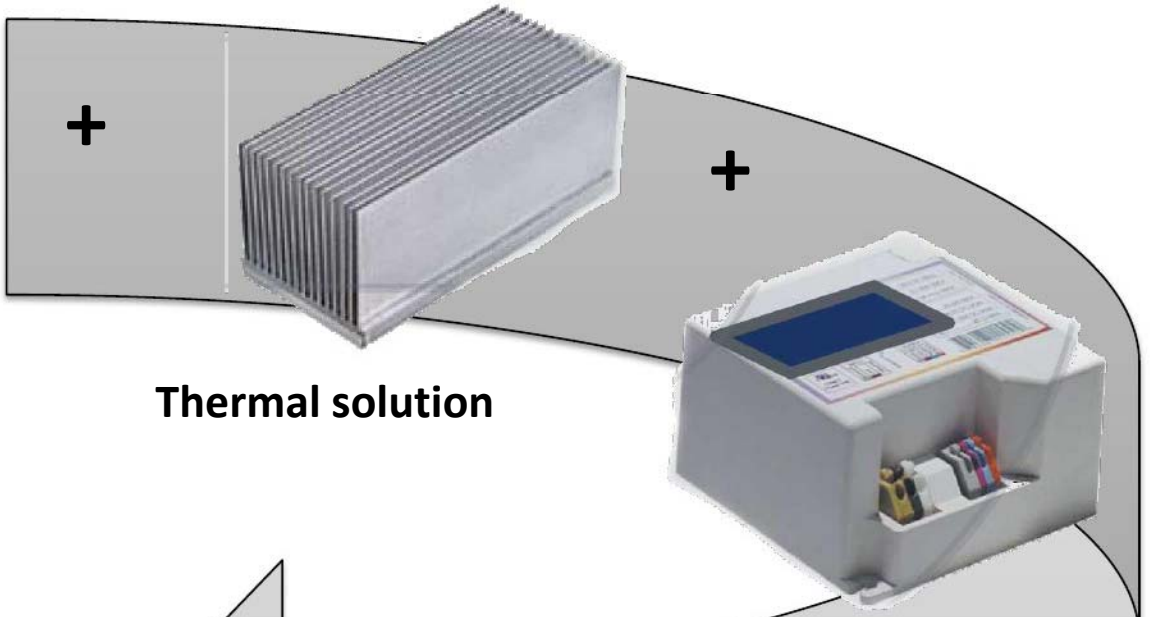
DLOR = Downward Light Output Ratio

TLOR = Total Light Output Ratio

Efficiency is the sum of the parts….



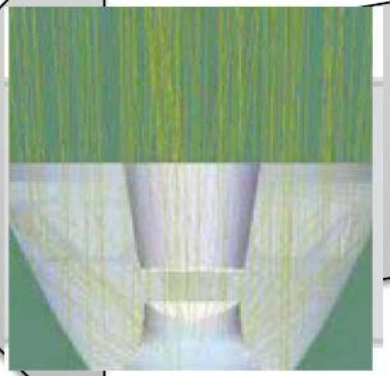
LED package efficiency



Thermal solution

Power supply
(Driver) efficiency

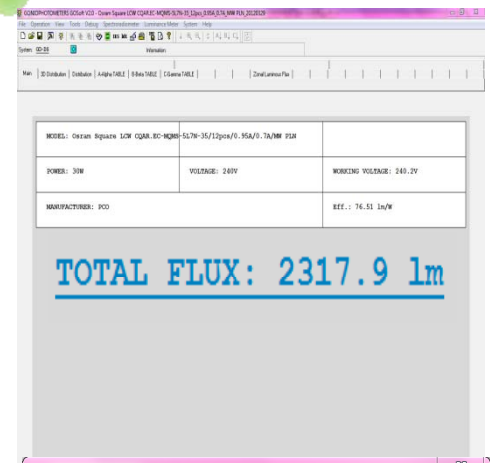
Resultant Luminaire
efficacy



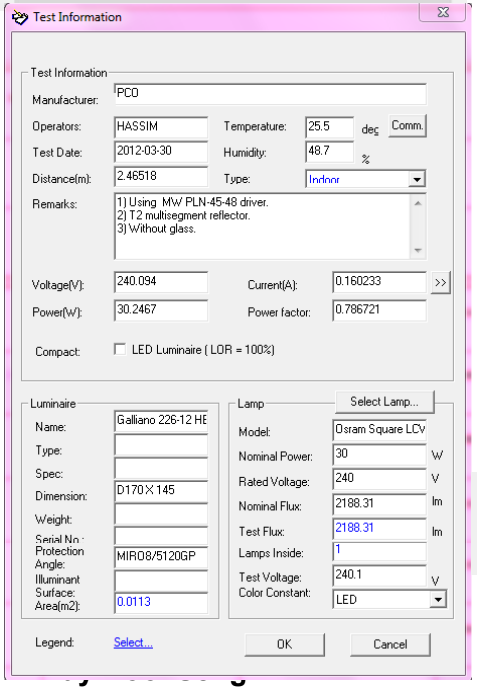
Fixture / optical
Design efficiency

How to determine LOR = Light Output Ratio

1. Bare Lamp Flux



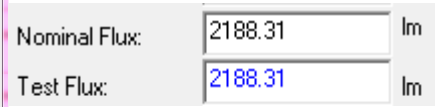
2. Luminaire Flux



3. LOR = 1./2.

= 2188.31/2317.9

= 94.4%

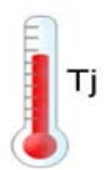


Light Quality

Light Quality

1. Light Output Ratio

2. Light output at Tj of 25/85°



3.Color

- Consistency
- Color Rendering

4. Life

Manufacturers Data

LUXEON® Rebel

Typical Light Output Characteristics over Temperature

Cool-White, Neutral-White, Warm-White, Green, Cyan, Blue and Royal-Blue at Test Current

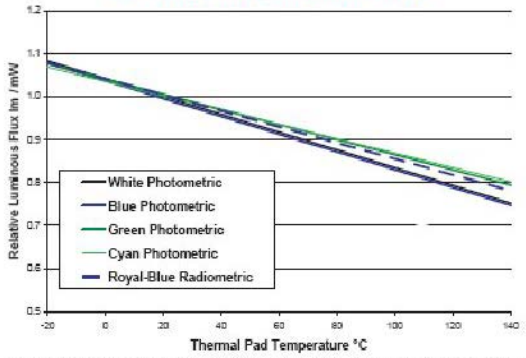


Figure 8. Relative light output vs. Thermal Pad temperature for White, Green, Cyan, Blue and Royal-Blue.

Red, Red-Orange and Amber at Test Current

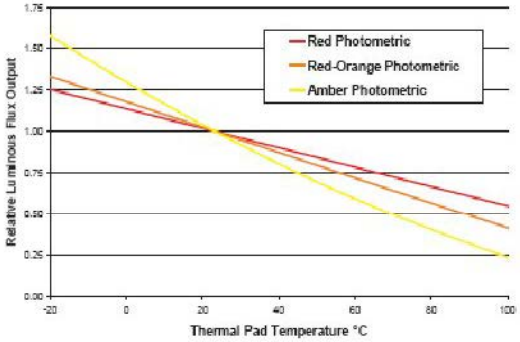
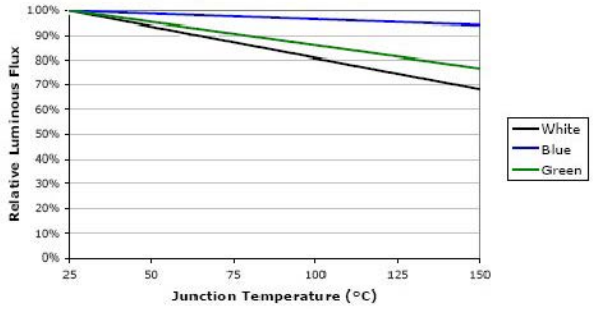
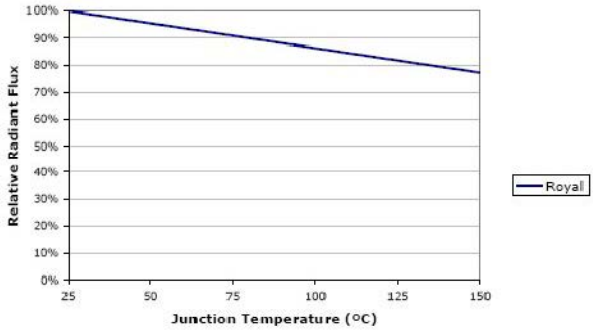


Figure 7. Relative light output vs. Thermal Pad temperature for Red, Red-Orange and Amber.

CREE

Relative Flux vs. Junction Temperature (I_F = 350 mA)



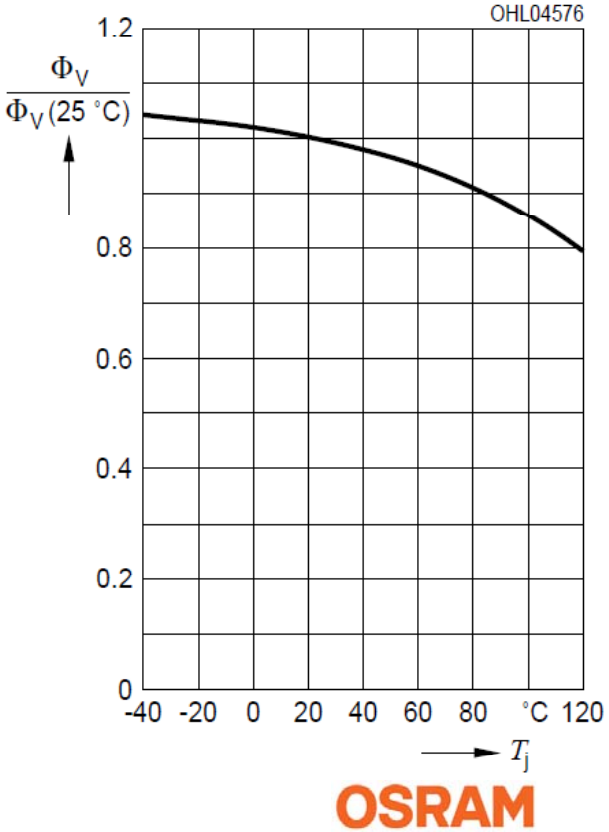


Cree, Inc.
4600 Silicon Drive
Durham, NC 27703
USA Tel: +1.919.313.5300
www.cree.com/xlamp

Manufacturers Data

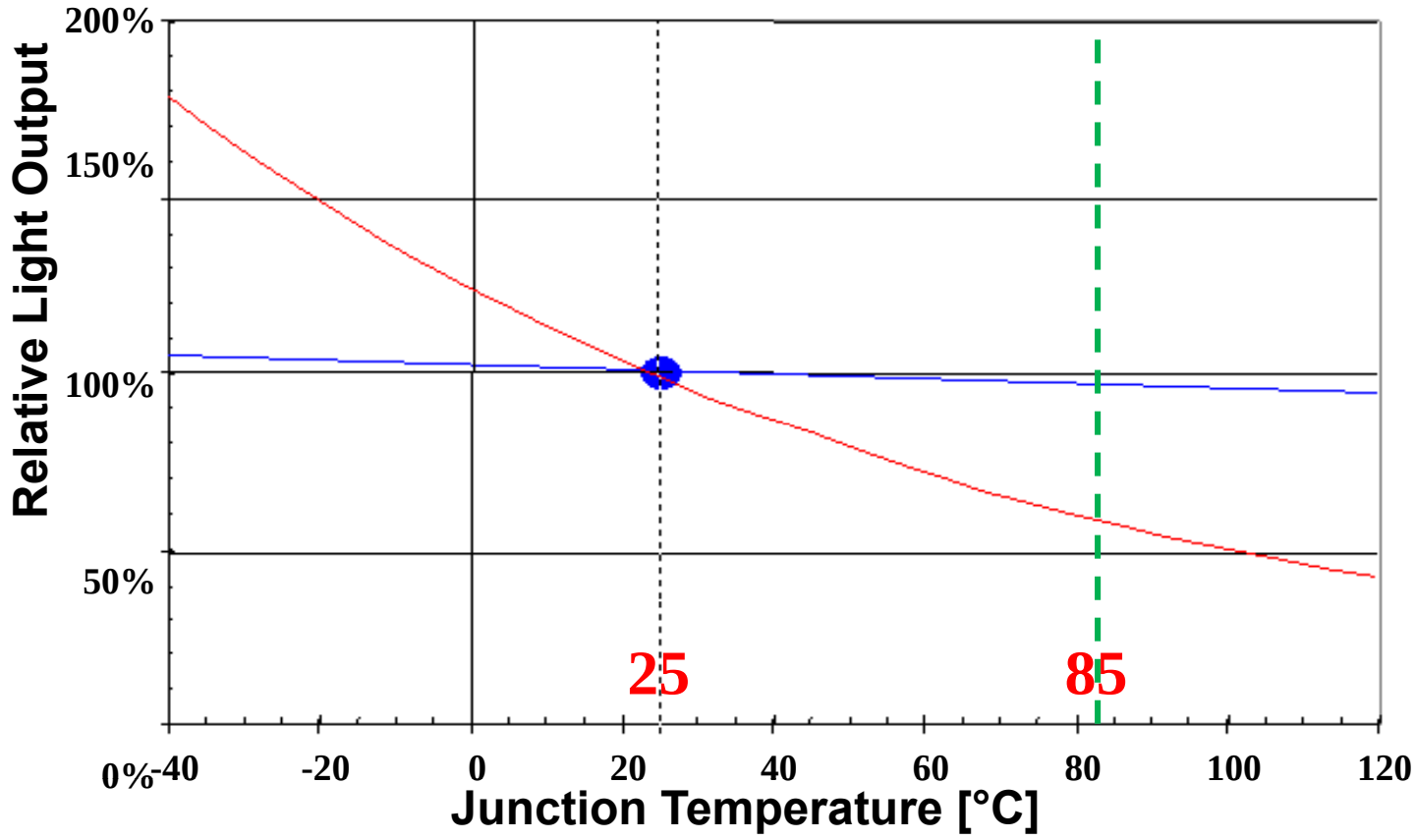
LCW CQAR.EC

Relative Luminous Flux[4] page 23
Relativer Lichtstrom[4] Seite 23
$\Phi_V/\Phi_V(700\ mA) = f(T_j);\ T_S = 25\ °C$



