New Emerging Market of LED Lighting and Its Requirements

Intertek Hong Kong

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LED Development

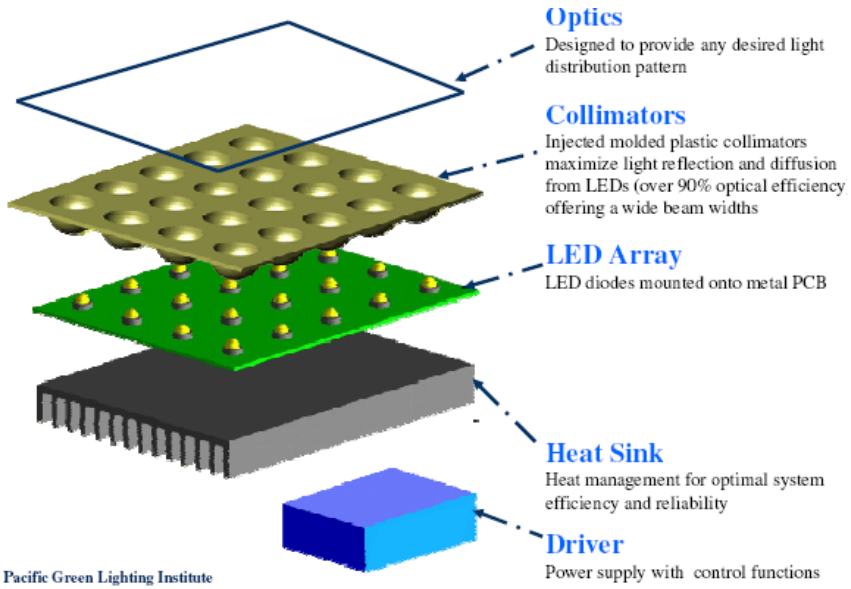
What is LED product ?

- Long life time (50,000 hours)
- Low maintenance
- Low voltage operation
- No UV and IR emission
- Mercury free
- Small form factor, higher design flexibility
- No filament, resists vibration
- Colour is tunable (by means of RGB)

The definition of a “light engine” by the IESNA:

An integrated assembly of:

- LED packages or array
- Optical components
- Thermal components
- LED driver
- Other electrical components



LED Development

For Traditional Lighting System

Quality control for lamp bulb manufacturers:

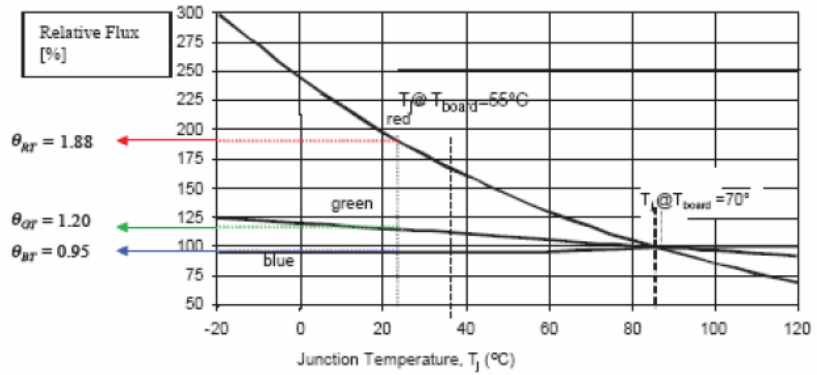
> Lumen, color rendering, life, thermal issues, etc.

Quality control for luminaries manufacturers:

> Light distribution, thermal issues, etc.

LED has both characteristics of lamp bulb and luminaries:

- Sensitive to temperature (Thermal Management)
- Complicated optic design
- Photobiological issues (Blue light)
- Control dirt accumulation



Relative Luminous Light Output vs Temperature

Regulation for New Emerging Market

Until this moment, there are only safety and EMC requirements on LED product for new emerging market which are following the IEC/EN standard.

For performance requirements, there are no standard and regulations until this moment, such as ELI, MEPS and SASO program.

With reference to the development history of CFL, all of performance standards may be developed according the well established standard from U.S.A. and EU.

Total Lighting Solution

Key Test requirements for LEDs:

- **Photo-biological Safety**
- **Performance Testing**
  - Light Efficacy
  - Light Distribution
  - Energy Efficiency
- **Safety Testing**
- **EMC, FCC**

