Measuring LED Performance

DOE SSL Market Introduction Workshop

July 9-11, 2008

Why Do We Need Photometric Testing?

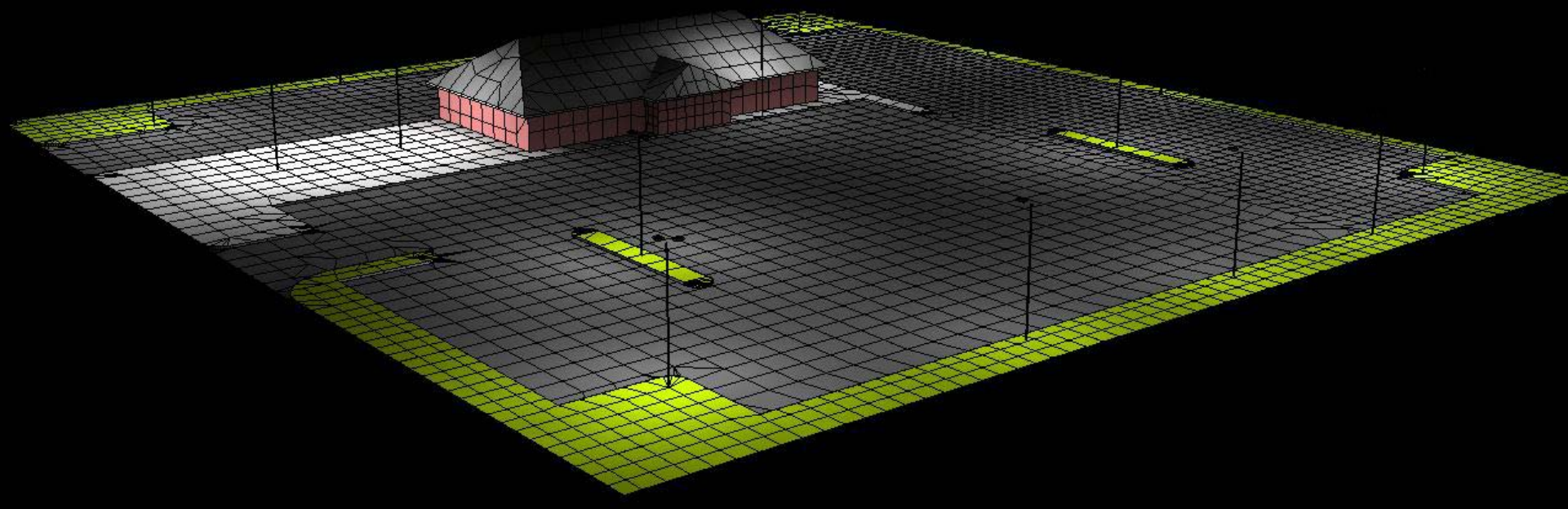
It allows us to evaluate the performance of lighting products.

- Total Luminous Flux (Lumens)
- Luminaire Efficacy (Lumens per Watt)
- Luminous Intensity (Candela)

Why Do We Need Photometric Testing?

The results can be used to predict the performance of the luminaire in its application.

- IES Format Files
- Illuminance (Footcandles, Lux)
- Average footcandles within a space, max/min ratios, etc.



Why Do We Need Photometric Testing?

