NVLAP LAB CODE 200960-0

LM-79-08 Test Report

for

ESPEN TECHNOLOGY, INC.

SANTA FE SPRINGS CA 90670 USA 562-529-2938

LED LAMP

Model: LT40W/840-ID

Laboratory: Leading Testing Laboratories

NVLAP CODE: 200960-0

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Report No.: HZ16080008j

The laboratory that conducted the testing detailed in this report has been accredited for SSL by NVLAP.

Review by: April Zou

Engineer: April Zou

Aug. 04, 2016

Approved by:

Manager: Jim Zhang

Aug. 04, 2016

Note: This report does not imply product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

Test Summary

Sample Tested: **LT40W/840-ID**

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)	Power Factor
117.9	2047.0	17.36	0.9639

CCT (K)	CRI	Stabilization Time (Light & Power)
4105	84.3	60

Table 1: Executive Data Summary

Note: The above results are recorded/ derived from measurements made using an Integrating Sphere.

Test specifications:

Date of Receipt	: Mar. 09, 2016
Date of Test	: Mar. 15, 2016
Test item	: Total Luminous Flux, Luminous Distribution Intensity, Luminous Efficacy, Correlated Color Temperature, Color Rendering Index, Chromaticity Coordinate, Electrical parameters
Reference Standard	: IESNA LM-79-2008 Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products

TABLE OF CONTENT

Sample Photos

Figure 1- Overview of the sample

Equipment Under Test (EUT)	
Name	: LED LAMP
Model	: LT40W/840-ID
Electrical Ratings	: 120-277V, 60Hz, 18W
Product Description	: 2G11 base, fixed end caps, 4000K, Frosted lens
Manufacturer	: ESPEN TECHNOLOGY, INC.
Address	: SANTA FE SPRINGS CA 90670 USA 562-529-2938

TEST RESULTS

Test ambient temperature was 24.5℃.

Base orientation was Horizontal. Test was conducted without a dimmer in the circuit.

The stabilization time of the sample was 60 minutes, and the total operating time including stabilization was 65 minutes.

Sphere-Spectroradiometer Method

Parameter	Result	
Test Voltage (V)	120.0	277.0
Voltage frequency (Hz)	60	60
Test Current (A)	0.150	0.077
Power Factor	0.9639	0.8269
Test Power (W)	17.36	17.56
THD A%	23.80	17.59
Luminous Efficacy (lm/W)	117.9	117.5
Total Luminous Flux (lm)	2047.0	2064.0
Color Rendering Index (CRI)	84.3	
R9	14.6	
Correlated Color Temperature (CCT)(K)	4105	
Chromaticity Chroma x	0.3757	
Chromaticity Chroma y	0.3732	
Chromaticity Chroma u	0.2234	
Chromaticity Chroma v	0.3329	
Duv	0.0007	
Chromaticity Chroma u ’	0.2234	
Chromaticity Chroma v’	0.4993	

Special Color Rendering Indices	
R1	82.9
R2	89.8
R3	94.8
R4	83.8
R5	83.2
R6	85.9
R7	86.9
R8	67.2
R9	14.6
R10	75.8
R11	83.2
R12	65.8
R13	84.6
R14	97.3

Table 2: Test data per Sphere-Spectroradiometer Method

Note: According to CIE 1976 (u’,v’) diagram, u’ = u = 4x/(-2x+12y+3), v’ = 3v/2 = 9y/(-2x+12y+3).

Goniophotometer Method

Test ambient temperature was 24.2℃.

The photometric distance is 30m.

Luminous data was taken at 0.5°vertical intervals and 10°horizontal intervals.

Parameter	Result
Test Voltage (V)	120.0
Voltage frequency (Hz)	60
Test Current (A)	0.151
Power Factor	0.9644
Test Power (W)	17.45
Luminous Efficacy (lm/W)	116.6
Total Luminous Flux (lm)	2033.8
Beam Angle (°)	114.0
Center Beam Candle Power (cd)	596
Spacing Criteria	1.22 (0°-180°)/ 1.26 (90°-270°)
Zonal Lumens in the 0°-60°Zone	65.18%
Zonal Lumens in the 60°-90°Zone	23.52%
Zonal Lumens in the 90°-120°Zone	6.94%
Zonal Lumens in the 120°-180°Zone	4.36%