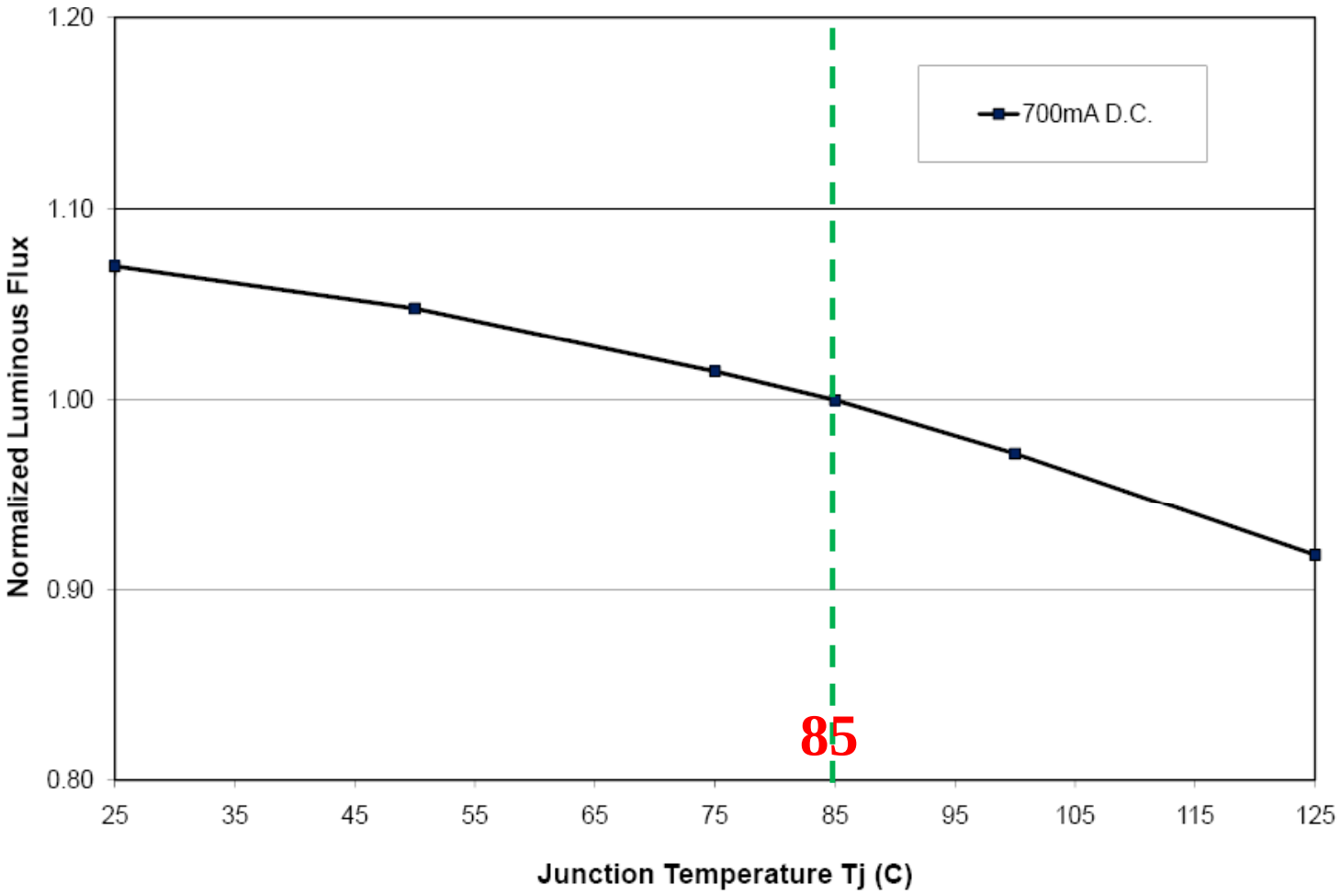
OSRAM

Junction Temperature
Light Output Flux/Im decreases in increase in Tj

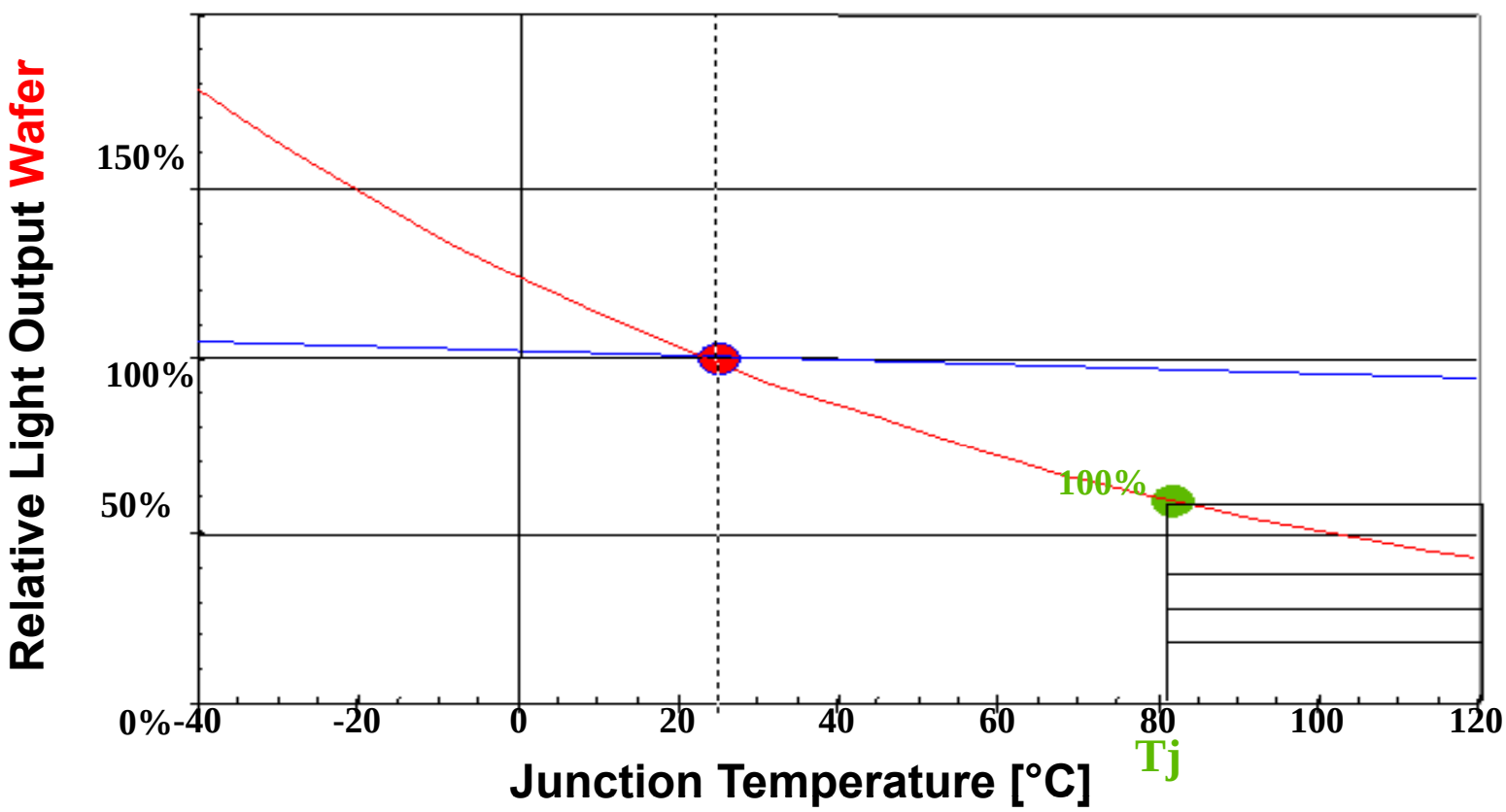


Junction Temperature
Light Output Flux/lm decreases in increase in Tj

Heat/Hot is not cool!

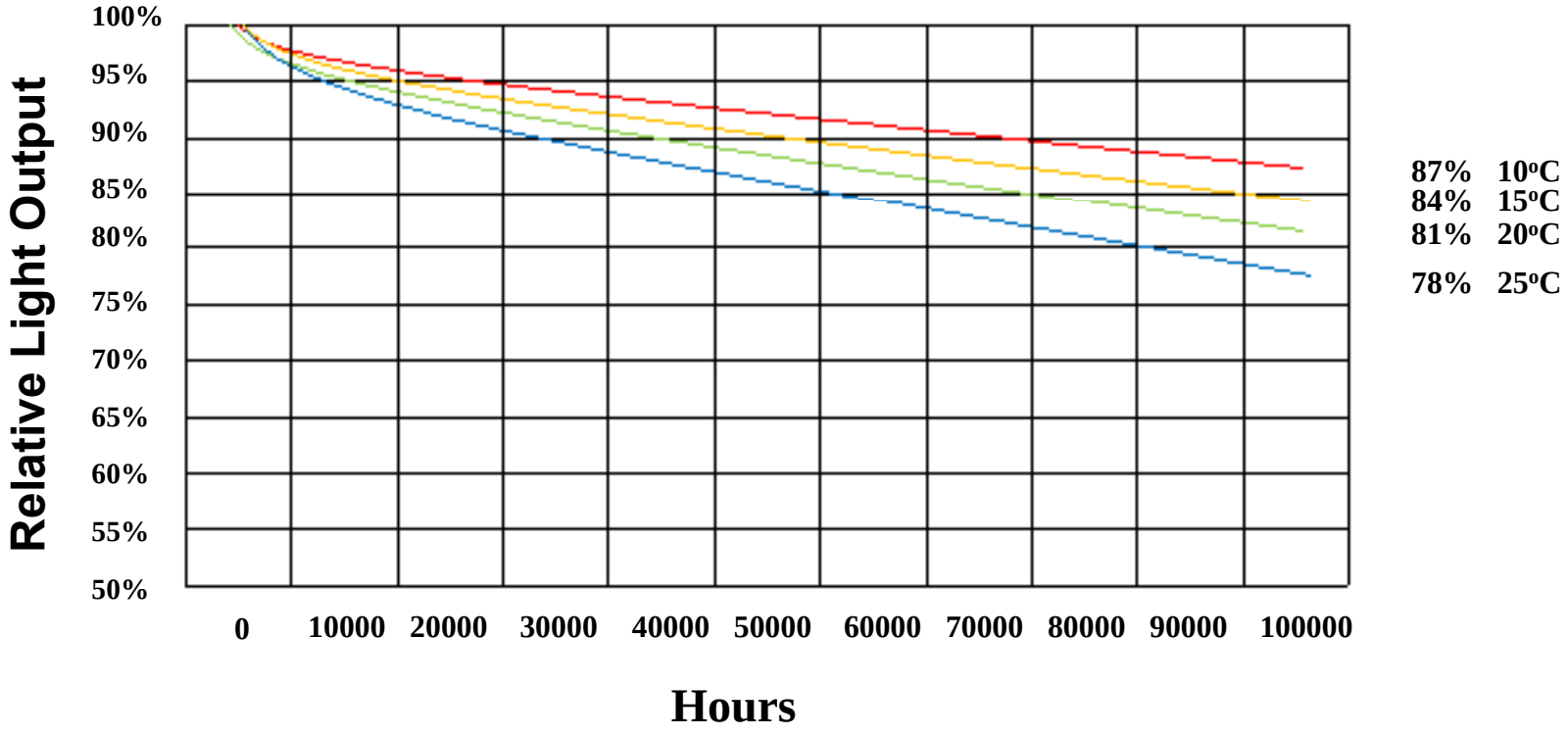


Relative Light Output inside Luminaire



Ambient temperature

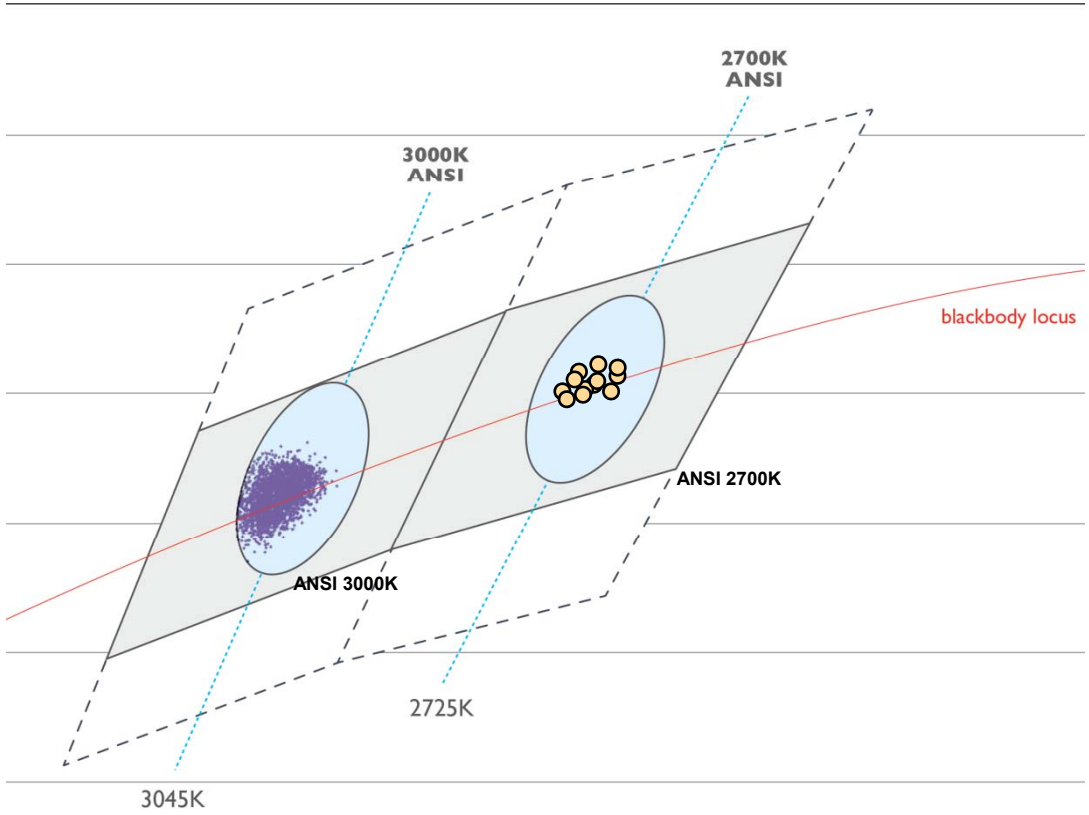
Effect of measurement temperature on performance