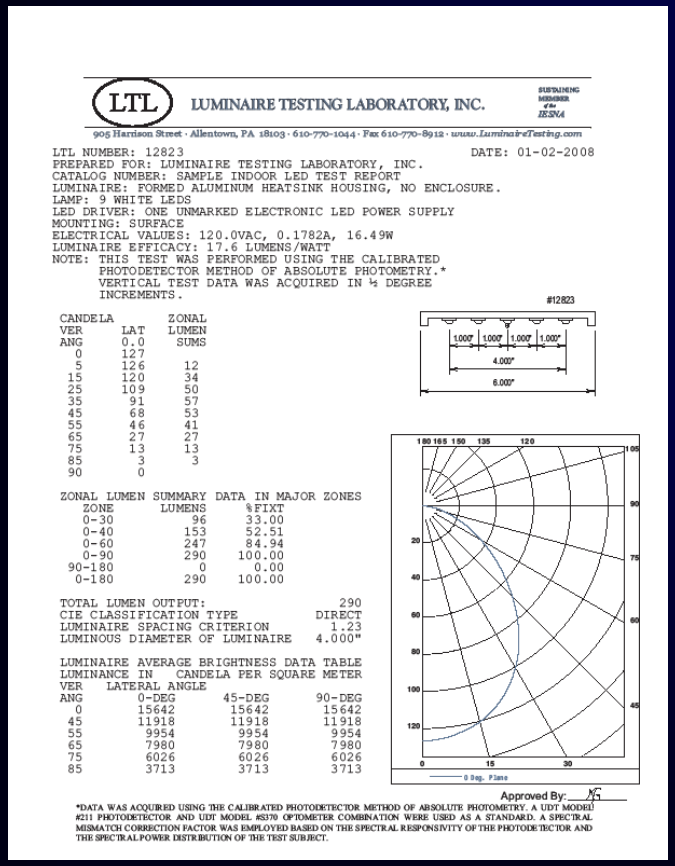
It gives us a metric to evaluate the color of the light produced by a luminaire.

- CCT (Correlated Color Temperature)
- CRI (Color Rendering Index)
- Chromaticity Coordinates (x,y and u',v')

Type ‘C’ Goniophotometer

- Luminous intensity distribution
- Total luminous flux
- Zonal lumen sums
- IES format file
- Spatial Uniformity of Color

Type ‘C’ Goniophotometer



LTL LUMINAIRE TESTING LABORATORY, INC.

SUSTAINING MEMBER of the IESNA

905 Harrison Street · Allentown, PA 18103 · 610-770-1044 · Fax 610-770-8912 · www.LuminaireTesting.com

LTL NUMBER: 12823 DATE: 01-02-2008
PREPARED FOR: LUMINAIRE TESTING LABORATORY, INC.
CATALOG NUMBER: SAMPLE INDOOR LED TEST REPORT
LUMINAIRE: FORMED ALUMINUM HEATSINK HOUSING, NO ENCLOSURE.
LAMP: 9 WHITE LEDS
LED DRIVER: ONE UNMARKED ELECTRONIC LED POWER SUPPLY
MOUNTING: SURFACE
ELECTRICAL VALUES: 120.0VAC, 0.1782A, 16.49W
LUMINAIRE EFFICACY: 17.6 LUMENS/WATT
NOTE: THIS TEST WAS PERFORMED USING THE CALIBRATED PHOTODETECTOR METHOD OF ABSOLUTE PHOTOMETRY.* VERTICAL TEST DATA WAS ACQUIRED IN ½ DEGREE INCREMENTS.

#12823

1.000" 1.000" 1.000" 1.000"
4.000"
6.000"

CANDELA VER ANG	LAT 0.0	ZONAL LUMEN SUMS
0	127	
5	126	12
15	120	34
25	109	50
35	91	57
45	68	53
55	46	41
65	27	27
75	13	13
85	3	3
90	0	

ZONAL LUMEN SUMMARY DATA IN MAJOR ZONES

ZONE	LUMENS	%FIXT
0-30	96	33.00
0-40	153	52.51
0-60	247	84.94
0-90	290	100.00
90-180	0	0.00
0-180	290	100.00

TOTAL LUMEN OUTPUT: 290
CIE CLASSIFICATION TYPE DIRECT
LUMINAIRE SPACING CRITERION 1.23
LUMINOUS DIAMETER OF LUMINAIRE 4.000"

LUMINAIRE AVERAGE BRIGHTNESS DATA TABLE
LUMINANCE IN CANDELA PER SQUARE METER

VER ANG	LATERAL ANGLE 0-DEG	45-DEG	90-DEG
0	15642	15642	15642
45	11918	11918	11918
55	9954	9954	9954
65	7980	7980	7980
75	6026	6026	6026
85	3713	3713	3713