Table 3: Test data per Goniophotometer Method

Spectral Power Distribution - Sphere Spectroradiometer Method

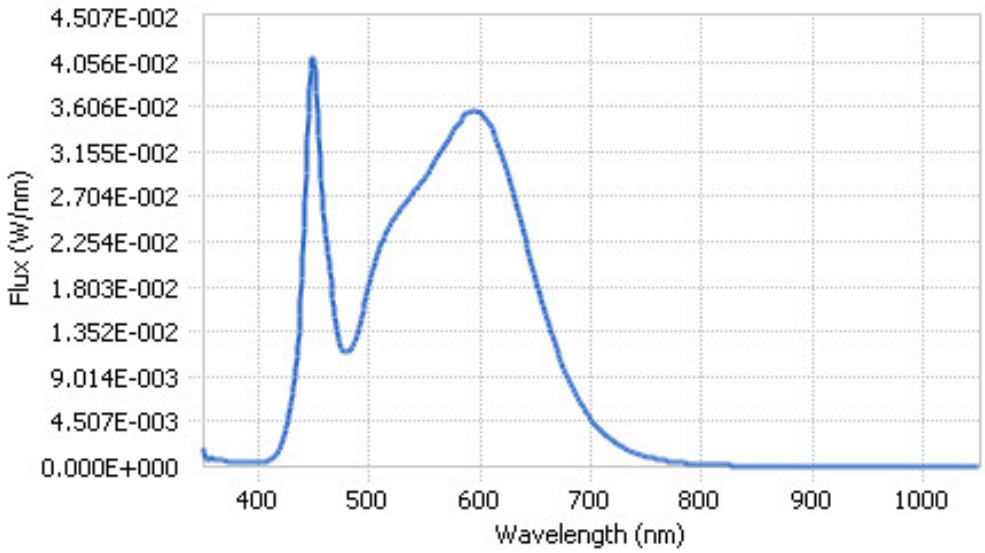
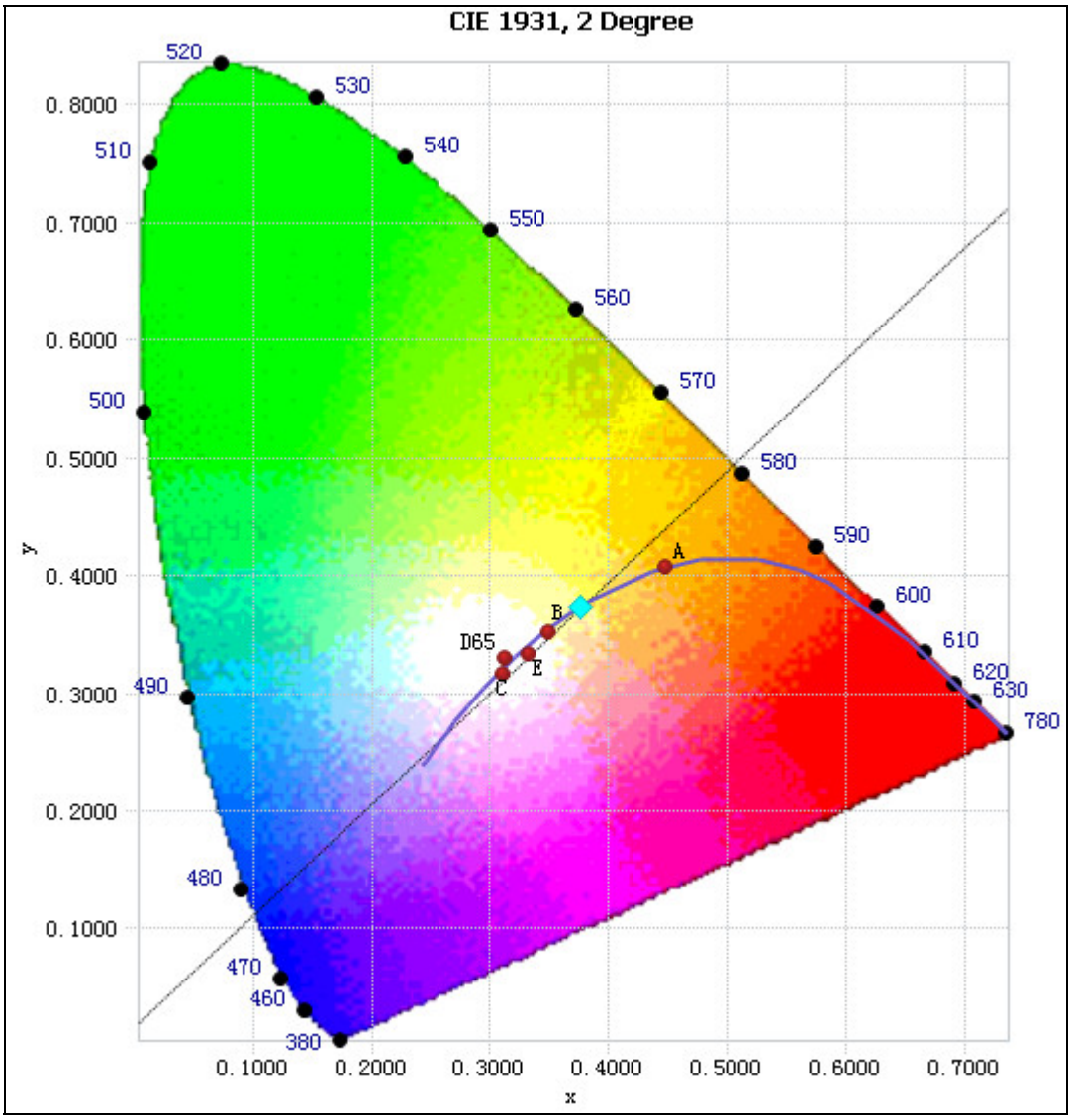