Hot testing and color targeting

Testing and binning at operating condition eliminates unknowns, simplifies the design process, lowers costs, and raises confidence

- **Eliminate light output calculations from 25°C to 85°C**
- **Eliminate efficacy calculations at operating conditions**
- **Eliminate need to work from de-rating data**
- **Reduce time to develop system**



Light Quality

Light Quality

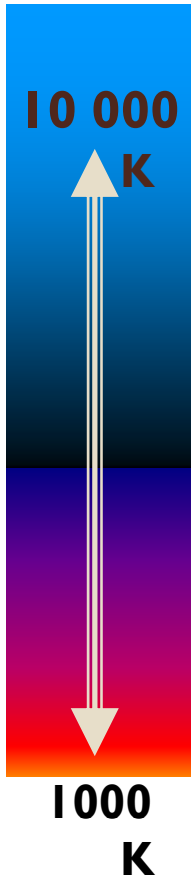
1. Light Output Ratio
2. Light output at Tj of 25/85°

3.Color

- **Consistency**
- **Color Rendering**

4. Life

Color Appearance & Color Rendering



1. Color Appearance of Light source
   - Measured by Color Temperature in Kelvin

2. Color Rendering of Objects by the light source
   - Describes the capacity of a light source to faithfully reveal and reproduce the natural colours

Color Appearance of Light source

gives indication of:
appearance of light

warm ambience

low colour temperature

cool ambience

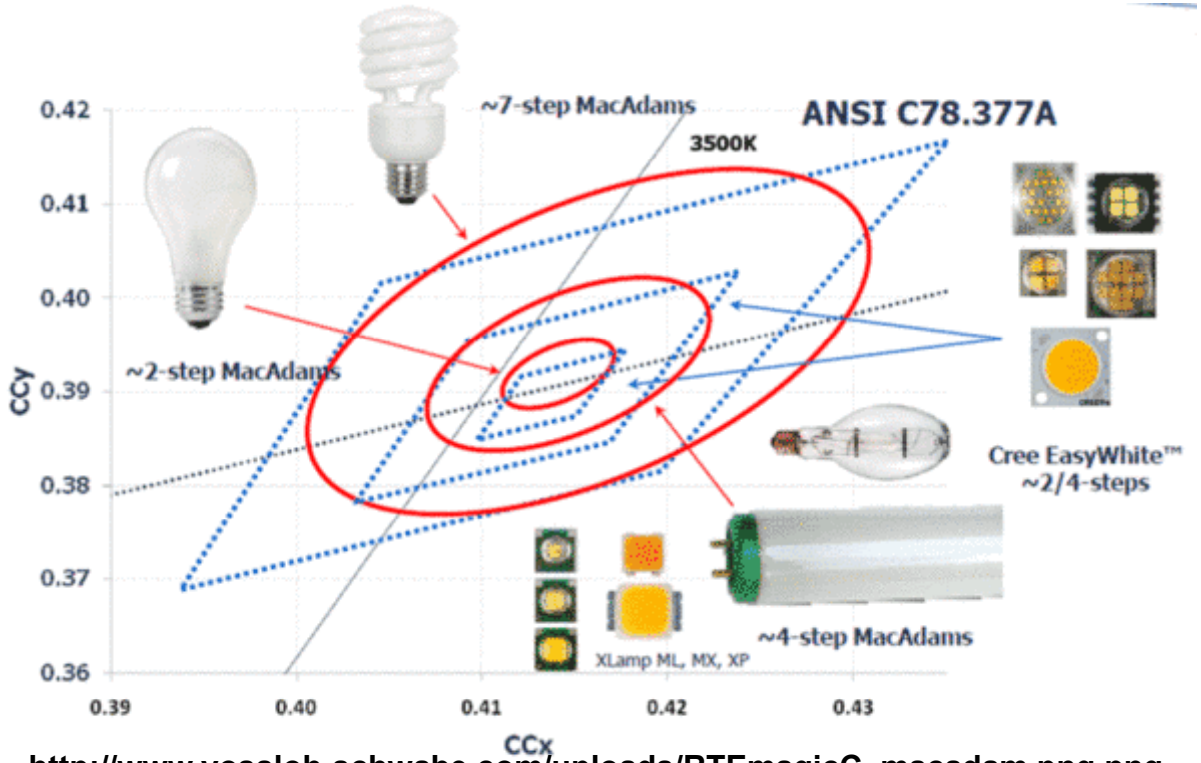
high colour temperature

Color Appearance of Light source

Color Rendering of Objects by the light source

MacAdam ellipses

In the study of color vision, MacAdam ellipses refer to the region on a chromaticity diagram which contains all colors which are indistinguishable, to the average human eye, from the color at the center of the ellipse. The contour of the ellipse therefore represents the just noticeable differences of chromaticity.



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Color Consistencies

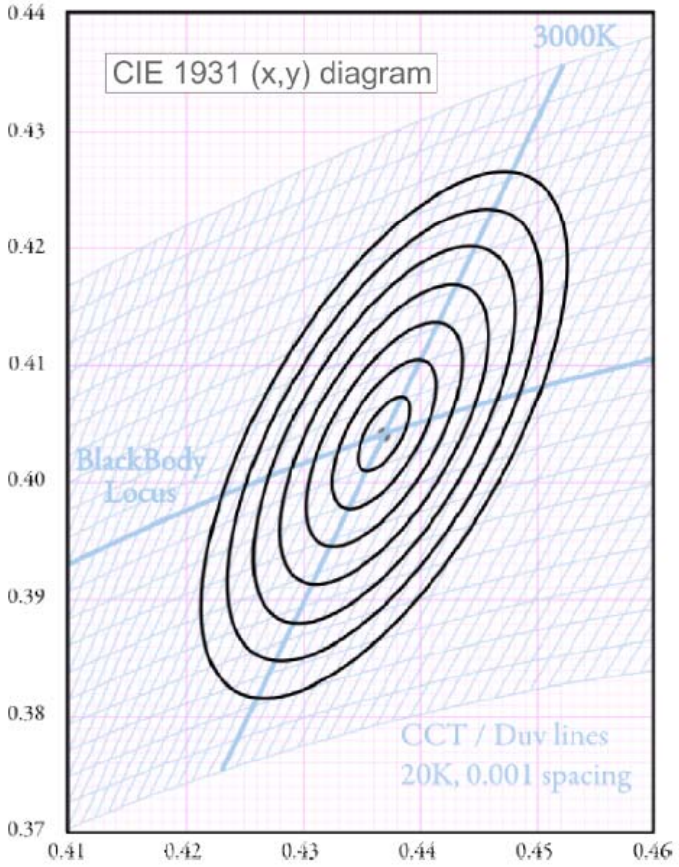


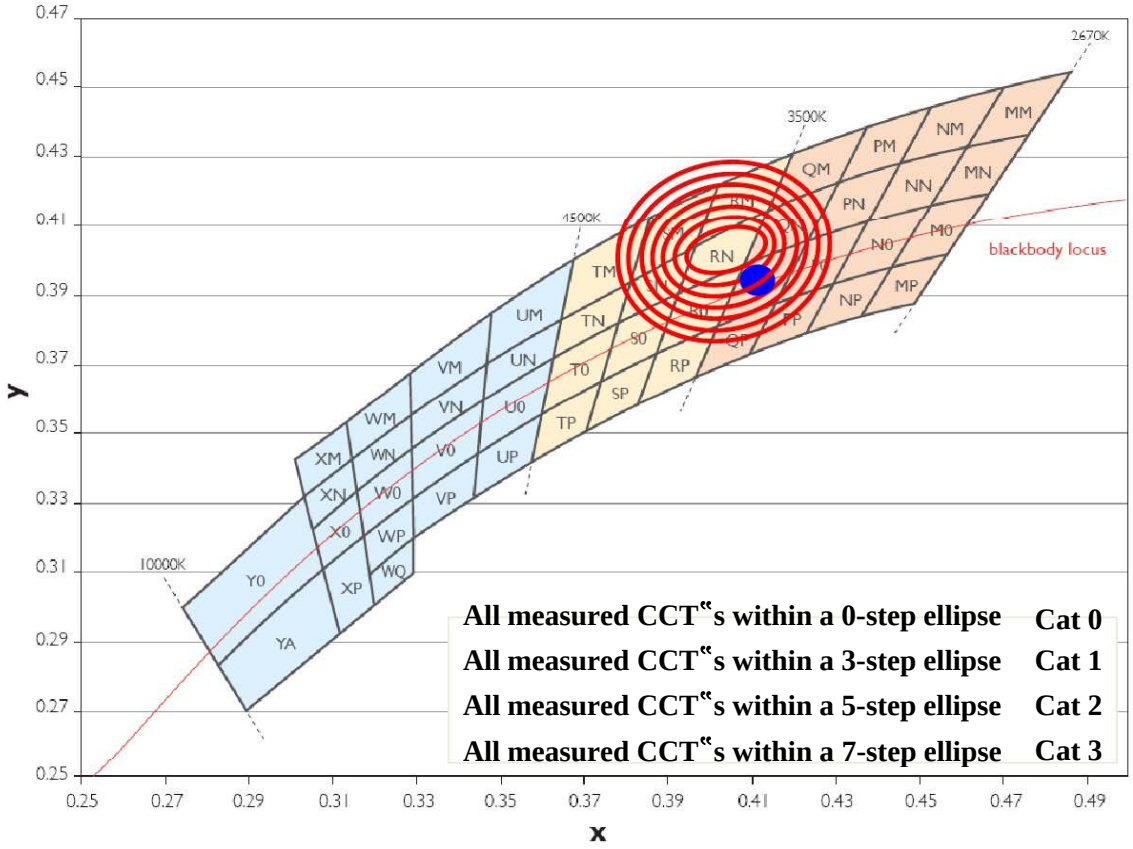
Figure 2: CIE 1931 diagram with the 1x to 7x Standard Deviation of Color Matching ellipses (as established by MacAdam) around the 3000K black body locus,

ble 1: Approximate size of Standard eviation of Color Matching Ellipses DCM).