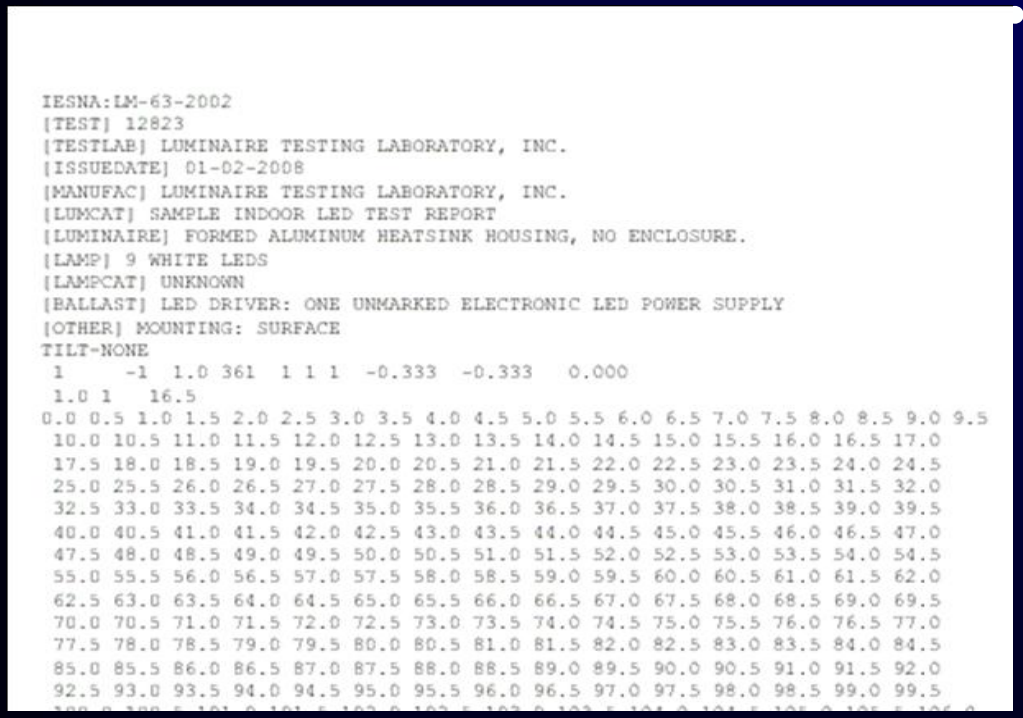
180 165 150 135 120 105 90 75 60 45 20 40 60 80 100 120 0 15 30 0 Deg. Plane

Approved By:

*DATA WAS ACQUIRED USING THE CALIBRATED PHOTODETECTOR METHOD OF ABSOLUTE PHOTOMETRY. A UDT MODEL #211 PHOTODETECTOR AND UDT MODEL #S370 OPTOMETER COMBINATION WERE USED AS A STANDARD. A SPECTRAL MISMATCH CORRECTION FACTOR WAS EMPLOYED BASED ON THE SPECTRAL RESPONSIVITY OF THE PHOTODETECTOR AND THE SPECTRAL POWER DISTRIBUTION OF THE TEST SUBJECT.

- A Photometric Test Report is a summary of the photometric distribution in the form of graphs and tables.