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	3.89E-04	485	1.22E-02	590	3.55E-02	695	5.57E-03
385	4.13E-04	490	1.38E-02	595	3.56E-02	700	4.76E-03
390	4.21E-04	495	1.59E-02	600	3.54E-02	705	4.06E-03
395	4.10E-04	500	1.84E-02	605	3.48E-02	710	3.46E-03
400	4.26E-04	505	2.04E-02	610	3.40E-02	715	2.97E-03
405	4.97E-04	510	2.22E-02	615	3.27E-02	720	2.56E-03
410	6.41E-04	515	2.36E-02	620	3.10E-02	725	2.18E-03
415	1.06E-03	520	2.45E-02	625	2.93E-02	730	1.87E-03
420	2.15E-03	525	2.52E-02	630	2.74E-02	735	1.59E-03
425	4.13E-03	530	2.60E-02	635	2.52E-02	740	1.37E-03
430	7.25E-03	535	2.66E-02	640	2.31E-02	745	1.16E-03
435	1.22E-02	540	2.75E-02	645	2.10E-02	750	9.99E-04
440	2.12E-02	545	2.82E-02	650	1.89E-02	755	8.56E-04
445	3.54E-02	550	2.90E-02	655	1.68E-02	760	7.39E-04
450	4.06E-02	555	2.99E-02	660	1.49E-02	765	6.38E-04
455	3.08E-02	560	3.08E-02	665	1.31E-02	770	5.44E-04
460	2.31E-02	565	3.18E-02	670	1.15E-02	775	4.71E-04
465	1.87E-02	570	3.25E-02	675	9.98E-03	780	4.04E-04
470	1.42E-02	575	3.36E-02	680	8.65E-03		
475	1.17E-02	580	3.43E-02	685	7.49E-03		
480	1.15E-02	585	3.51E-02	690	6.49E-03		

Table 4: Spectral Power Distribution Numerical Data per Sphere - Spectroradiometer Method

Chromaticity Diagram - Sphere Spectroradiometer Method



Tristimulus values(x, y): (0.3757, 0.3732)

Chart 2: Chromaticity Diagram per Sphere - Spectroradiometer Method

Note: The location on the diagram of the tristimulus coordinates are indicated by the blue diamond.