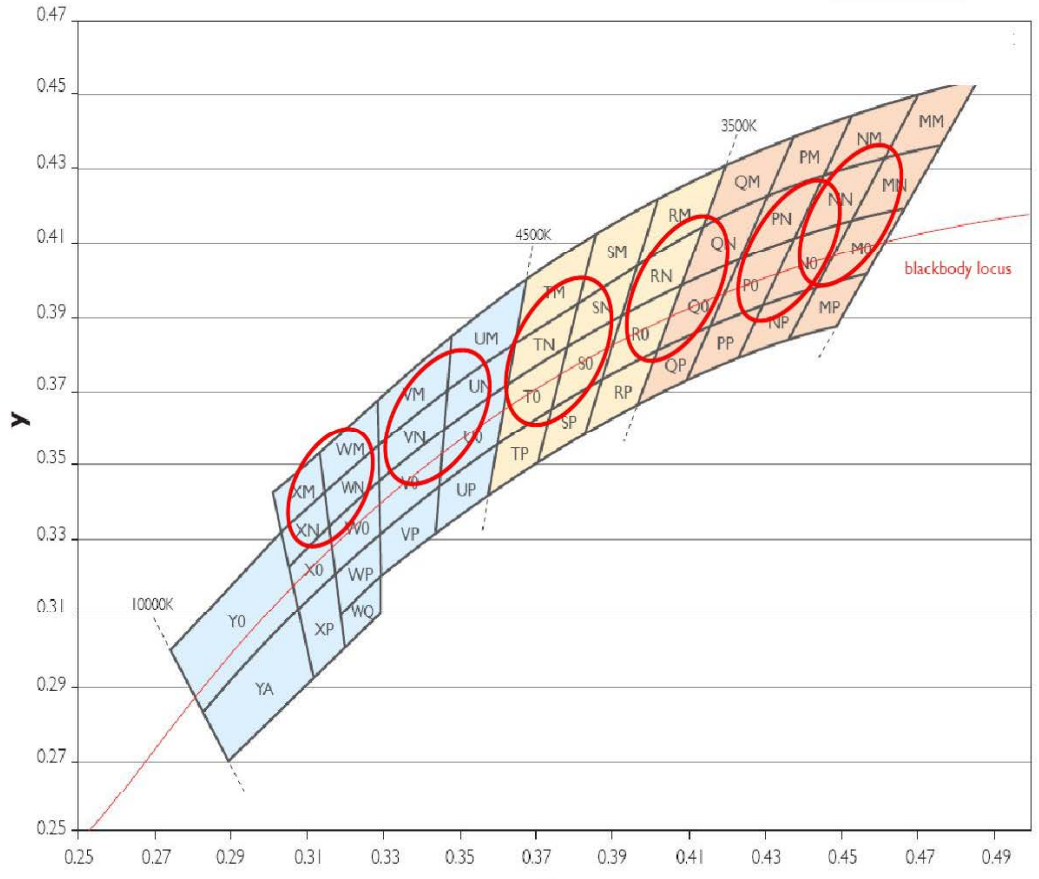
SDCM	CCT Range 3000K	ΔUV
1x	±30K	±0.0007
2x	±60K	±0.0010
4x	±100K	±0.0020
7-8x *(1)*	±175K	±0.0060

(1) Ansi-Nema C78.37377-2008

Specifying the performance of LED‟s



ENERGY STAR
7-step ellipse i.e. Cat 3



Tay Hooi Seng
Date: 120405

Light Quality

Light Quality

1. Light Output Ratio
2. Light output at
Tj of 25/85°

3.Color
- Consistency
- Color Rendering

4. Life of Leds / Lum

Quality Criteria Over Time

Luminaire lifetime claims based on lumen maintenance and luminaire life are very different things

- Luminaire lifetime claims based on lumen maintenance refers to the lumen maintenance projections of the LED's integrated into that luminaire, the number of hours that a LED luminaire will deliver a sufficient amount of light in a given application;
- Luminaire life has to do with the reliability of the components of an LED luminaire as a system, the entire system lasts as long as the critical component with the shortest life. From this point of view LED's are simply one critical component among many.

- **LED luminaire**
  The complete system consisting of the LED light source or LED module including the electronics, materials, housing, wiring, connectors, seals, and so on

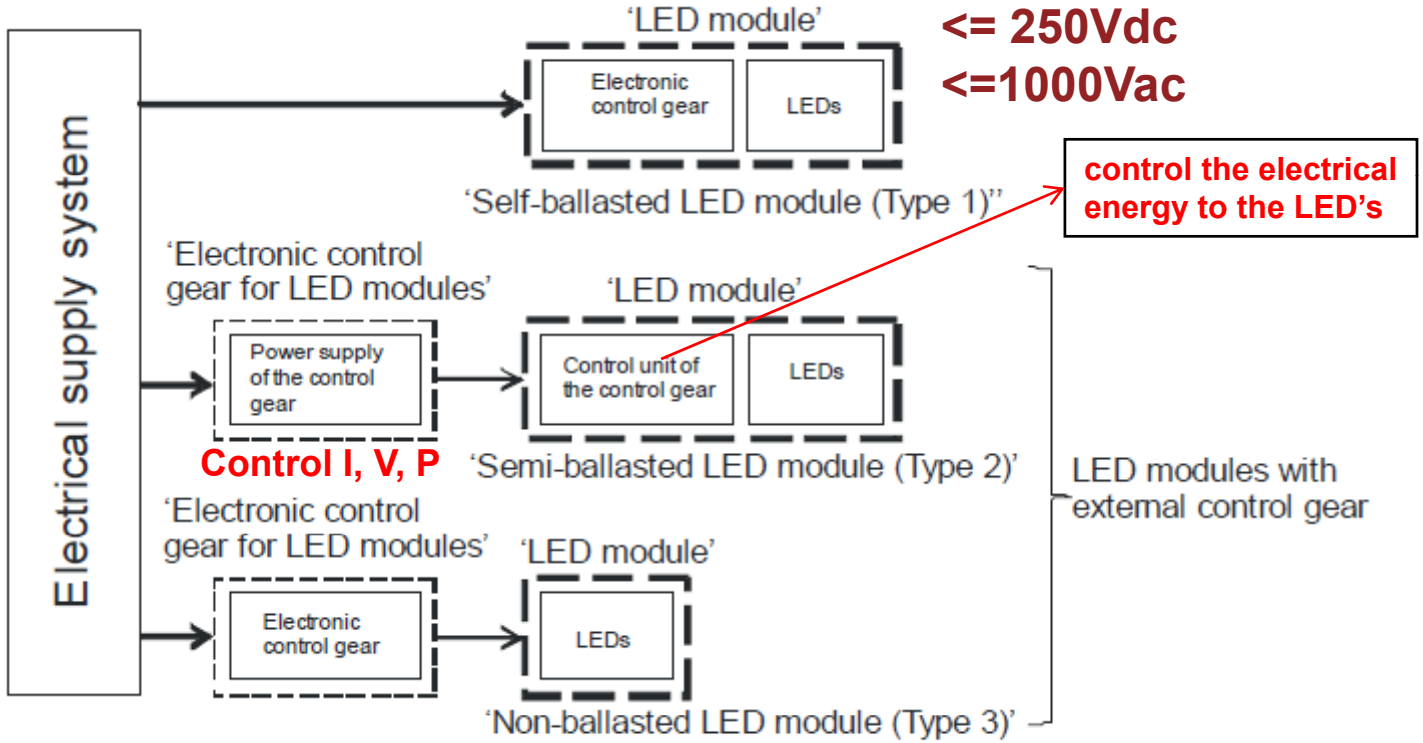
Lifetime of Leds

- Be careful of claimed lifetimes 100,000+ hours
- Lifetimes
  - Vary for different manufacturers depending on construction techniques
  - Can be affected by environmental conditions: thermal, electrical (current)
- More relevant to speak of life time at a certain lumen maintenance
  - Eg some LEDs are rated at 50,000 hours at 70% lumen maintenance
  - Some 5mm LEDs degrade 80% within 12,000 hours
- 50,000-75,000 hours is realistic for some LED packages
- The driver may be the limiting factor- rated at between 20,000 & 50,000 hours
- Standard method of measurement and rating lifetimes of LED packages and drivers is pending (IEC)

Lifetime of Leds

- Led temperature can affect
  - Flux, Life, Colour(shift) and Efficacy
  - Basically the cooler the better
  - Determined by
    - Drive current
    - Heat sinking
    - Ambient temp
- Not all LED fittings are equal!
- Consider in specification
  - Does the luminaire manufacturer/systems design adequately protect the led from heat?
  - The application and installation: appropriate ventilation must be designed in

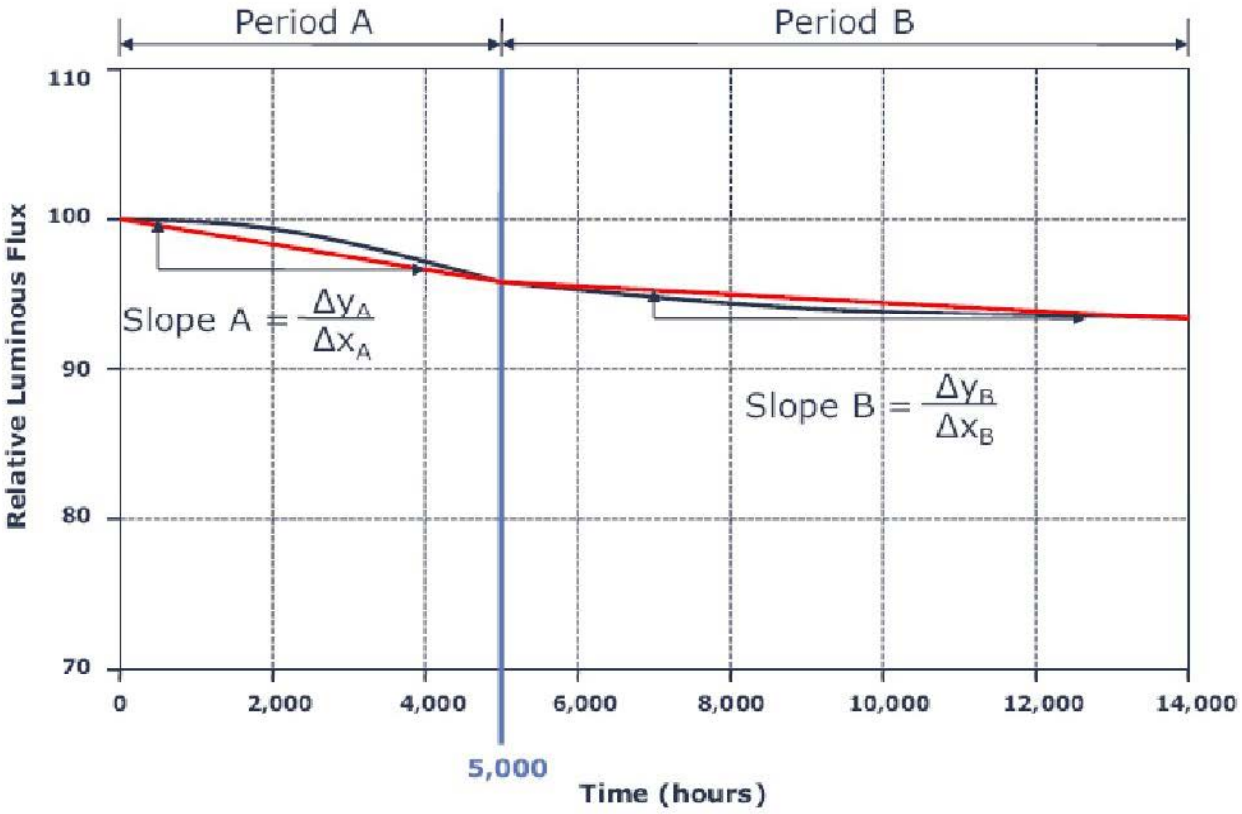
MS 62717:2012 (P), LED modules for general lighting - Performance requirements



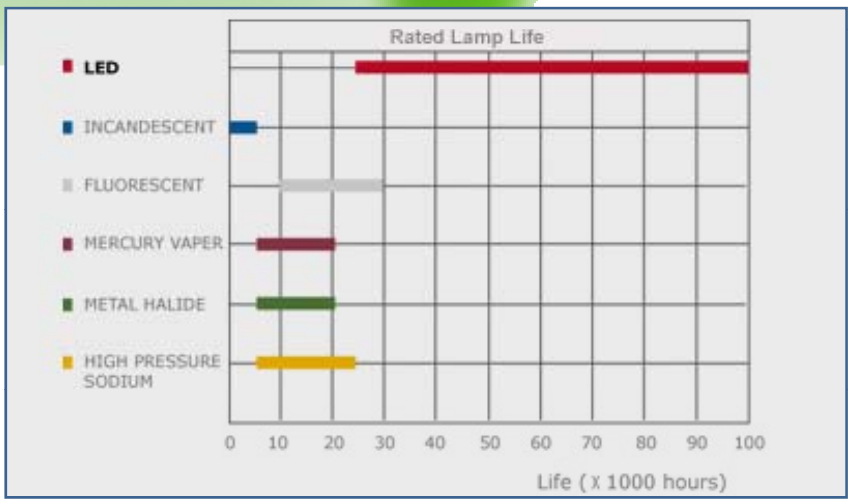
MS 62722-2-1(P), Luminaire performance - Part 2-1: Particular requirements for LED luminaires

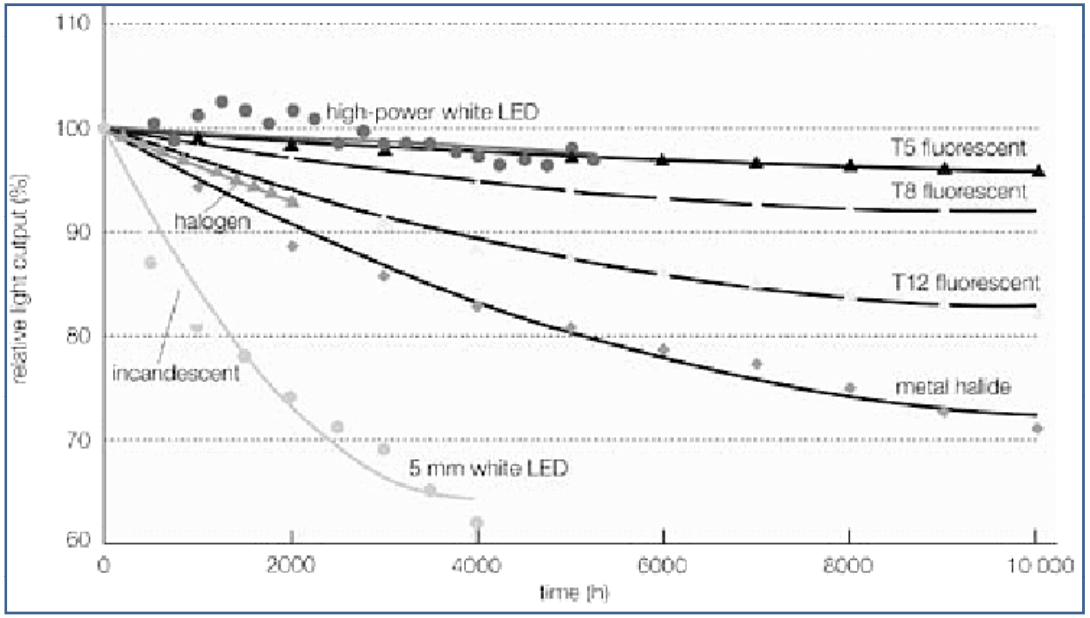
- Scope
  - As this PAS has been simultaneously developed and edited with the PAS for LED modules, where appropriate the compliance of the modules to the provisions of IEC/PAS 62717 may be transferred to the whole luminaire.
  - This PAS specifies the performance requirements for LED luminaires, together with the test methods and conditions, required to show compliance with this PAS. It applies to LED luminaires for general lighting purposes, where claims of operational performance are made.
  - The following types of LED luminaires are distinguished:
    - Type A – Luminaires using LED modules that have not been shown to comply with IEC/PAS 62717;
    - Type B – Luminaires using LED modules that have been shown to comply with IEC/PAS 62717;
    - Type C – Luminaires using a LED lamp and covered in IEC/PAS 62722-1.
  - The requirements of this PAS only relate to type testing.