Type ‘C’ Goniophotometer



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IESNA:LM-63-2002
[TEST] 12823
[TESTLAB] LUMINAIRE TESTING LABORATORY, INC.
[ISSUEDATE] 01-02-2008
[MANUFAC] LUMINAIRE TESTING LABORATORY, INC.
[LUMCAT] SAMPLE INDOOR LED TEST REPORT
[LUMINAIRE] FORMED ALUMINUM HEATSINK HOUSING, NO ENCLOSURE.
[LAMP] 9 WHITE LEDS
[LAMPCAT] UNKNOWN
[BALLAST] LED DRIVER: ONE UNMARKED ELECTRONIC LED POWER SUPPLY
[OTHER] MOUNTING: SURFACE
TILT-NONE
 1      -1  1.0 361  1 1 1  -0.333  -0.333   0.000
 1.0 1   16.5
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5
 10.0 10.5 11.0 11.5 12.0 12.5 13.0 13.5 14.0 14.5 15.0 15.5 16.0 16.5 17.0
 17.5 18.0 18.5 19.0 19.5 20.0 20.5 21.0 21.5 22.0 22.5 23.0 23.5 24.0 24.5
 25.0 25.5 26.0 26.5 27.0 27.5 28.0 28.5 29.0 29.5 30.0 30.5 31.0 31.5 32.0
 32.5 33.0 33.5 34.0 34.5 35.0 35.5 36.0 36.5 37.0 37.5 38.0 38.5 39.0 39.5
 40.0 40.5 41.0 41.5 42.0 42.5 43.0 43.5 44.0 44.5 45.0 45.5 46.0 46.5 47.0
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 77.5 78.0 78.5 79.0 79.5 80.0 80.5 81.0 81.5 82.0 82.5 83.0 83.5 84.0 84.5
 85.0 85.5 86.0 86.5 87.0 87.5 88.0 88.5 89.0 89.5 90.0 90.5 91.0 91.5 92.0
 92.5 93.0 93.5 94.0 94.5 95.0 95.5 96.0 96.5 97.0 97.5 98.0 98.5 99.0 99.5
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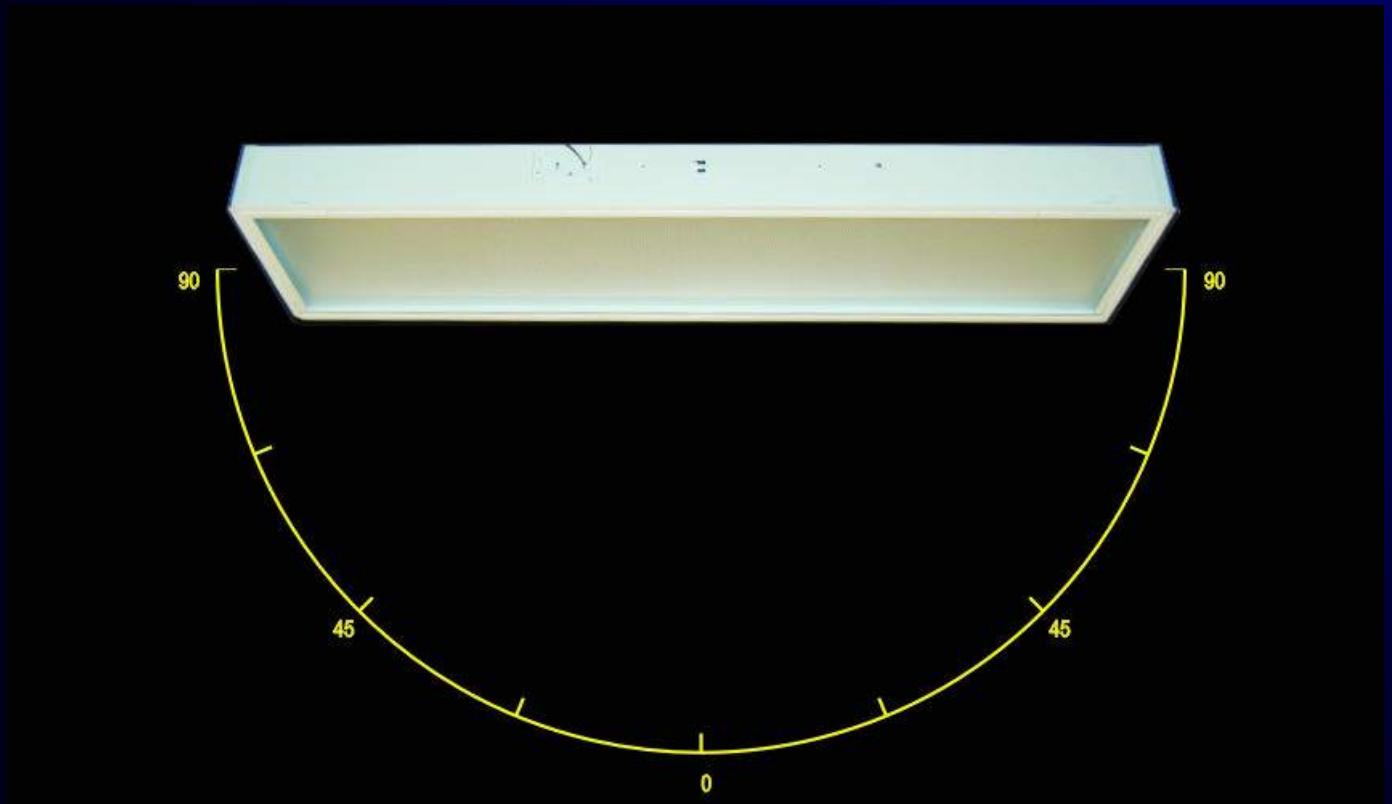
- An IES format file can be used in lighting applications software to predict the performance of a luminaire in its installation.