Nominal CCT Quadrangles – Sphere Spectroradiometer Method

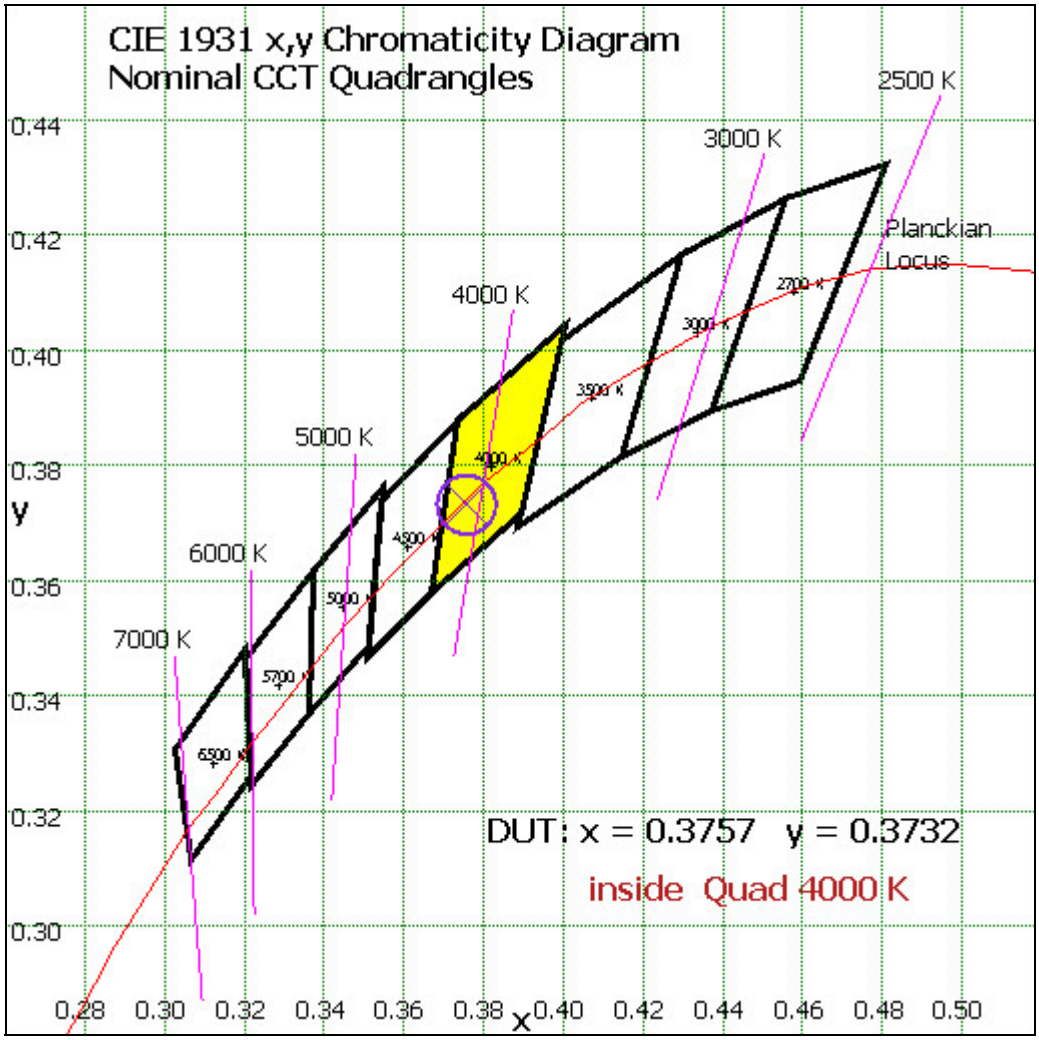


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

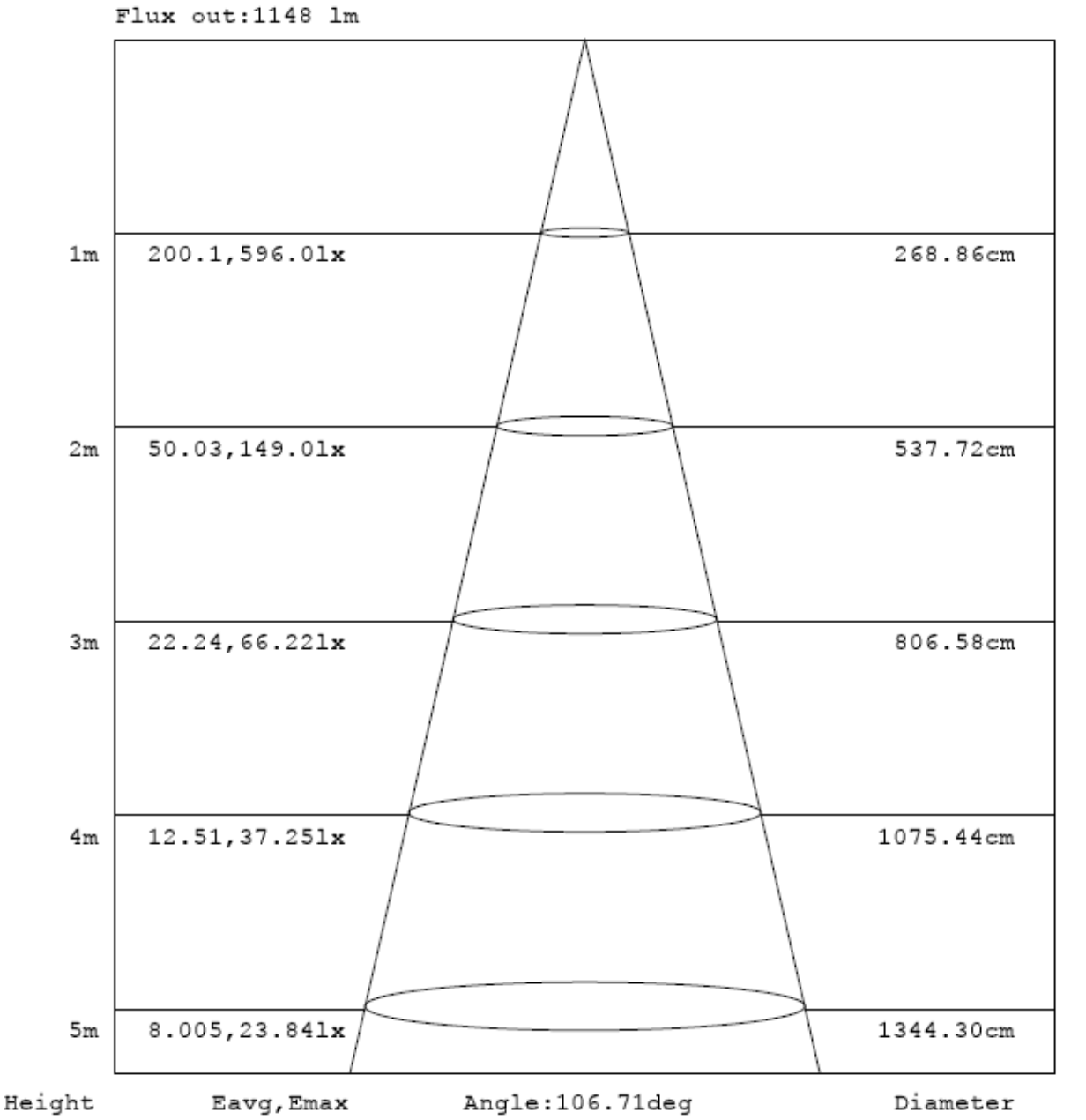
Zonal Lumen Tabulation- Goniophotometer Method