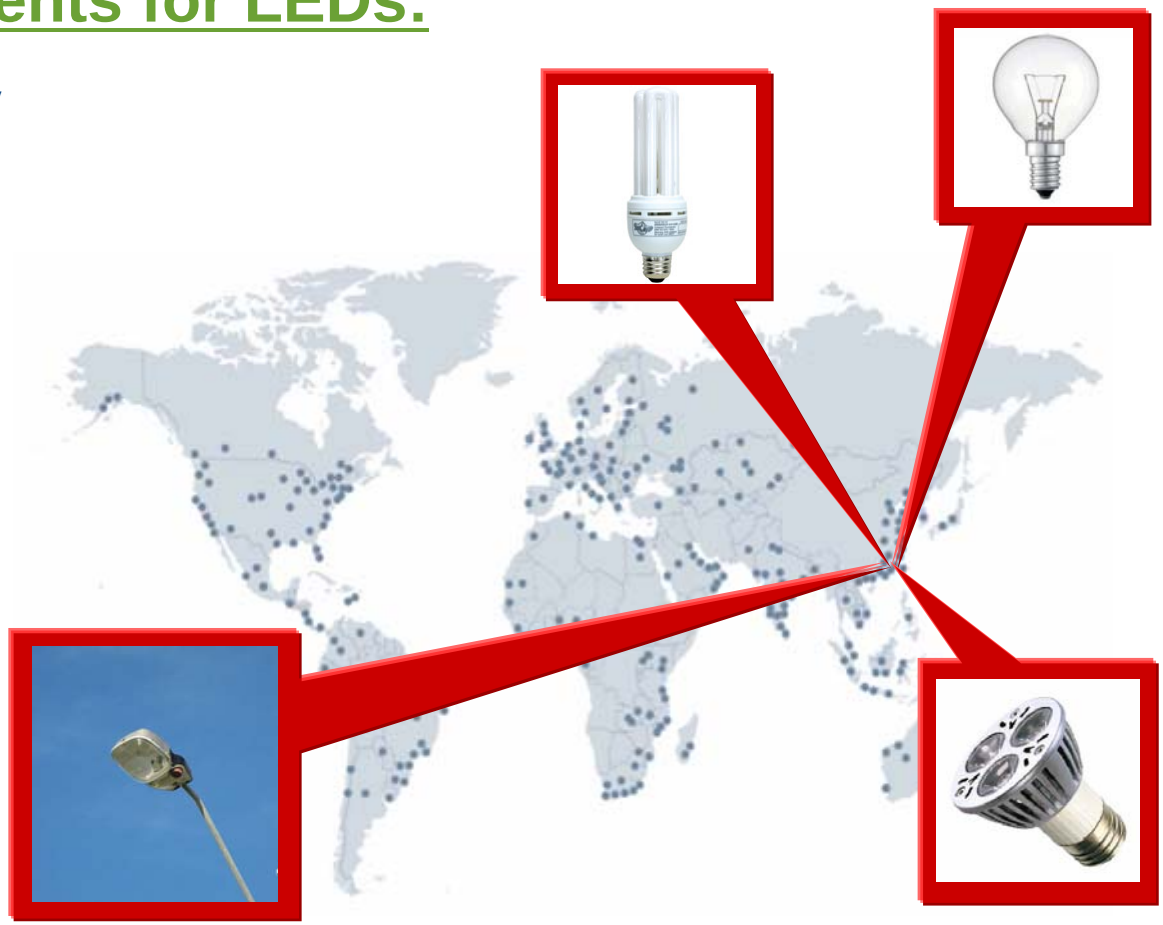


Photo-biological Safety- EU market

White light LEDs were widely used in most of LED products which has the unique “Blue Light” hazard.

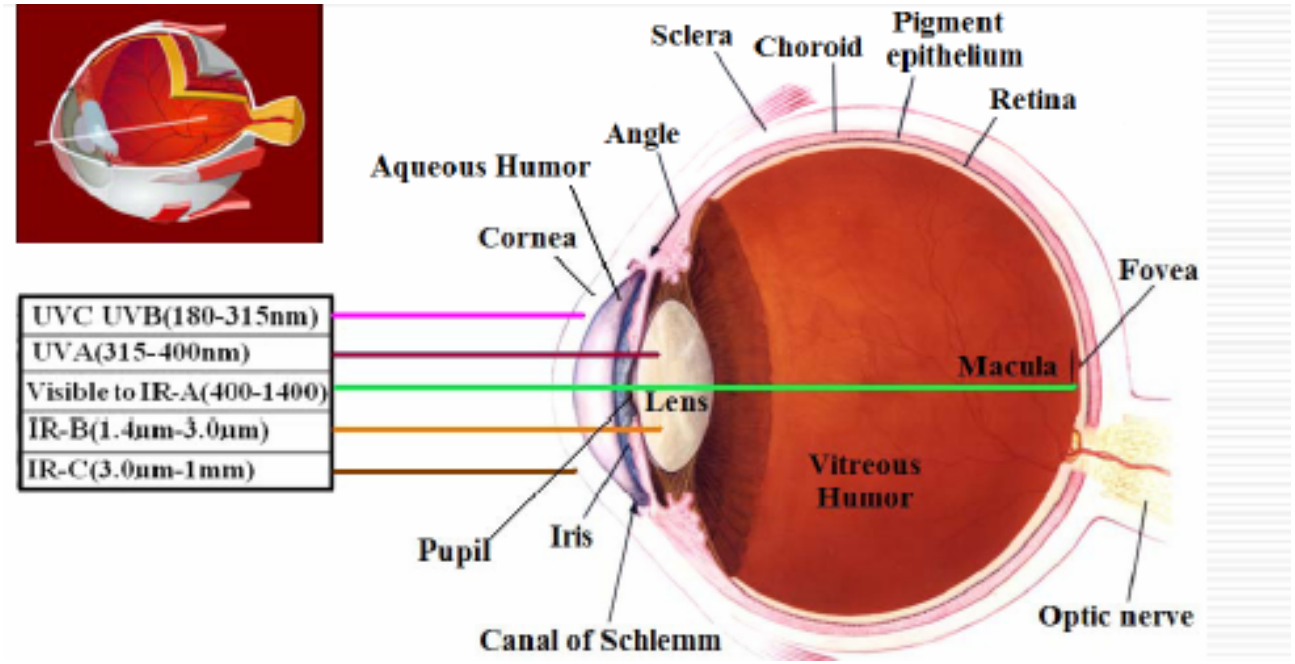
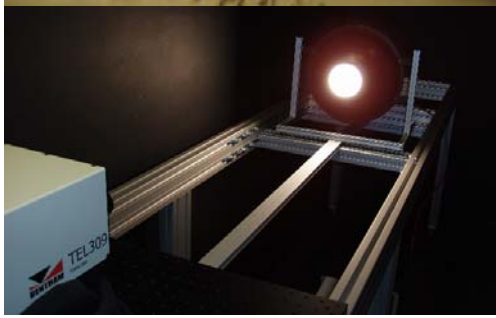