Type ‘C’ Goniophotometer

The goal of a type C goniophotometer is to measure the luminous intensity of the luminaire from specific angles.

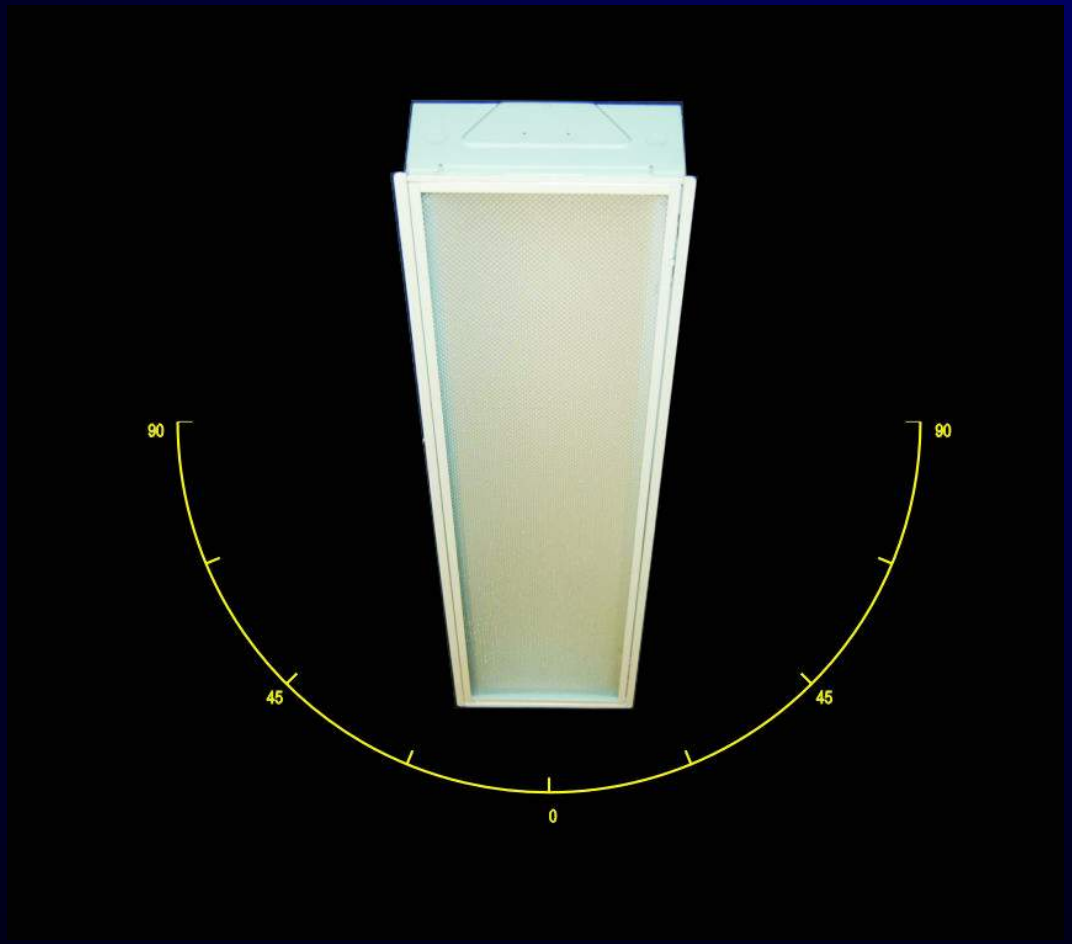
This typically includes a scan of vertical angles through each of a series of lateral planes