γ(°)	Lumens	% Total
0- 10	56.257	2.77%
10- 20	160.218	7.88%
20- 30	240.775	11.84%
30- 40	288.587	14.19%
40- 50	300.711	14.79%
50- 60	279.065	13.72%
60- 70	228.831	11.25%
70- 80	159.059	7.82%
80- 90	90.384	4.44%
90-100	58.552	2.88%
100-110	46.408	2.28%
110-120	36.29	1.78%
120-130	28.477	1.40%
130-140	22.506	1.11%
140-150	17.254	0.85%
150-160	12.023	0.59%
160-170	6.784	0.33%
170-180	1.657	0.08%
Total	2033.8	100%

γ(°)	Lumens	% Total
0- 60	1325.613	65.18%
60- 90	478.274	23.52%
0-90	1803.887	88.69%
90- 180	229.951	11.31%
0- 180	2033.8	100%

Table 5: Zonal Lumen Data

Illuminance Plots- Goniophotometer Method



Note:The Curves indicate the illuminated area and the average illumination when the luminaire is at different distance.

Chart 4: Beam Angle

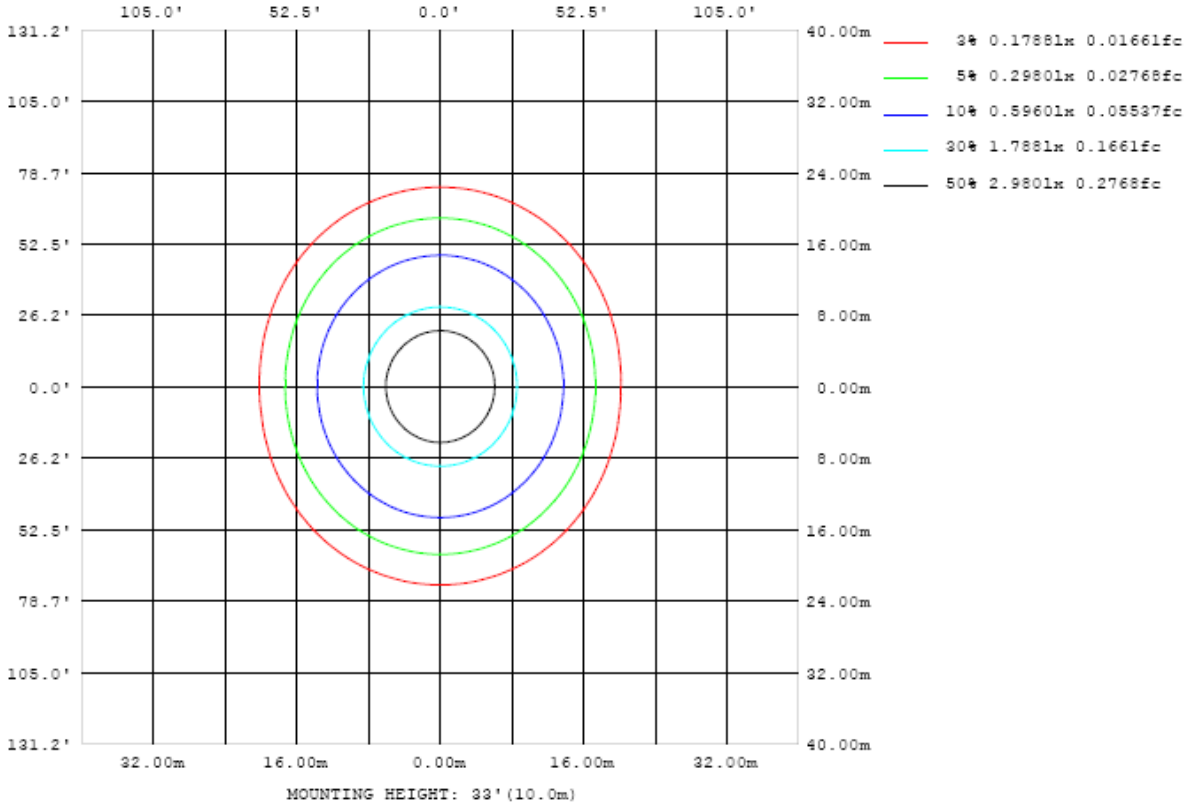


Chart 5: Illuminance Plot (Footcandles)