Photo-biological safety

The Spectroradiometer system were introduced, which can measure a light source with spectral range **200-1700nm**. **(From UVC to IRB),** and can be further expanded to **3000nm**.

With the Spectroradiometer system, we can perform the LED photo-biological safety testing (i.e. **EN 62471**) and Ultra-Violet radiation measurement according to different requirement (e.g. ErPs directvie)



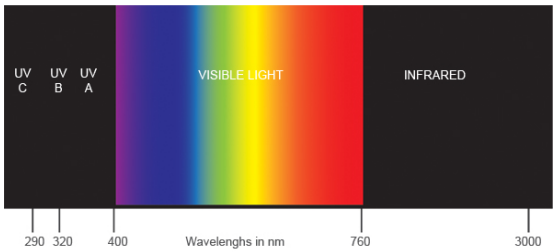


Photo-biological safety

Spectroradiometer, fully automated 200-1700nm

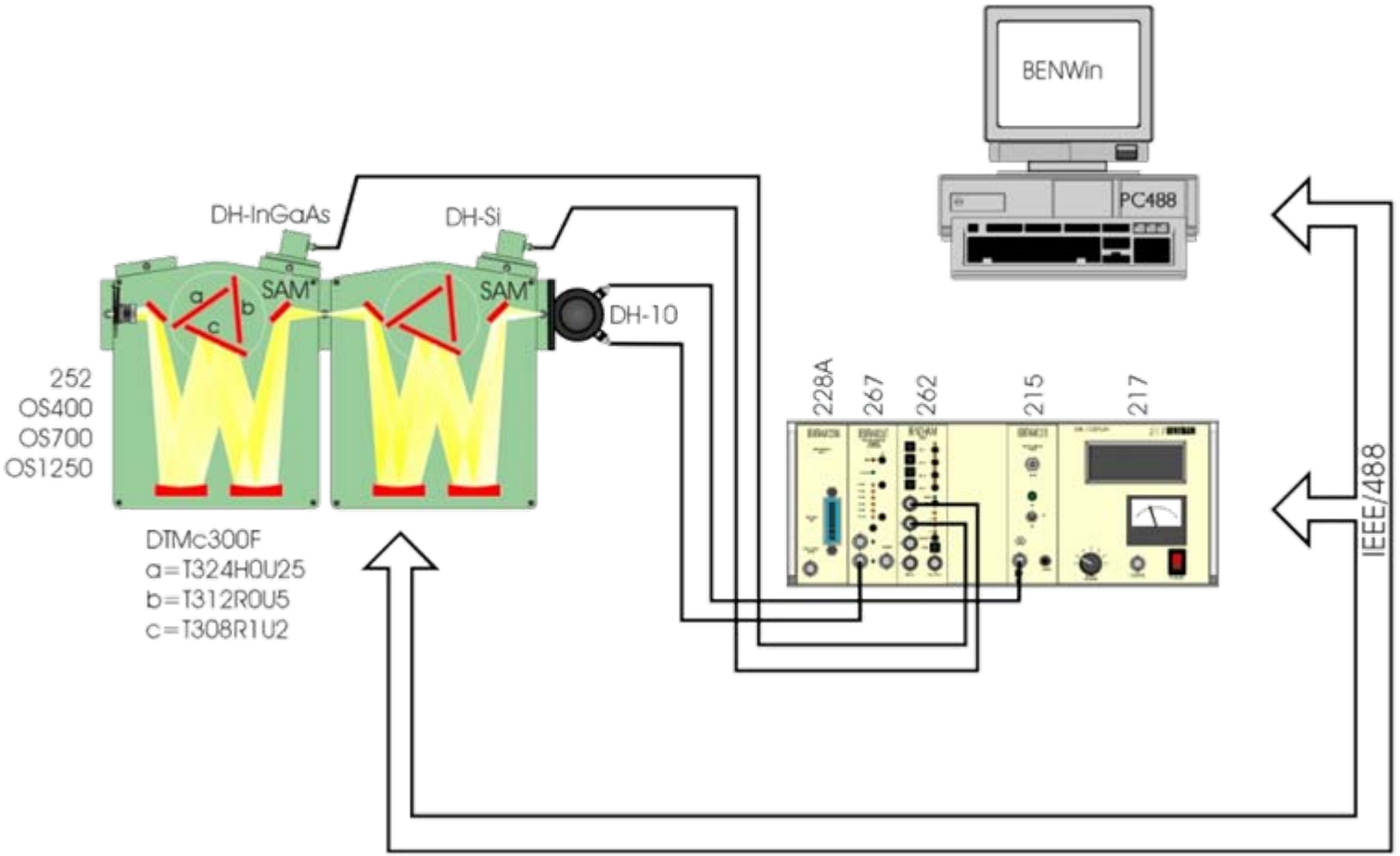


Photo-biological safety

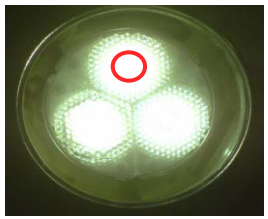
FOV For Radiance Measurement (Cl.4.2)

Measurement FOV	Blue Light	Retinal Thermal	Retinal Thermal (weak visual stimulus)
Exempt	100 mrad	11 mrad	35 mrad
Group 1	11 mrad	11 mrad	11 mrad
Group 2	1.7mrad	1.7 mrad	11 mrad

Photo-biological safety

FOV For Radiance Measurement (Cl.4.2)

Physiological” Radiance, FOV independent of actual source extent



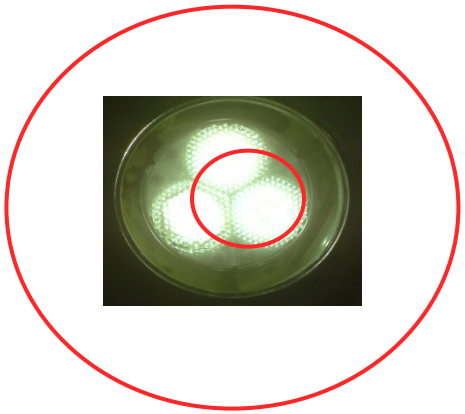
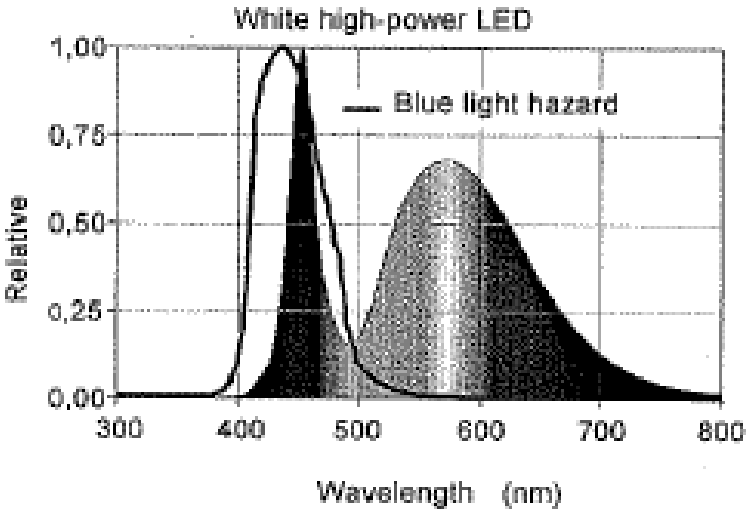


Photo-biological safety

Example – Classification

Figure A.4 shows an example of a "pc-white" LED component, where the B(λ)-weighted radiance was measured with an imaging radiance-meter.



γ_{Prov} [mrad]	Measured [$W \cdot m^{-2} \cdot sr^{-1}$]	Limit [$W \cdot m^{-2} \cdot sr^{-1}$]
100 (Exempt Risk Group)	250	100
11 (Risk Group 1)	$7,5 \times 10^{3}$	1×10^{4}
1,7 (Risk Group 2)	$1,1 \times 10^{4}$	4×10^{6}

Photo-biological safety

Classification (Cl. 6)

Exempt Group (RG 0)

Risk Group 1 (Low-Risk)

Risk Group 2 (Moderate-Risk)

Risk Group 3 (High-Risk)