Type ‘C’ Goniophotometer



Vertical Angles Through the 0 Degree Lateral Plane

Type ‘C’ Goniophotometer



Vertical Angles Through the 90 Degree Lateral Plane

Type ‘C’ Goniophotometer

Type C goniophotometer configurations:

- boom
- track (moving detector)
- multi-detector
- swinging mirror

Type ‘C’ Goniophotometer

Total Luminous Flux (Lumens) is calculated from the luminous intensity distribution

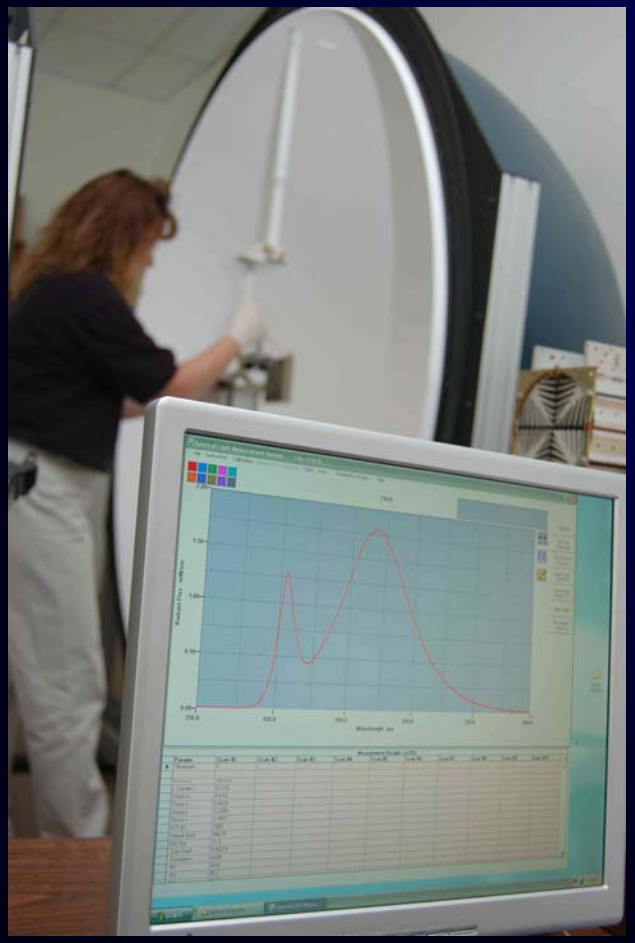
Zonal lumen sums can be calculated by summing the lumens within specific angular ranges.

Type ‘C’ Goniophotometer

Zonal Lumen Distribution:

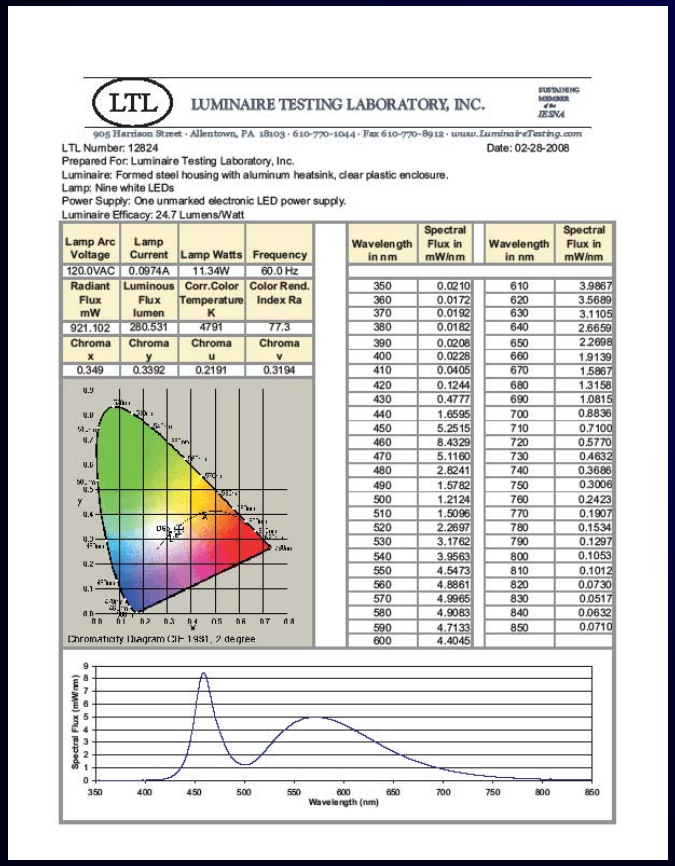
Is the light from the luminaire getting to the appropriate place?