Luminous Intensity Distribution Plots- Goniophotometer Method

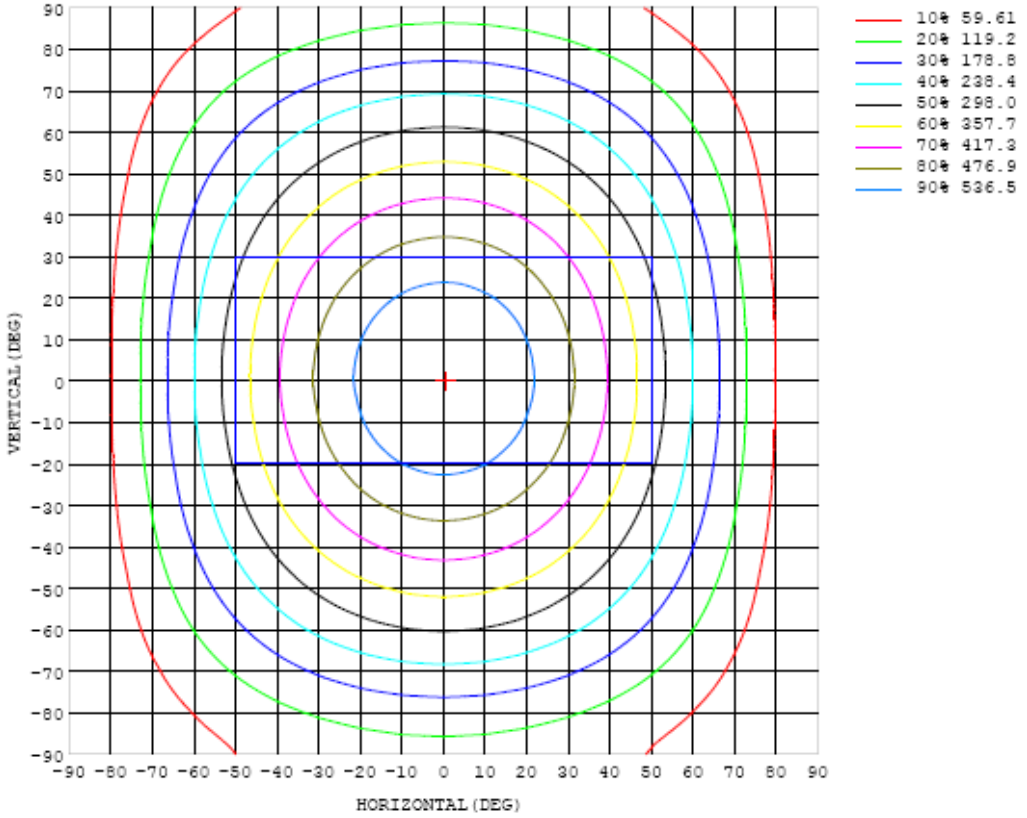


Chart 6: Isocandela Plot

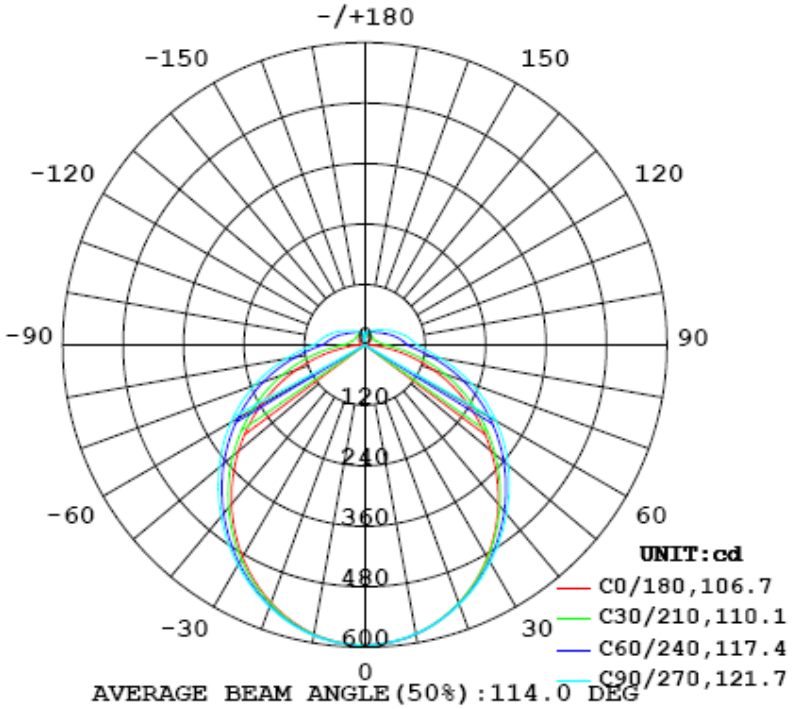


Chart 7: Polar Candela Distribution

Luminous Intensity Data- Goniophotometer Method

Table--1 UNIT: cd

γ (DEG) \ C (DEG)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
0	596	596	596	596	596	596	596	596	596	596	596	596	596	596	596	596	596	596	596
5	592	592	592	592	592	592	592	592	592	592	591	592	592	592	592	592	592	592	592
10	583	582	583	583	582	582	582	582	582	582	582	582	582	582	582	582	582	582	583
15	567	566	566	566	566	567	567	568	567	567	567	567	567	566	566	566	566	566	566
20	545	545	545	545	545	546	547	548	547	548	548	547	546	545	545	544	544	544	545
25	518	517	518	519	520	521	522	524	524	525	524	523	522	520	519	518	517	517	517
30	486	486	487	488	490	492	495	496	497	498	497	496	494	491	489	487	486	485	486
35	451	451	452	454	457	460	464	467	468	469	468	466	463	460	457	453	451	450	450
40	412	412	414	417	421	426	431	434	437	437	437	434	430	426	421	417	413	412	412
45	371	371	374	378	384	390	396	401	404	405	404	400	396	390	383	378	373	371	371
50	328	328	332	338	345	353	360	366	370	371	370	366	360	352	345	337	332	328	328
55	283	284	289	296	305	314	323	330	335	336	335	330	323	314	305	296	289	284	283
60	237	239	245	254	264	275	285	293	299	300	299	293	285	275	264	254	245	239	238
65	191	193	201	211	223	235	247	256	261	263	261	256	247	236	224	212	201	194	192
70	145	148	157	169	182	196	208	217	223	225	223	217	208	196	183	170	157	148	146
75	99.3	103	114	128	143	157	170	179	186	188	186	180	170	158	144	129	115	104	101
80	57.2	62.1	74.9	90.3	106	121	134	144	150	152	150	144	134	122	107	91.8	76.5	63.3	58.4
85	22.4	28.8	43.3	59.5	75.5	90.9	104	114	120	123	121	115	105	92.3	77.4	61.4	45.6	31.1	24.0