Risk Group	Philosophical Basis
Exempt	No photobiological hazard
Group 1	No photobiological hazard under normal behavioural limitations
Group 2	Does not pose a hazard due to aversion response to bright light or thermal discomfort
Group 3	Hazardous even for momentary exposure

Photo-biological safety

Permissible Exposure Time (Cl. 6)

	Exposure time before hazard exceeded			
Hazard	**Exempt**	**group 1**	**group 2**	**group 3**
Actinic UV	30000	10000	1000	-
UVA hazard	1000	300	100	-
Blue Light Radiance	10000	100	0.25	-
Blue Light Small Source	10000	100	0.25	-
Retinal Thermal	10	10	0.25	-
Retinal Thermal weak visual	1000	100	10	-
IR Eye	1000	100	10	-

Unit: s

Photo-biological safety

Labeling – IEC62471-2 (Cl. 5.4)

Hazard	Exempt	Group 1	Group 2	Group 3
Actinic UV	-	NOTICE UV emitted from this product. Minimise exposure to eyes or skin. Use appropriate shielding.	CAUTION. UV emitted from this product. Eye or skin irritation may result from exposure. Use appropriate shielding.	WARNING. UV emitted from this product, Avoid eye and skin exposure to unshielded product.
UVA	-	NOTICE UV emitted from this product. Minimise exposure to eyes or skin. Use appropriate shielding.	CAUTION. UV emitted from this product. Eye or skin irritation may result from exposure. Use appropriate shielding.	WARNING. UV emitted from this product, Avoid eye and skin exposure to unshielded product.
Blue Light Radiance	-	-	CAUTION. Possibly hazardous optical radiation emitted from this product. Do not stare at operating lamp. May be harmful to the eye	WARNING. Possibly hazardous optical radiation emitted from this product. Do not look at operating lamp. Eye injury may result.