Integrating Sphere



- Total Luminous Flux
- Spectral Power Distribution
- Chromaticity Coordinates
- CRI
- CCT

Integrating Sphere



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LTL Number: 12824 Date: 02-28-2008

Prepared For: Luminaire Testing Laboratory, Inc.

Luminaire: Formed steel housing with aluminum heatsink, clear plastic enclosure.

Lamp: Nine white LEDs

Power Supply: One unmarked electronic LED power supply.

Luminaire Efficacy: 24.7 Lumens/Watt

Lamp Arc Voltage	Lamp Current	Lamp Watts	Frequency
120.0VAC	0.0974A	11.34W	60.0 Hz
Radiant Flux mW	**Luminous Flux lumen**	**Corr.Color Temperature K**	**Color Rend. Index Ra**
921.102	280.531	4791	77.3
Chroma x	**Chroma y**	**Chroma u**	**Chroma v**
0.349	0.3392	0.2191	0.3194

Chromaticity Diagram CIE 1931, 2 degree

Wavelength in nm	Spectral Flux in mW/nm	Wavelength in nm	Spectral Flux in mW/nm
350	0.0210	610	3.9867
360	0.0172	620	3.5689
370	0.0192	630	3.1105
380	0.0182	640	2.6659
390	0.0208	650	2.2698
400	0.0228	660	1.9139
410	0.0405	670	1.5867
420	0.1244	680	1.3158
430	0.4777	690	1.0815
440	1.6595	700	0.8836
450	5.2515	710	0.7100
460	8.4329	720	0.5770
470	5.1160	730	0.4632
480	2.8241	740	0.3686
490	1.5782	750	0.3006
500	1.2124	760	0.2423
510	1.5096	770	0.1907
520	2.2697	780	0.1534
530	3.1762	790	0.1297
540	3.9563	800	0.1053
550	4.5473	810	0.1012
560	4.8861	820	0.0730
570	4.9965	830	0.0517
580	4.9083	840	0.0632
590	4.7133	850	0.0710
600	4.4045		

Spectral Flux (mW/nm)

Wavelength (nm)

An integrating sphere test report is an overview of the color properties of the luminaire.

It also includes the total luminous flux of the luminaire.

Integrating Sphere

High reflectance, highly diffuse spherical chamber

The luminaire is typically mounted in the center

The total luminous flux and spectral power distribution are measured directly.

CCT, CRI, and chromaticity coordinates are calculated from the spectral power distribution.

Relative Photometry

Luminaires that use conventional lighting sources are usually tested using relative photometry.

- The luminaire is measured.
- The lamp(s) and ballast(s) are removed and measured.
- Luminaire Efficiency can then be calculated
- The luminous intensity distribution is scaled to candela per rated lumen.

Relative Photometry

Why not use relative photometry for SSL luminaires?

- The LED devices are usually difficult to remove from the luminaire.
- Many LED devices will not operate properly without the heat-sinking that the luminaire provides.
- The thermal environment that the LED devices experience within the luminare is often radically different from the thermal environment it will experience in its “bare lamp” configuration.

Relative vs. Absolute Photometry

Relative

- Typically performed for luminaires using conventional sources
- Luminaire test is referenced to the luminous flux measured from the “bare” lamp(s)
- cd per rated lumens
- Normalizes ballast factor, lamp age
- Includes luminaire efficiency

Absolute

- Luminaire test is referenced to a calibrated standard lamp
- Absolute luminous intensity (cd)
- No luminaire efficiency
- Total luminous flux (lumens)
- Used to calculate absolute luminaire efficacy (lumens per watt)

Measuring LED Performance

Michael Grather

mike@LuminaireTesting.com