90	1.67	9.21	24.0	40.6	57.6	72.2	85.3	95.4	102	104	102	96.5	87.1	74.4	59.8	43.8	27.3	12.5	4.25
95	0.66	5.54	19.1	34.8	50.6	65.0	77.6	87.3	93.3	95.6	93.7	88.2	79.3	67.3	53.4	38.1	22.6	8.99	3.55
100	1.60	4.83	15.8	29.8	45.0	58.8	70.4	79.5	85.3	87.4	85.7	80.6	72.1	60.8	47.9	33.1	18.9	8.39	4.58
105	3.13	6.03	14.1	26.4	39.8	52.5	63.4	72.0	77.5	79.5	77.8	72.9	64.7	54.0	41.6	29.1	17.4	9.60	6.16
110	4.98	7.41	13.2	23.6	35.4	47.0	57.3	64.4	69.1	70.7	69.1	64.6	57.8	48.4	37.7	26.6	17.2	10.9	8.12
115	7.04	7.75	13.4	22.1	31.9	42.0	51.3	58.1	62.1	63.5	62.1	58.4	52.0	43.6	34.3	25.3	16.8	12.4	10.3
120	9.19	9.50	15.5	20.6	29.6	38.0	45.8	51.9	55.9	57.2	56.0	52.5	46.7	39.8	32.1	24.6	18.6	13.9	12.5
125	11.4	11.2	16.7	21.1	28.0	35.1	41.6	46.6	49.9	51.1	50.1	47.2	42.6	36.9	30.8	24.2	19.5	15.4	14.5
130	13.6	12.6	17.4	22.3	25.9	32.9	38.3	42.4	45.1	46.2	45.4	43.1	39.5	34.9	29.2	24.8	20.5	16.9	16.4
135	15.8	15.4	17.4	22.8	27.1	30.3	35.5	39.2	41.4	42.2	41.7	39.9	37.0	33.0	29.1	25.0	21.5	18.3	18.2
140	17.7	17.0	19.0	23.0	26.7	30.4	33.1	35.9	38.2	38.9	38.5	37.1	34.8	31.8	28.5	25.3	22.4	19.5	19.8
145	19.5	18.1	20.1	22.4	26.4	29.3	31.9	34.0	35.4	36.0	35.7	34.6	32.9	30.5	28.0	25.5	23.2	20.6	21.1
150	20.5	17.5	21.1	23.3	25.2	28.3	30.3	31.9	33.0	33.4	33.2	32.4	31.1	29.4	27.5	25.7	23.4	21.1	21.8
155	21.1	17.9	22.4	24.0	25.1	26.6	28.7	30.1	30.9	31.2	31.1	30.5	29.6	28.4	27.0	25.3	24.1	20.6	22.2
160	21.4	18.4	23.2	24.4	24.9	26.2	27.0	27.9	28.7	29.1	29.0	28.7	28.1	27.3	26.0	25.0	24.5	20.7	22.2
165	19.1	17.5	20.5	24.8	25.6	25.3	25.5	26.1	26.9	27.2	27.2	26.7	26.2	25.7	25.6	25.7	23.2	18.7	19.9
170	15.6	14.6	14.6	15.7	22.6	25.8	26.1	26.2	26.1	25.8	25.8	26.1	25.7	23.4	21.1	18.4	16.1	15.9	16.9
175	13.0	12.7	12.7	11.8	11.0	12.3	16.1	19.6	21.2	21.4	18.7	14.5	14.4	13.8	13.6	13.6	13.6	13.6	13.6
180	16.6	16.9	16.5	15.7	12.4	8.26	6.55	6.56	0.00	0.00	0.00	1.35	5.19	9.58	12.8	14.5	15.7	16.4	16.6