Photo-biological safety

Labeling – IEC62471-2 (Cl. 5.4)

Hazard	Exempt	Group 1	Group 2	Group 3
Retinal Thermal Hazard	-	-	CAUTION. Possibly hazardous optical radiation emitted from this product. Do not stare at operating lamp. May be harmful to the eye	WARNING. Possibly hazardous optical radiation emitted from this product. Do not look at operating lamp. Eye injury may result.
IR radiation eyes	-	NOTICE IR emitted from this product. Use appropriate shielding or eye protection.	CAUTION. IR emitted from this product. Do not stare at operating lamp.	WARNING IR emitted from this product. Avoid eye exposure. Use appropriate shielding or eye protection.
Retinal Thermal Hazard Weak Visual	-	WARNING IR emitted from this product. Do not stare at operating lamp	WARNING IR emitted from this product. Do not stare at operating lamp	WARNING IR emitted from this product. Do not look at operating lamp

Performance Testing

Lamp Efficacy

Two integrating sphere were setup with spectrometer system and perform the test with following test method:

- CIE 13.3
- CIE 15
- CIE 18
- CIE 84
- CIE 97

According to following requirement:

- IEC/EN 60969
- IEC/EN 60901
- IEC/EN 60064
- IEC/EN 60357

Testing Services:

Energy Star, EST, ELI, MEPS, HKEELS …etc

Performance Testing

Light Distribution

The Goniophotometer system were setup and suitable to measure the spatial luminous intensity distribution of lighting luminaires, according with the requirements

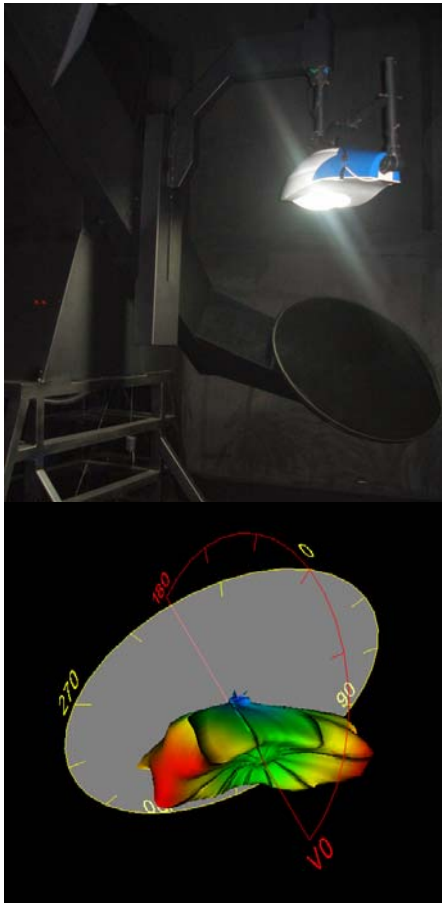
- CIE 70 /121
- IEC/EN 61341

Then to analyze the luminaire photometric parameters, including:

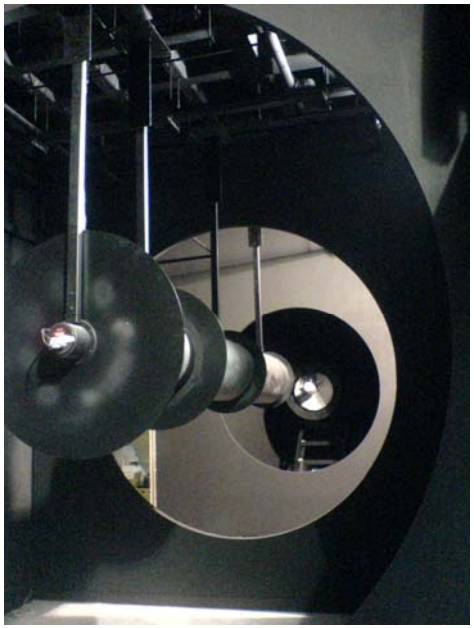
- intensity distribution
- iso-intensity curve
- iso-illuminance curve
- luminance limitation curve
- effective beam angle
- effective luminous flux
- upward and downward luminous flux
- utilization factor
- luminaire efficiency …etc.