Predicting Life of LEDs



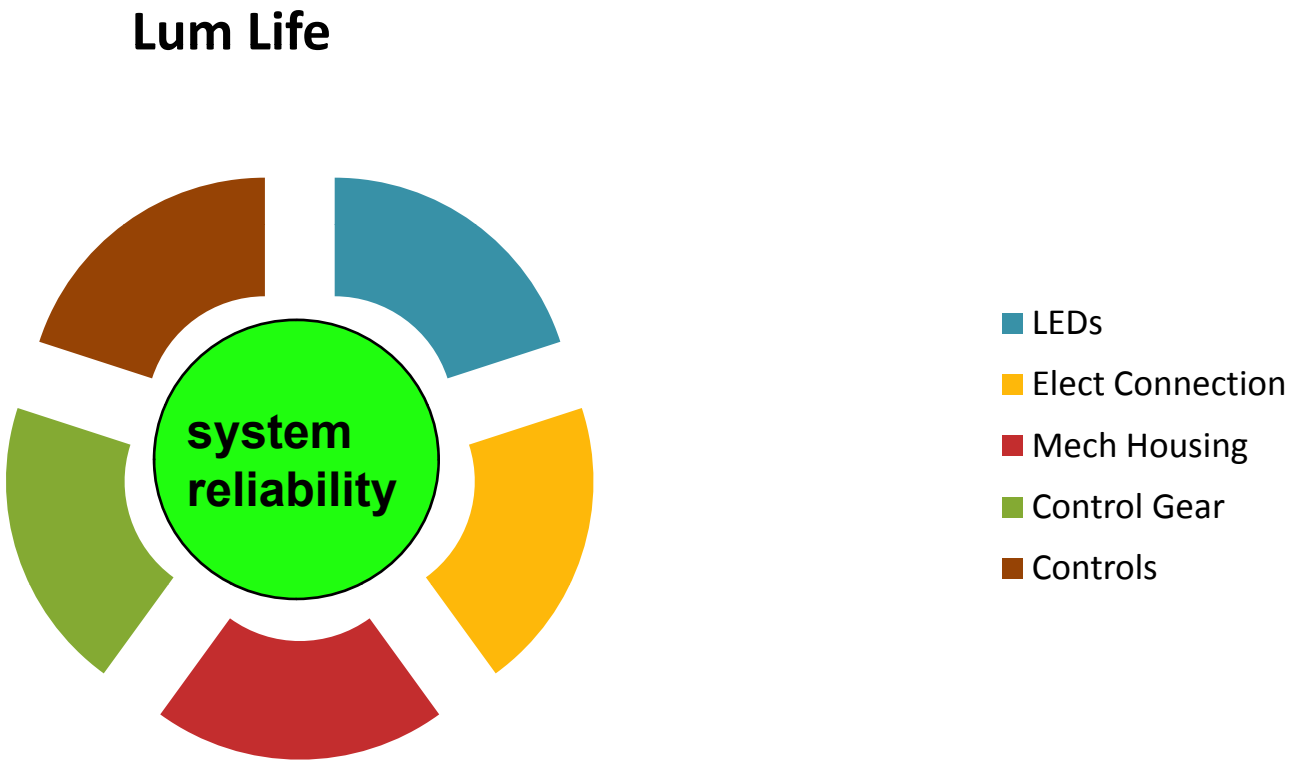
Lifetime





Tay Hooi Seng
Date: 120405

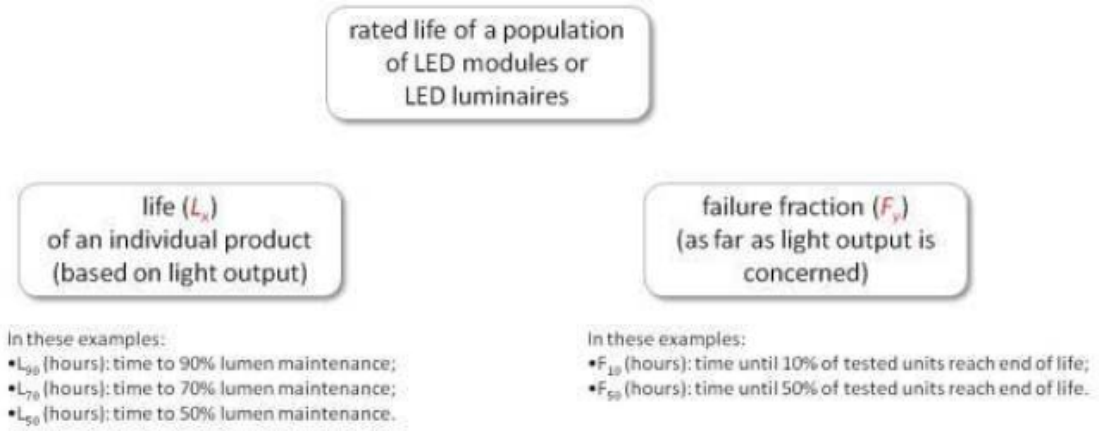
Luminaire life is about system reliability



Quality Criteria Over Time

Luminaire lifetime claims based on lumen maintenance and luminaire life are very different things

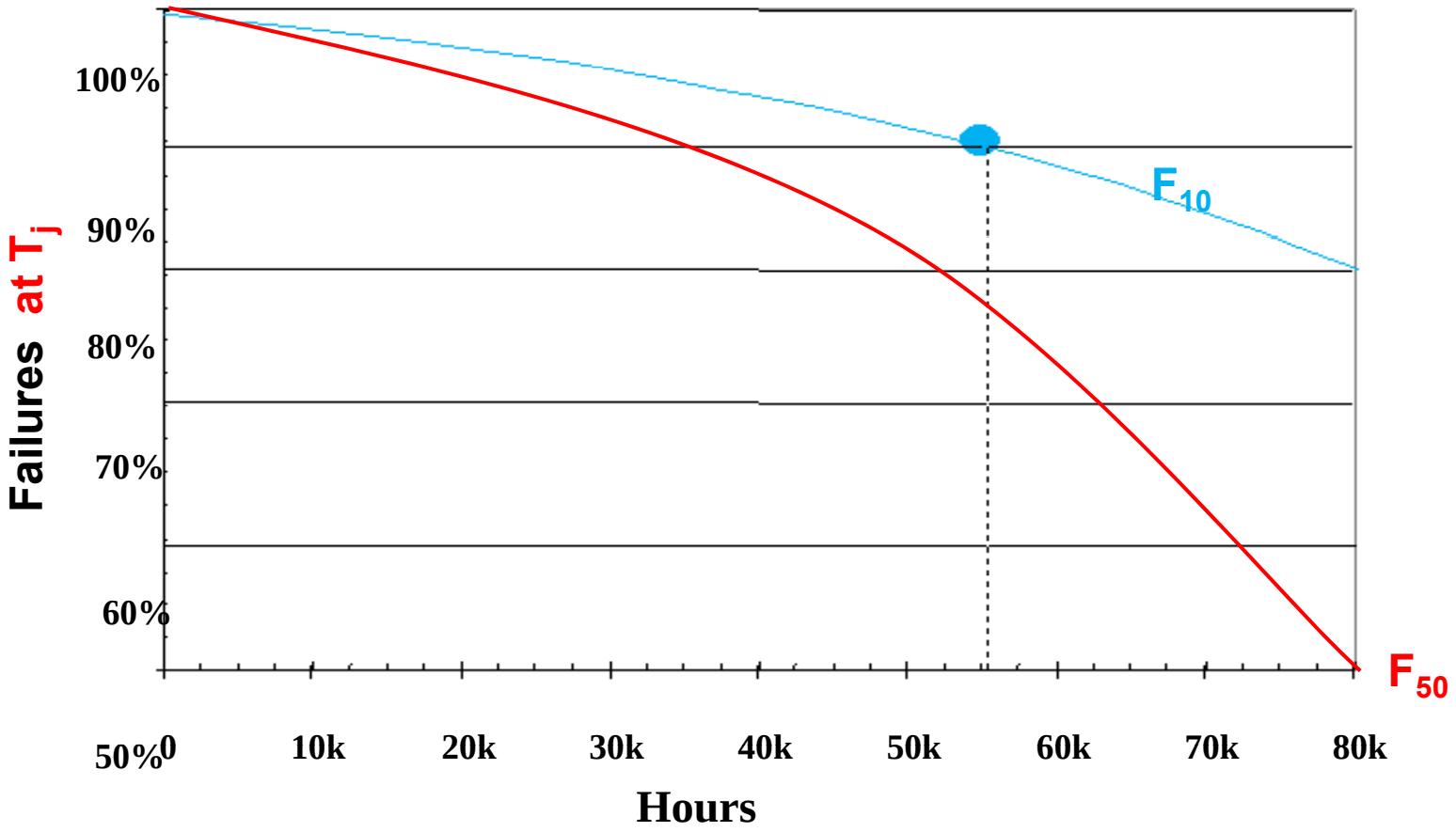
- LED luminaire life according to the IEC/PAS 62722 should always be published as a combination of life at lumen maintenance (Lx) and failure fraction (Fy). The failure fraction expresses the combined effect of gradual and abrupt failure of all components of a luminaire, including mechanical, as far as the light output is concerned. This means that the LED luminaire could either emit less light than claimed or no light at all.



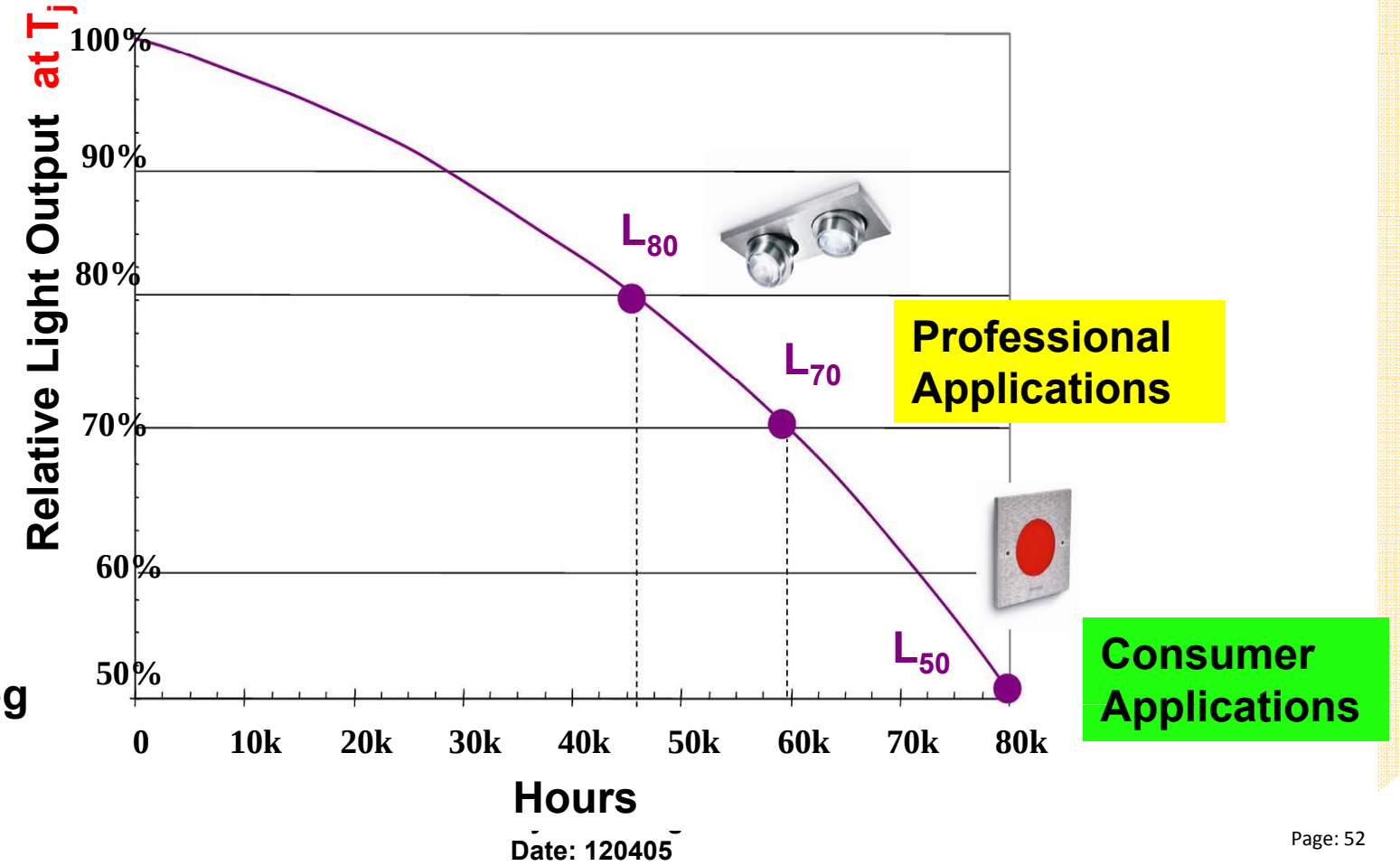
Failure Fraction F_y

= combined effect of gradual B and abrupt failure C of all components of a luminaire, including mechanical