Testing Services:

Energy Star, EST, ELI, MEPS …etc



Type C Mirror Type Goniophotometer

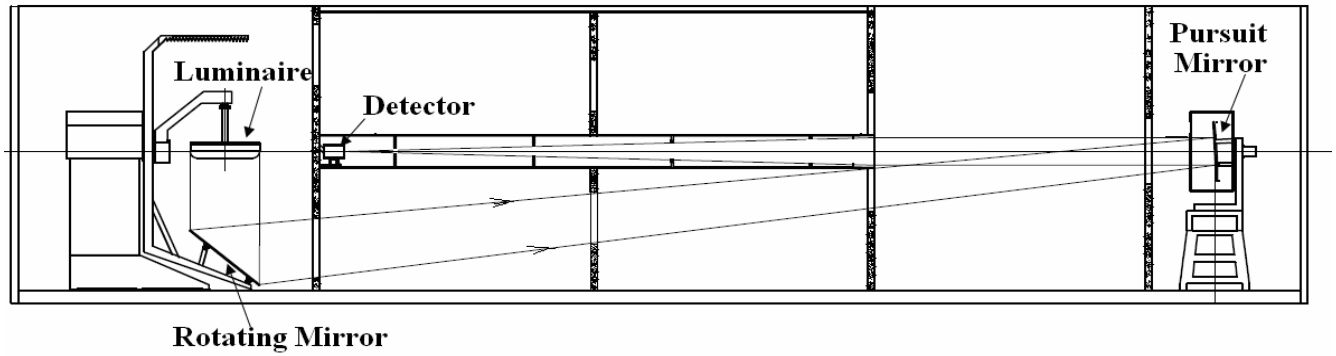


Equipment Size:

Tall	4m
Length	13m
Weight	50 kg

Chamber Size:

High	4.3m
Wide	4m
Length	15m



Energy Efficiency Requirements

European Market:

- ErP (Energy-related Product) Directive (Mandatory)
- Energy Saving Trust - EST (UK Voluntary Program)

North American Market:

- Energy Star (Voluntary Program)
- California Energy Commission - CEC (Mandatory Program for California)

Performance Testing

Energy Efficiency Requirements - Europe

ErP Directive - EC244/2009

Stage	Date	Main result
Stage 1	**1 Sept 2009**	**Start of incandescent lamp phase-out (lamps of ≥100W) + raising the level to A-class for Non-clear lamps (CFLs) + functionality**
Stage 2	**1 Sept 2010**	**Phase-out of 75W incandescent lamps and product information requirements**
Stage 3	**1 Sept 2011**	**Phase-out of 60W incandescent lamps**
Stage 4	**1 Sept 2012**	**Complete incandescent lamp phase-out (40W and 25W)**
Stage 5	**1 Sept 2013**	**More ambitious functionality requirements**
Stage 6	**1 Sept 2016**	**Raising the minimum level to B class for clear lamps (phasing out C-class halogen lamps other than the one with G9 or R7s cap)**

Lamp Efficacy Requirements - Europe

ErP Directive - EC244/2009

Application Date	Energy class equivalents	
	Clear lamps	Non-clear lamps
Stages 1 to 5	Energy class C	Energy class A
Stage 6	Energy class B	Energy class A

Performance Testing

Energy Saving Trust - UK

Performance Standards:

61341 Method of measurement of centre beam intensity and beam angle(s) of reflector lamps.

62384 DC and AC supplied electronic control gear for LED modules.

IEC/PAS 62612 Ed. 1 Self-ballasted led-lamps for general lighting services >50

ANSI NEMA/ANSLG C78.377: Specifications for chromaticity of solid state lighting products.

Other Standards:

ISO 9001:2000 Requirements for a Quality Management system

ISO/IEC 17025 General Requirements for the Competence of Calibration and Testing Laboratories

60669-2-1:2004 Switches for household and similar fixed electrical installations. Electronic switches

IEC 62504 Terms and definitions of LEDs and LED modules in general lighting. (Draft)

Performance Testing

Energy Star – North America

- **SSL Luminaires Version 1.1**

  (Effective: 1st February, 09)

- **Integral LED Lamps Version 1.0**

  (Effective: 31st August, 10)

Reference Testing Standards:

- IESNA LM 79: Approved Method: Electrical and Photometric Measurements of Solid State Lighting
- IES LM 80: Approved Method: Measuring Lumen Maintenance of LED Light Sources

Performance Testing

Energy Star – North America

SSL Luminaires

Scope:

SSL Luminaires Version 1.1:

1. **SSL products used for general illumination**
2. **Residential and commercial products**
3. **Products connected to the electric power grid**

Exemption:

1. **SSL products made for indication**
2. **Products exclusively intended for decoration**
3. **Intended for retrofit into existing fixtures**

Performance Testing

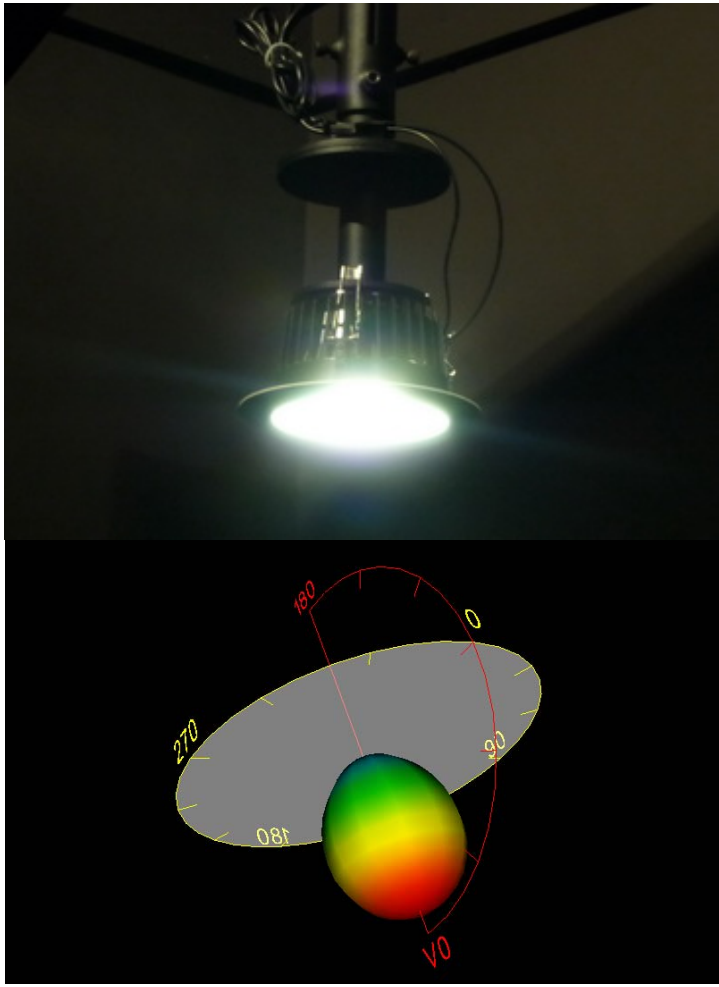
Energy Star – North America

SSL Luminaires

Test items:

1. Lamp Efficacy (Lumens/watt)
2. Lumen maintenance of LED Light Sources (L_{70})
3. CCT and CRI
4. Color Spatial Uniformity
5. Color maintenance
6. Zonal density requirement
7. Off-state Power
8. Thermal Management
9. Power Factor
10. Transient Protection
11. Operating Frequency
12. Electromagnetic Interference

...etc



Performance Testing

Energy Star – North America

SSL Luminaires

Zonal density requirement

Table 3 - Zonal Lumen Tolerances

Category A Application	Zonal Lumen Density Requirement			Tolerance	Method of Measurement
	Zone (bilaterally symmetrical)	Minimum Percentage of Total Lumens	Maximum Percentage of Total Lumens	(Values below are subtracted from minimum % values on the left)	
Under-cabinet kitchen lighting	0-60°	60%	--	- 5%	IESNA LM-79-08 Section 9.1
	60-90°	25%	--	- 10%	
Under-cabinet shelf-mounted task lighting	0-60°	60%	--	- 5%	
	60-90°	25%	--	- 10%	
Under-cabinet shelf-mounted task lighting (asymmetrical distribution)	60-90°	12.5%		- 3%	
Portable desk task lights	0-60°	85%	--	- 15%	
Recessed, surface, and pendant-mounted downlights	0-60°	75%	--	- 10%	
Cove lighting	120 - 150°	35%	--	- 3%	
Surface-mounted luminaires with directional heads	0 - 90°	85%	--	- 3%	
Wall wash luminaires	20 - 40°	50%	--	- 3%	
Outdoor wall-mounted porch lights	0-90°	85%	--	- 5%	
Outdoor step lights	0-90°	85%	--	- 10%	
Outdoor pathway lights	0-90°	85%	--	- 10%	
Outdoor pole/arm-mounted decorative luminaires	0-90°	85%	--	- 3%	
	110° and above	--	0%	+ 3%	
Bollards	90 – 110%	--	0 – 15%	+ 3%	
	110° and above	--	0%	+ 3%	

Performance Testing

Energy Star – North America

Integral LED Lamps

Scope:

1. **Integral LED lamps**
2. **Non-standard form and standard form, including non-directional lamps, decorative lamps and reflector lamps.**
3. **Other types of replacement lamps may be added in the future**

Performance Testing

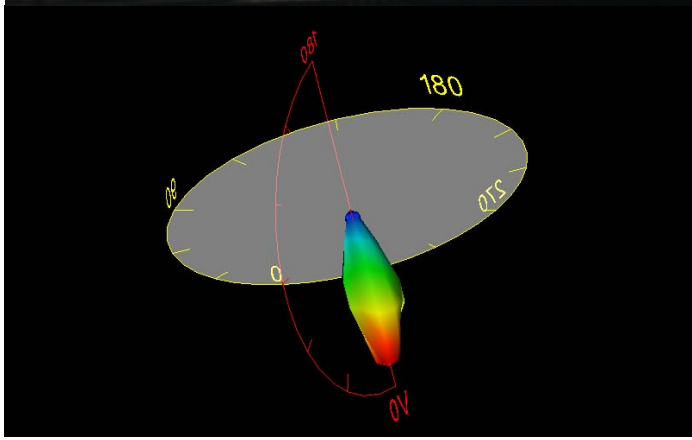
Energy Star – North America

Integral LED Lamps

Test items:

1. Lamp Efficacy (Lumens/watt)
2. Lumen maintenance at the end of 6000 hours
3. CCT and CRI
4. Luminous intensity distribution
5. Power Factor
6. Rapid Cycle Stress Test
7. Transient Protection
8. Operating Frequency
9. Electromagnetic Interference
10. Base