Eg For >20lamps



Lumen Maintenance Lx
Eg For >20lamps



End of Life eg

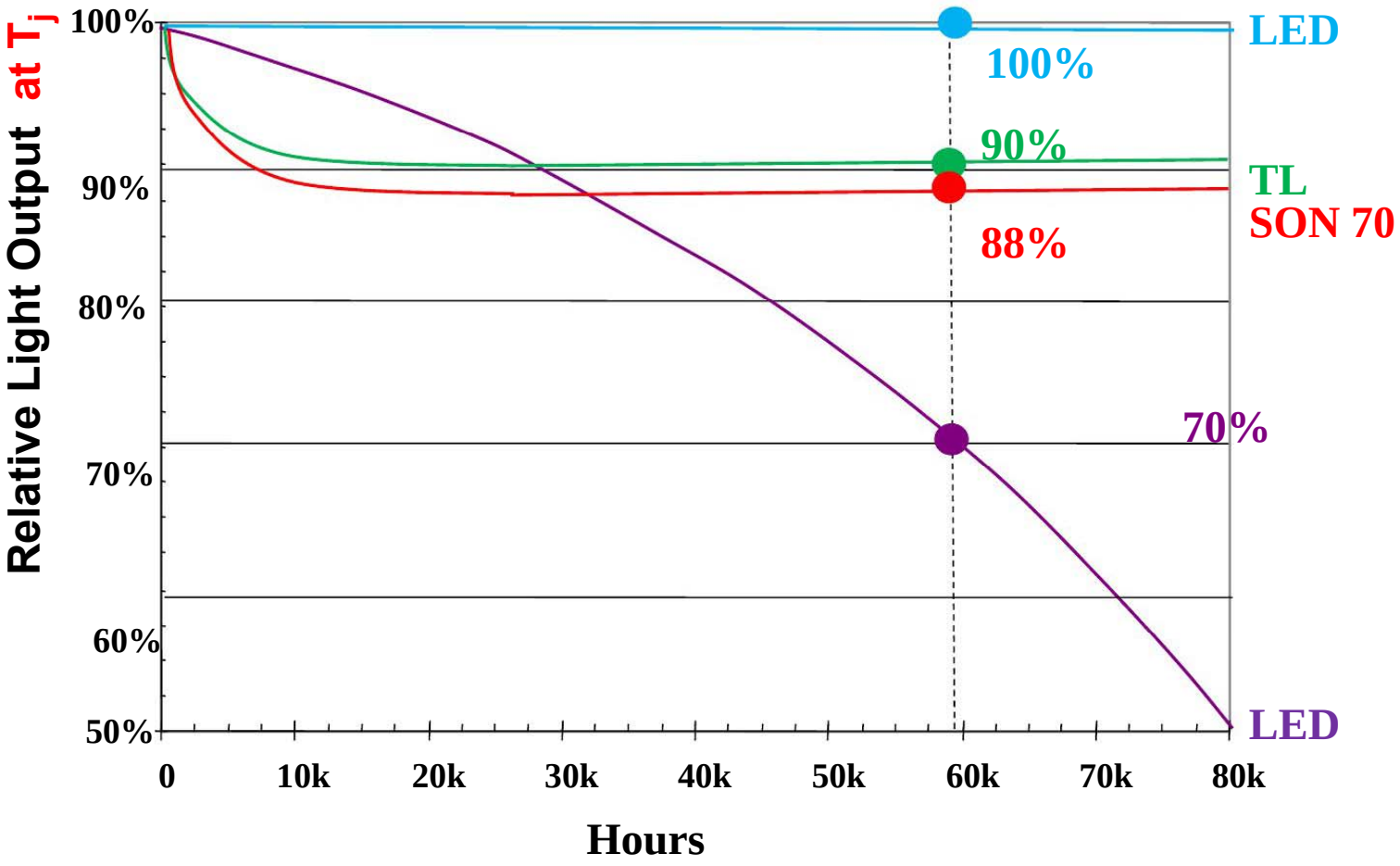
$L_{70}F_{10}$

$L_{50}F_{50}$

Date: 5/18/2012

Date: 120405

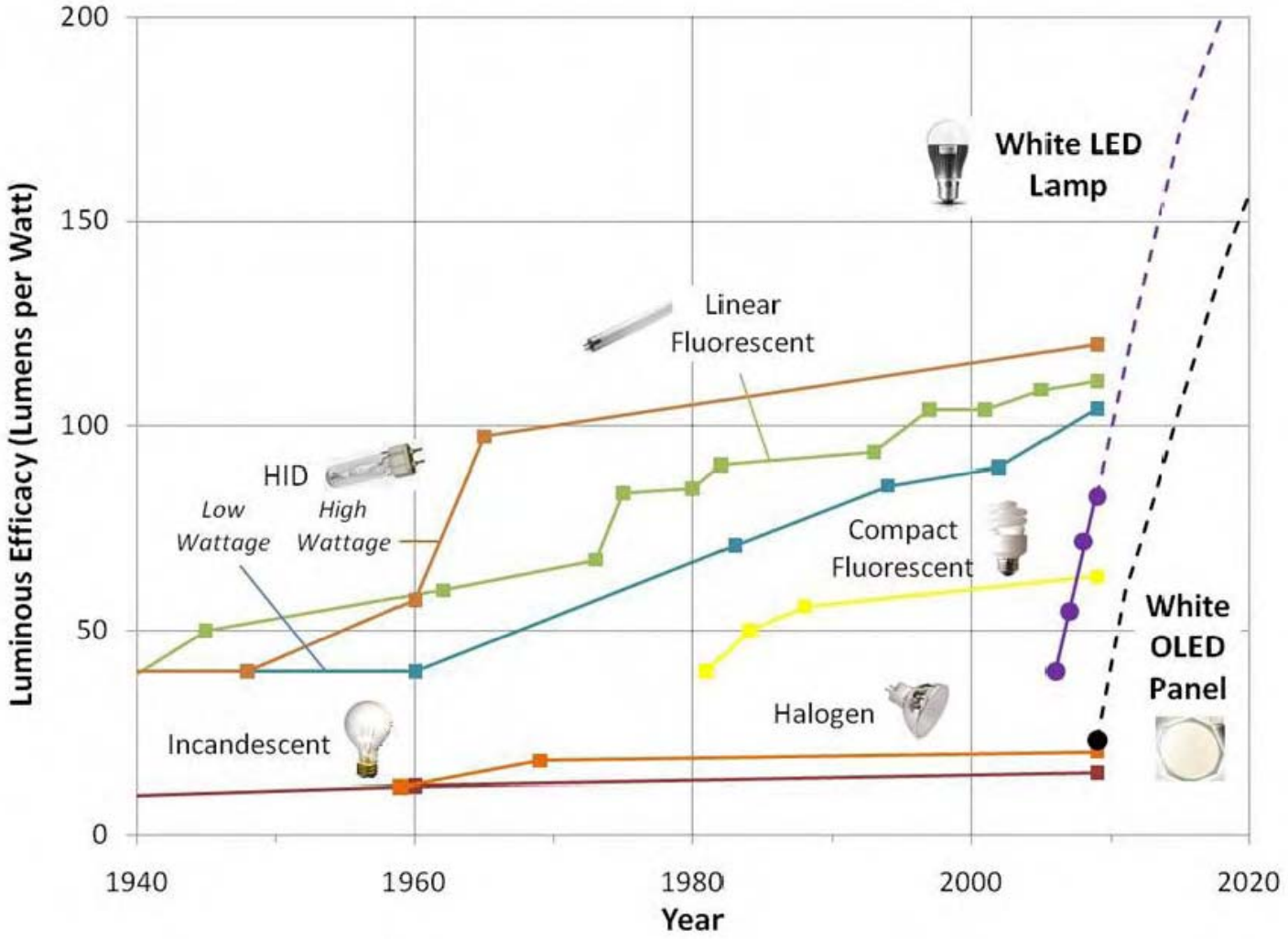
Maintenance Factors



Tay Hooi Seng
Date: 120405

Costs & Efficiencies

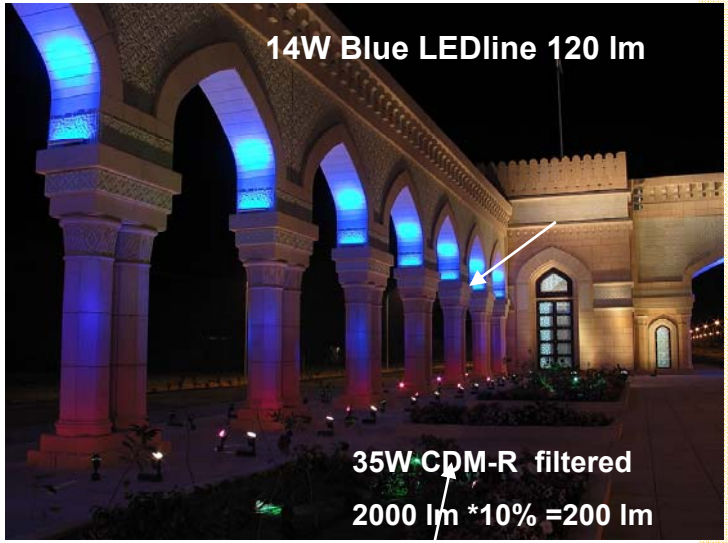
Historical and predicted efficacy of light sources



Source: SSL Research & Development: Multi-Year Program US Department of Energy, Mar 2010

Costs & Efficiencies

- Lumen package does not always accurately represent lit effect in the same way as conventional light sources
  - Visual effects can be same or better but with lower lumen packages
  - Saturated Colour
- Calculating Total Operating costs is more relevant
  - Cost of cabling and installing: simple DC series connections
  - Extended lifetime (No lamp changing costs; cost of replacement lamp itself)
  - Minimal maintenance (Smaller fixtures, Robust, No moving parts)
  - As a total solution LEDs are often cheaper in exterior applications



Conclusion

LED's

We hope this FORUM has given all of you the neccesary consideration and evaluation methods of providing

Good Lighting using

LEDs

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PCO ELECTRICAL (M) SDN BHD

a. b. No 11-A, Jln Kenari 17/D, Bandar Puchong Jaya, 47100 Puchong,

Terima Kasih

ank you grazie merci danke grazias 謝謝 спасибо

acias obrigado ありがとう dank takk bedankt dakuje

Appendix A - Quality Criteria as per MS/IEC

Quality criteria to be considered when evaluating manufacturer's claims

- a) Rated input power
- b) Rated luminous flux
- c) LED luminaire efficacy
- d) Luminous intensity distribution
- e) Photometric code
- f) Correlated Colour Temperature (CCT)
- g) Rated Colour Rendering Index (CRI)
- h) Rated chromaticity co-ordinate values both initial and maintained
- i) Lumen maintenance code
- j) Rated life (in h) of the LED module and the associated rated lumen maintenance (Lx)
- k) Failure fraction (Fy), corresponding to the rated life of the LED module in the luminaire
- l) Ambient temperature (tq) for a luminaire

Brief explanation of the quality criteria

- a) Rated input power
  - The rated input power shows the amount of energy consumed by a luminaire, including its power supply. It is expressed in watts.
- b) Rated luminous flux It corresponds to the light emitted by the luminaire which is expressed in lumen (unit of light output). It is expressed in lumens.
- c) LED luminaire efficacy The measured initial luminous flux divided by the measured initial input power of the same individual LED luminaire. It is expressed in lumens per watt.

Brief explanation of the quality criteria

- d) Luminous intensity distribution The spatial distribution of the luminous flux graphically depicted in a luminous intensity distribution curve, which is usually expressed in a polar coordinate diagram representing the light intensity as a function of angle about a light source. It is expressed in cd = lm × sr-1.
- e) Photometric code A six digit photometric code that displays the important 'quality of light' parameters: CRI, CCT, chromaticity co-ordinates and luminous flux.

Brief explanation of the quality criteria

- f) Rated Colour Rendering Index (CRI) The CRI of a LED module giving white light is the effect on the color appearance of objects by conscious or subconscious comparison with their color appearance under a reference illuminant.
- g) Correlated Colour Temperature (CCT) The colour temperature of a LED module giving white light is determined by comparing the light emitted by the LED module with light of an ideal black-body radiator at the given temperature. It is expressed in Kelvin.
- h) Rated chromaticity co-ordinate values both initial and maintained The behaviour of the chromaticity co-ordinates of a LED module expressed in two measurement results of both initial and maintained chromaticity co-ordinates.

Brief explanation of the quality criteria

- i) Lumen maintenance code The measured initial luminous flux (initial value) is normalised to 100% and used as the first data point for determining the LED module life. The maintained luminous flux (maintained value) is measured at 25 % of rated life time up to a maximum of 6.000 hours and expressed as percentage of the initial value. The maintained value determines the lumen maintenance code (see table 3).
- j) Rated life of the LED module and the associated rated lumen maintenance (Lx) The length of time during which a population of LED modules provides more than the claimed percentage (x) of the initial luminous flux always published in combination with the failure fraction. It is expressed in hours.

Brief explanation of the quality criteria

- k) Failure fraction (Fy), corresponding to the rated life of the LED module in the luminaire The percentage (y) of a number of LED modules of the same type at their rated life designates the percentage (fraction) of failures. This failure fraction expresses the combined effect of all components of a module including mechanical, as far as the light output is concerned. The effect of the LED could either be less light than claimed or no light at all.
- l) Ambient temperature (tq) for a luminaire The ambient temperature around the luminaire related to the specified performance. For a given performance claim the ambient temperature (tq) is a fixed value. It is possible to specify performance claims at different ambient temperatures. It is expressed in degrees Celsius.

Quality Criteria Over Time

Luminaire lifetime claims based on lumen maintenance and luminaire life are very different things

- Luminaire lifetime claims based on lumen maintenance refers to the lumen maintenance projections of the LED's integrated into that luminaire, the number of hours that a LED luminaire will deliver a sufficient amount of light in a given application;
- Luminaire life has to do with the reliability of the components of an LED luminaire as a system, the entire system lasts as long as the critical component with the shortest life. From this point of view LED's are simply one critical component among many.

Quality Criteria Over Time

Luminaire lifetime claims based on lumen maintenance and luminaire life are very different things

- Lifetime claims based on lumen maintenance and luminaire life are two very different things. The lifetime claims based on lumen maintenance refers to the lumen maintenance projections of the LED light sources integrated into that luminaire in simple Dutch, the number of hours that a LED luminaire will deliver a sufficient amount of light in a given application.

Quality Criteria Over Time

Luminaire lifetime claims based on lumen maintenance and luminaire life are very different things

- Many LED luminaire manufacturers use test results typically provided by LM-80 as the L90, L70 and L50 lumen maintenance thresholds of LED luminaires.
- But there is a disconnection between the LM-80 test results usually made by the LED manufacturer and the results on a LED luminaire where for example the thermal management can change the actual performance.
- LM-80 requires testing of LED's for 6.000 hours, and recommends testing for 10.000 hours. It calls for testing at three surface temperatures (55° C, 85° C, and a third temperature to be determined by the manufacturer) so that users can see the effects of temperature on light output, and it specifies additional test conditions to ensure consistent and comparable results.

Quality Criteria Over Time

Luminaire lifetime claims based on lumen maintenance and luminaire life are very different things

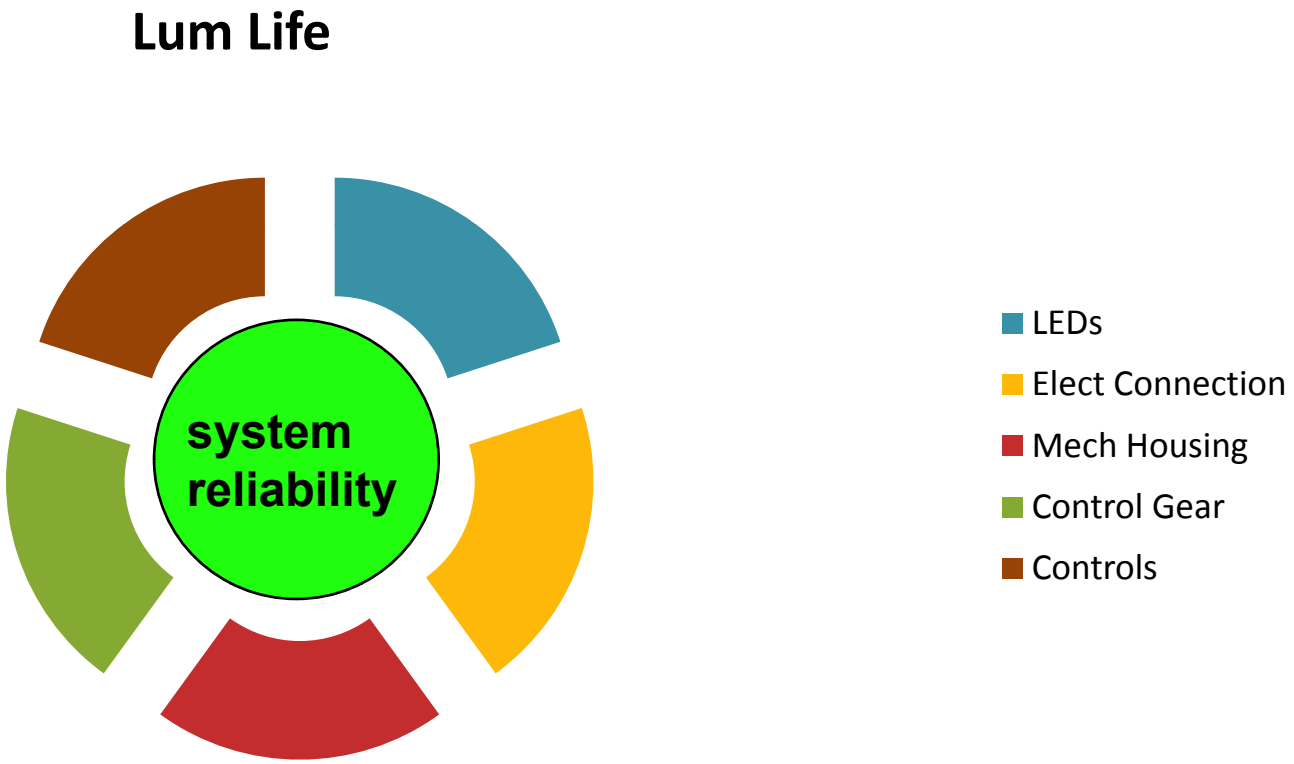
- In practice, leading LED manufacturers test their products to the LM-80 minimums of 6.000 or 10.000 hours, and then apply extrapolation methodologies as described in TM-21 to arrive at L90, L70 and L50 figures.
- Luminaire manufacturers translate these curves into LED luminaire specific curves. There are two constraints in translating these test results into LED luminaire performance:
  - First: catastrophic failures of individual LED's and other failure modes participate to the light output depreciation of a population of LED's in a LED luminaire are not taken into consideration;
  - Second: there is no validated way to translate the lumen maintenance curve of an individual LED into a curve for the LED luminaire.

Quality Criteria Over Time

Luminaire lifetime claims based on lumen maintenance and luminaire life are very different things

- Luminaire life, on the other hand, has to do with the reliability of the components of an LED luminaire as a system, including the electronics, materials, housing, wiring, connectors, seals, and so on. The entire system lasts only as long as the critical component with the shortest life, whether that critical component is a weather seal, an optical element, an LED, an electronic control gear circuit or something else. From this point of view, LED's are simply one critical component among many — although they are often the most reliable component in the whole lighting system.

Luminaire life is about system reliability



Quality Criteria Over Time

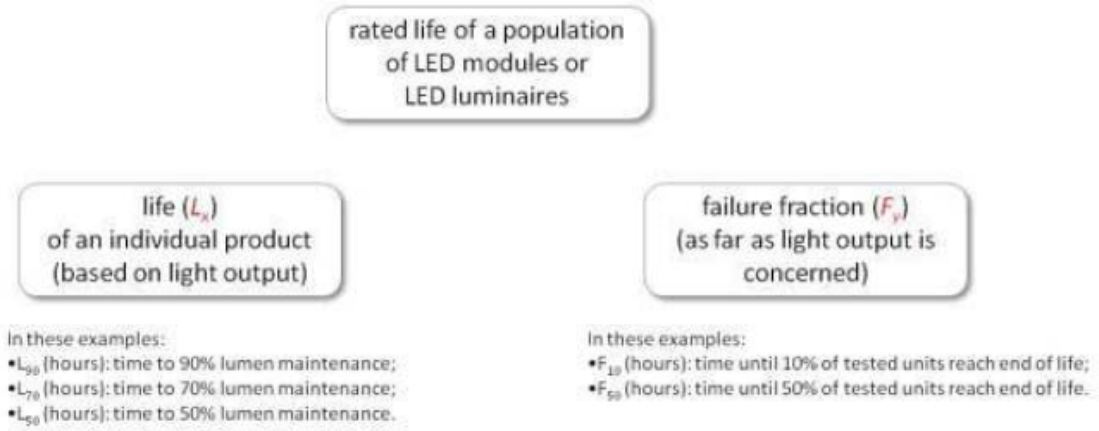
Luminaire lifetime claims based on lumen maintenance and luminaire life are very different things

- If an LED luminaire is equipped with a replaceable LED module, luminaire life can be decoupled from the LED module and its life. This brings luminaire life closer to the current definition of luminaire life for conventional light sources. For instance, the life of road lighting luminaires is often 30 to 40 years. However it is preferable to publish the LED module life as the LED luminaire life.
- LED luminaire design is then typically validated through a series of laboratory tests to verify that the luminaire is meeting the expected performance levels for heat dissipation, light output, and so on. Since all the aspects of an LED luminaire are interdependent, operational performance can be determined only by testing the luminaire as an integrated system.

Quality Criteria Over Time

Luminaire lifetime claims based on lumen maintenance and luminaire life are very different things

- LED luminaire life according to the IEC/PAS 62722 should always be published as a combination of life at lumen maintenance (Lx) and failure fraction (Fy). The failure fraction expresses the combined effect of gradual and abrupt failure of all components of a luminaire, including mechanical, as far as the light output is concerned. This means that the LED luminaire could either emit less light than claimed or no light at all.



Appendix A - Quality Criteria as per MS/IEC

Appendix A - Quality Criteria as per MS/IEC

62722-1	62722-2-1	62717	62612
1 Scope	1 Scope	1 Scope	1 General - Scope
2 Normative references	2 Normative references	2 Normative references	2 Normative references
3 Terms and definitions	3 Terms and definitions	3 Terms and definitions	3 Terms and definitions
4 General requirements	4 Product information	4 Marking	4 Marking
5 Light sources and components of luminaires	5 Not used	5 Dimensions	5 Dimensions
6 Photometric data	6 Test conditions	6 Test conditions	6 Test conditions
7 Electrical data	7 Total input power	7 Module power	7 Lamp wattage
8 Luminaire efficacy data	8 Light output	8 Light output	8 Luminous flux
	9 Chromaticity co-ordinates, correlated colour temperature and colour rendering	9 Chromaticity co-ordinates, correlated colour temperature (CCT) and colour rendering	9 Correlated colour temperature and colour rendering
	10 LED luminaire life	10 LED module life	10 Lamp life
	11 Verification	11 Verification	11 Assessment
		12 Information for luminaire design	12

Appendix A - Quality Criteria as per MS/IEC

	62722-1		62722-2-1		62717		62612
A	Annex A (normative) Use of regional standards	A	Annex A (normative) Method of measuring LED luminaire characteristics	A	Annex A (normative) Method of measuring LED module characteristics	A	Annex A (normative) Method of measuring lamp characteristics
B	Annex B (normative) Measurement method of total power of luminaires and associated parasitic power	B	Annex B (informative) Explanation of recommended life time metrics	B	Annex B (informative) Information for luminaire design	B	Annex B (normative) Method of measuring luminous flux for LED lamps
C	Annex C (informative) Symbols to assist the communication of instructions for maintenance through life and end of life recycling			C	Annex C (informative) Explanation of recommended life time metrics		
				D	Annex D (normative) Explanation of the photometric code		
				E	Annex E (informative) Meaning of confidence intervals		

MS 62504:2012 (P
General lighting - LEDs and LED modules -
Terms and definitions

MS 62612:2012 (P) Self-ballasted LED-lamps for general lighting services - Performance requirements

- Scope
  - a rated wattage up to 60 W;
  - a rated voltage of > 50 V a.c. up to 250V a.c.;
  - a lamp cap according to IEC 62560
- Life time of LED lamps is in most cases much longer than the practical test times. Consequently, verification of manufacturer's life time claims cannot be made in a sufficiently confident way, because projecting test data further in time is not standardised. For that reason the acceptance or rejection of a manufacturers life time claim, past an operational time as stated in 7.1, is out of the scope of this standard.

MS 62612:2012 (P) Self-ballasted LED-lamps for general lighting services - Performance requirements

- Instead of life time validation this standard has opted for lumen maintenance codes at a defined finite test time. Therefore, the code number does not imply a prediction of achievable life time. The categories, represented by the code, are lumen-depreciation character categories showing behaviour in agreement with manufacturer's information which are provided before the test is

Marking

	Product	Packaging	Product datasheets, leaflets or website
a) Rated luminous flux (lm), centre beam intensity and beam angle (NOTE2)		X	X
b) Lamp photometric code (see Annex B).		X	X
c) Rated life (h) and the related lumen maintenance (x)		X	X
d) Failure fraction (Fx), corresponding to the rated life		X	X
e) Lumen maintenance code (see Table 5)			X
f) Rated colour (for example: F 2700 to F 6500, see Table 3) including initial and maintained colour variation category (see Table 4)		X	X
g) Rated Colour Rendering Index		X	X
h) Ageing time (h), if different to 0 h			X
i) Rated efficacy (lm/W) (NOTE 3)			X
j) Dimensions, including dimensional tolerances			X
k) Displacement factor (see Annex D)			X

NOTE 1 These requirements are minimal. Additional regional regulatory marking requirements may exist and overrule.
NOTE 2 For directional lamps, centre beam intensity and beam angle are measured according to IEC TR 61341.
NOTE 3 Efficacy of directional lamps can be classified with a luminous flux defined in a 120° (π sr) cone or 90° (0.6 π sr) cone, which must be indicated in the product datasheet

Photometric code

Eg.