…etc



Performance Testing

Energy Star – North America

Integral LED Lamps - Claimed Lamp Life vs Test Periods (Lumen Maintenance)

Table 1. 6000-Hour Lumen Maintenance Thresholds			
	Minimum lumen maintenance at end of 6000 hours (% of initial lumens; -3% tolerance)	**Maximum L_{70} Life Claim (hours)**	**ENERGY STAR Approval Available After 6000-hour test**
Minimum for Decorative	86.7%	15,000	**Full approval** (no additional lumen maintenance testing required)
Optional for Decorative	89.9%	20,000	
Minimum for Non-standard, Omnidirectional, and Directional Optional for Decorative	91.8%	25,000	
Optional for All Lamp Types	93.1%	30,000	**Initial approval**, pending completion of total required test period (see Table 2 below)
	94.1%	35,000	
	94.8%	40,000	
	95.4%	45,000	
	95.8%	50,000	

Table 2. Total Required Test Periods for Life Claims >25,000 Hours		
Minimum cumulative test period (hours)	**Minimum lumen maintenance at end of test period (% of initial lumens; -3% tolerance)**	**Maximum L_{70} Life Claim (hours)**
7,500	91.2%	30,000
8,750	91.5%	35,000
10,000	91.5%	40,000
12,500	91.8%	50,000

Performance Testing

CEC – North America

Minimum Requirements for Portable LED Luminaires, and Portable Luminaires with LED Light Engines with Integral Heat Sink

Criteria	*Requirement*
Light Output	≥ 200 lumens (initial)
Minimum LED Luminaire Efficacy	29 lumens/W
Minimum LED Light Engine Efficacy	40 lumens/W
Color Correlated Temperature (CCT)	2700 K through 5000 K
Minimum Color Rendering Index (CRI)	75
Power Factor (for luminaires labeled or sold for residential use)	≥ 0.70

Electrical Safety - LED Part

Electrical Safety - LED Part

IEC/EN standards:

IEC/EN 60598 series: Luminaries, LED fixture

IEC/EN 60968 : Integrated LED Bulb

IEC/EN 61347-2-13: Electronic controlgear for LED modules

IEC/EN 62031: LED modules for general lighting

NA standards:

UL 8750: Light Emitting Diode (LED) Equipment for Use In Lighting Products

UL 1598: Fixed Luminaire

UL 153: Portable Luminaire

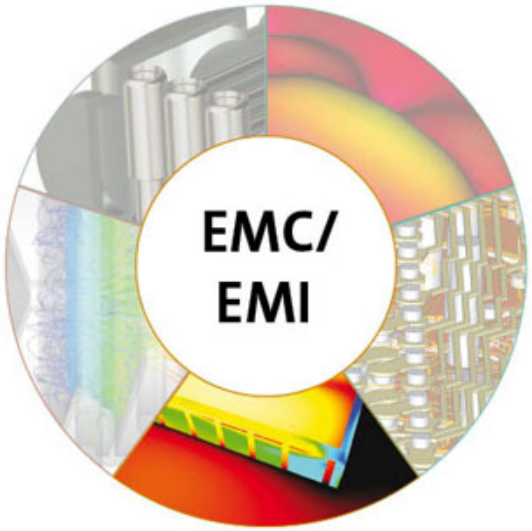
UL 1573: Stage and Studio Luminaire

UL 1993: Self-ballast lamp

UL 1786: Direct Plug-in Nightlight

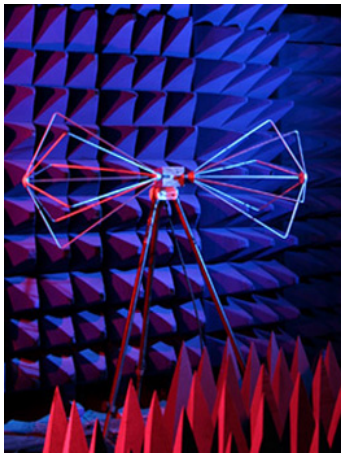
UL 1838: Low Voltage Landscape Lighting

EMC/ FCC Requirements



EMC/FCC Requirements

Europe:



Emission:

EN55015 : 2006 (Electrical Lighting and Similar Equipment)

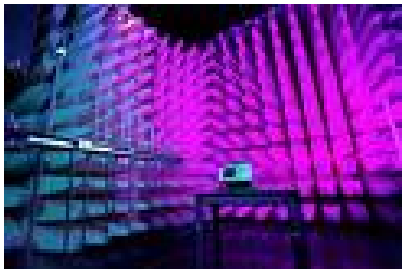
EN61000-3-2 : 2006 (Public low-voltage distribution systems up to 16A current.)

EN61000-3-3 : 1995 + A1 : 2001 + A2 : 2005 (ditto)

Immunity:

EN61547 : 1995 + A1 : 2000 (Applied to general lighting)

North America:



FCC Part 18:

a) Radiated emission and

b) Conducted emission.

Global Regulations Development

Development Speed :

Market penetration > Standards & Regulations development

Foreseeable problem within LED industries

(Repeat the historical problems of CFL)

Once the standard of US and Europe were well established, all others countries will also follow, e.g. ELI.

The painful filtering process within LED manufacturers will greatly impact the development of LED market.

Make your preparation right now with our full capability testing services !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