8	CRI of e.g. 77. The colour rendering value is expressed as one figure which is obtained by using the intervals: CRI = 67 to 76 a code “7” CRI = 77 to 86 a code “8” CRI = ≥ 87 a code “9” The highest value is 9.
3	initial CCT of 3000K = CCT/100
0	
/	
3	Initial spread of chromaticity co-ordinates within a 3-step MacAdam ellipse
5	Maintained spread of chromaticity co-ordinates at 25% of rated life (within a maximum duration of 6000 h) within a 5-step MacAdam
9	Code of lumen maintenance at 25% of rated lamp life (with a maximum duration of 6000 h); in this example: >=90% of the 0 h value.

Table 5 Lumen maintenance code at an operational time as stated in 7.1

Instead of life time validation

Lumen Maintenance %	Code
>= 90%	9
>= 80%	8
>= 70%	7

As the typical life of a LED luminaire is (very) long, it is time-consuming to measure the actual lumen reduction over life (e.g. L70 meaning the length of time during which the LED module provides more than the claimed 70% of the initial luminous flux). Also the actual LED behaviour with regard to lumen-maintenance may differ considerably per type and per manufacturer. It is not possible to express the lumen-maintenance of all LED's in simple mathematical relations. A fast initial decrease in lumen output does not automatically imply that a particular LED will not make its rated life. In order to validate a life time claim, an extrapolation of test data is needed. In IEC a general method of projecting measurement data beyond limited test time is under consideration. In the US an extrapolation based on LM-80 test data will be described in IES TM-21.

Table 4 Tolerance (categories) on rated chromaticity co-ordinate values

Size of MacAdam ellipse, centred on the rated colour target	Colour Variation Category	
	Initial	Maintained
3-step	3	3
5-step	5	5
7-step	7	7
> 7-step	7+	7+

Table 3 Colour (Colour variation categories)

"Colour"	CCT	x	y
F 6500	6400	0,313	0,337
F 5000	5000	0,346	0,359
F 4000	4040	0,380	0,380
F 3500	3450	0,409	0,394
F 3000	2940	0,440	0,403
F 2700	2720	0,463	0,420
P 2700	2700	0,458	0,410

Table 3 – Tolerance (categories) on nominal CCT values

MacAdams ellipse type	CCT category
All measured CCT's within a 1-step ellipse	Cat 1
All measured CCT's within a 2-step ellipse	Cat 2
All measured CCT's within a 3-step ellipse	Cat 3
All measured CCT's within a 4-step ellipse	Cat 4
All measured CCT's within a 5-step ellipse	Cat 5
All measured CCT's within a 6-step ellipse	Cat 6
All measured CCT's within a 7-step ellipse	Cat 7
All measured CCT's not within a 7-step ellipse	Cat 8

Table 4 – Categories of lumen maintenance after 6000h

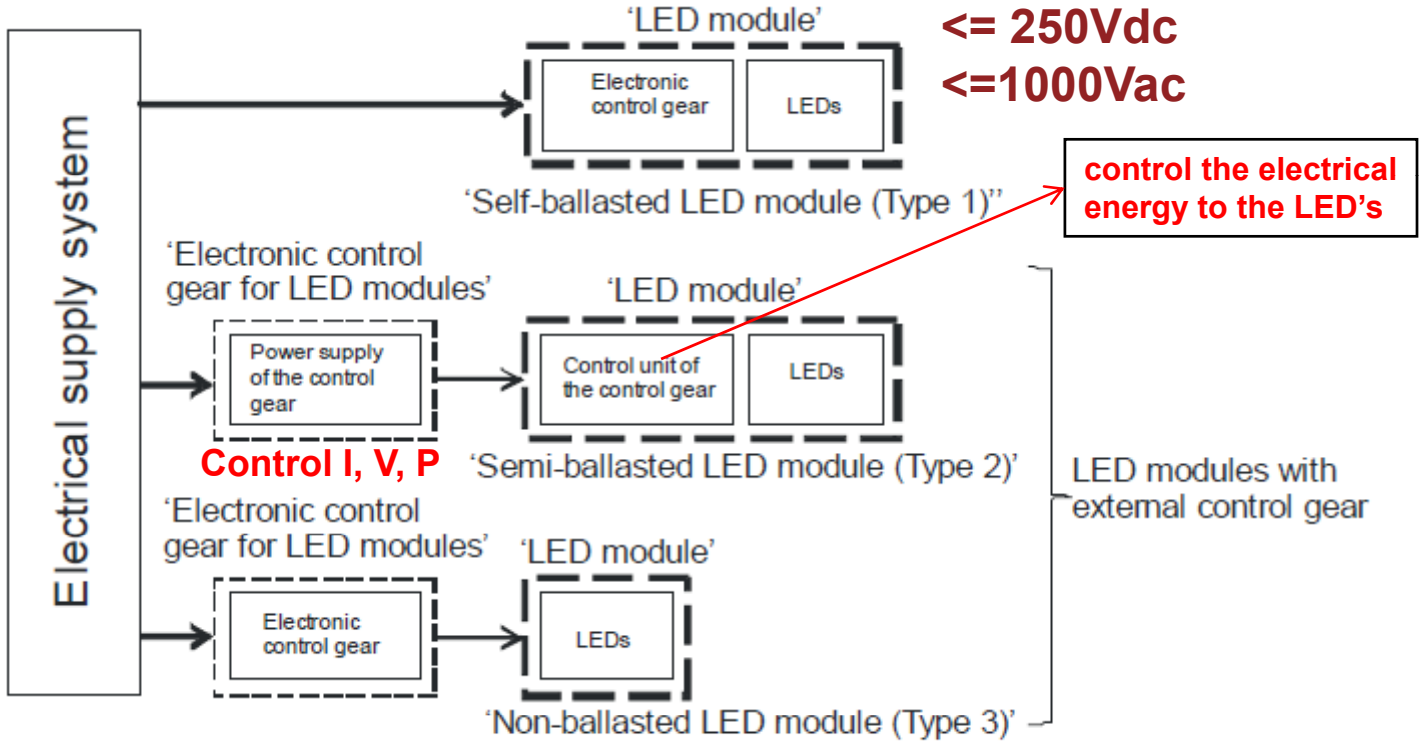
Luminous flux decrease at 6000h as % of 0h value	Δ ϕ category
Measured flux decreased by no more than 10% of rated flux	Cat A
Measured flux decreased by no more than 20% of rated flux	Cat B
Measured flux decreased by no more than 30% of rated flux	Cat C
Measured flux decreased by no more than 40% of rated flux	Cat D
Measured flux decreased by no more than 50% of rated flux	Cat E

Table D.1 Recommended values for displacement factor

		Limit		
	P ≤ 2 W	2 W < P≤ 5 W	5 W < P ≤ 25 W	P > 25 W
$k_{displacement}$ (cos ϕ1)	No limit	>= 0,4	>= 0,7	>= 0,9

MS 62717:2012 (P), LED modules for general lighting - Performance requirements

MS 62717:2012 (P), LED modules for general lighting - Performance requirements



MS 62717:2012 (P), LED modules for general lighting - Performance requirements

- Types of LED modules
  - Type 1: Self-ballasted LED modules for use on d.c. supplies up to 250 V or on a.c. supplies up to 1000 V at 50 Hz or 60 Hz; a rated voltage of > 50 V a.c. up to 250V a.c.;
  - Type 2: LED modules operating with external control gear connected to the mains voltage, and having further control means inside ("semi-ballasted") for operation under constant voltage, constant, current or constant power;
  - Type 3: LED modules where the complete control gear is separate from the module for operation under constant voltage, constant current or constant power.

MS 62717:2012 (P), LED modules for general lighting - Performance requirements

- Scope
  - The requirements of this PAS relate only to type testing.
  - Life time of LED modules is in most cases much longer than the practical test times. Consequently, verification of manufacturer's life time claims cannot be made in a sufficiently confident way, because projecting test data further in time is not standardised. For that reason, the acceptance or rejection of a manufacturers life time claim, past 25 % of rated life (with a maximum of 6 000 h), is out of the scope of this PAS
  - Instead of life time validation, this PAS has opted for lumen maintenance codes at a defined finite test time. Therefore, the code number does not imply a prediction of achievable life time. The categories are lumen-depreciation character categories showing behaviour in agreement with manufacturer's information
  - The pass/fail criterion of the life time test as defined in this PAS is different from the life time metrics claimed by manufacturers. For explanation of recommended life time metrics, see Annex C. which are provided before the test is started.

MS 62717:2012 (P), LED modules for general lighting - Performance requirements

- Scope
  - It may be expected that self-ballasted LED modules which comply with this PAS will start and operate satisfactorily at voltages between 92 % and 106 % of rated supply voltage. LED modules with external controlgear are expected to start and operate satisfactorily in combination with the specified controlgear complying with IEC 61347-2-13 and IEC 62384. All LED modules are expected to start and operate satisfactorily when operated under the conditions specified by the module manufacturer and in a luminaire complying with IEC 60598-1.
  - Instead of life time validation, this PAS has opted for lumen maintenance codes at a defined finite test time. Therefore, the code number does not imply a prediction of achievable life time. The categories are lumen-depreciation character categories showing behaviour in agreement with manufacturer's information
  - The pass/fail criterion of the life time test as defined in this PAS is different from the life time metrics claimed by manufacturers. For explanation of recommended life time metrics, see Annex C. which are provided before the test is started.

MS 62722-1:2012 (P), Luminaire performance - Part 1: General Requirements

MS 62722-1:2012 (P), Luminaire performance - Part 1: General requirements

- Scope
  - Covers specific performance and environmental requirements for luminaires, incorporating electric light sources for operation from supply voltages up to 1000 V where claims of operational performance are made. Unless otherwise detailed performance data covered under the scope of this PAS are for the luminaires in a condition representative of new manufacture, with any specified initial aging procedures completed.
  - IEC/PAS 62722-1 covers requirements for luminaires to support energy efficient use and responsible environmental management to the end of life. The object of this Part 1 is to provide a set of requirements which are considered to be generally applicable to most types of luminaires. Where additional performance requirements for specific types of light source are relevant, these are specified in the IEC 62722-2 series. The IEC 62722-2 series may also cover a wider scope of performance aspects appropriate to the particular light source technology.
  - It is the intention that the requirements of this Part 1 are to be met by the provision of information and data provided by the luminaire manufacturer (or responsible vendor). Conformity is considered to be met by the provision of the requested information. Any verification of data is to be conducted by the measurement requirements of this PAS.

MS 62722-1:2012 (P), Luminaire performance - Part 1: General requirements

- Scope
  - Covers specific performance and environmental requirements for luminaires, incorporating electric light sources for operation from supply voltages up to 1000 V where claims of operational performance are made. Unless otherwise detailed performance data covered under the scope of this PAS are for the luminaires in a condition representative of new manufacture, with any specified initial aging procedures completed.
  - IEC/PAS 62722-1 covers requirements for luminaires to support energy efficient use and responsible environmental management to the end of life. The object of this Part 1 is to provide a set of requirements which are considered to be generally applicable to most types of luminaires. Where additional performance requirements for specific types of light source are relevant, these are specified in the IEC 62722-2 series. The IEC 62722-2 series may also cover a wider scope of performance aspects appropriate to the particular light source technology.
  - It is the intention that the requirements of this Part 1 are to be met by the provision of information and data provided by the luminaire manufacturer (or responsible vendor). Conformity is considered to be met by the provision of the requested information. Any verification of data is to be conducted by the measurement requirements of this PAS.

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- Scope
  - As this PAS has been simultaneously developed and edited with the PAS for LED modules, where appropriate the compliance of the modules to the provisions of IEC/PAS 62717 may be transferred to the whole luminaire.
  - This PAS specifies the performance requirements for LED luminaires, together with the test methods and conditions, required to show compliance with this PAS. It applies to LED luminaires for general lighting purposes, where claims of operational performance are made.
  - The following types of LED luminaires are distinguished:
    - Type A – Luminaires using LED modules that have not been shown to comply with IEC/PAS 62717;
    - Type B – Luminaires using LED modules that have been shown to comply with IEC/PAS 62717;
    - Type C – Luminaires using a LED lamp and covered in IEC/PAS 62722-1.
  - The requirements of this PAS only relate to type testing.

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- Scope
  - Life time of LED luminaires is in most cases much longer than the practical test times. Consequently, verification of manufacturer's life time claims cannot be made in a sufficiently confident way. For that reason the acceptance or rejection of a manufacturer's life time claim, past 25 % of rated life (with a maximum of 6 000 h), is out of the scope of this PAS
  - Instead of life time validation this PAS has opted for lumen maintenance categories at a defined finite test time. Therefore, the category number does not imply a prediction of achievable life time. The categories are lumen-depreciation character categories showing behaviour in agreement with manufacturer's information which is provided before the test is started.
  - In order to validate a life time claim, an extrapolation of test data is needed. A general method of projecting measurement data beyond limited test time is under consideration. .
  - The pass/fail criterion of the life time test as defined in this PAS is different from the life time metrics claimed by manufacturers. For explanation of recommended life time metrics see IEC/PAS 62717, Annex C.

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- Scope
  - This PAS does not cover LED luminaires that intentionally produce coloured light; neither does it cover luminaires using OLEDs (organic LEDs).
  - These performance requirements are additional to the requirements in IEC/PAS 62722-1.
  - It may be expected that LED luminaires which comply with this PAS will start and operate satisfactorily at voltages between 92 % and 106 % of rated supply voltage and at an ambient air temperature within the declared range of the manufacturer.
  - The requirements of this PAS apply in addition to the IEC/PAS 62722-1.