Table 6: Luminous Intensity Data

Table--2 UNIT: cd

γ (DEG) \ C (DEG)	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350		
0	596	596	596	596	596	596	596	596	596	596	596	596	596	596	596	596	596		
5	592	592	593	593	593	593	593	593	593	594	593	593	594	593	593	593	593		
10	583	583	583	583	584	585	585	585	585	585	585	585	585	585	584	584	584		
15	566	567	568	569	570	570	571	571	572	572	571	571	570	570	569	568	568		
20	545	546	547	548	550	551	552	553	553	553	553	552	551	550	548	547	546		
25	518	520	521	523	525	527	529	530	530	530	529	528	526	525	523	521	520		
30	487	489	491	494	497	500	502	503	504	504	503	501	498	495	492	490	488		
35	451	454	457	461	465	469	472	474	476	475	473	470	466	463	459	455	453		
40	413	417	421	426	431	436	441	443	444	444	441	437	432	427	422	418	415		
45	372	377	382	389	395	402	407	410	412	411	407	403	396	390	383	377	373		
50	330	335	342	350	358	366	372	376	378	377	373	367	359	351	343	336	331		
55	286	292	301	310	320	329	336	341	343	341	337	330	321	311	301	293	287		
60	241	249	259	270	281	291	300	305	307	306	300	292	282	271	259	249	242		
65	196	205	216	229	242	253	262	268	270	269	263	254	243	230	217	205	196		
70	150	161	174	189	203	215	225	230	233	231	225	215	203	189	175	161	151		
75	106	119	134	149	164	177	187	193	195	194	187	177	164	150	134	119	106		
80	65.3	79.6	96.0	112	127	141	151	157	159	157	151	141	128	113	95.9	79.4	65.0		
85	32.0	47.1	63.8	80.2	95.4	109	119	125	127	125	119	109	95.3	79.9	63.2	46.2	30.9		
90	12.1	26.5	42.3	58.0	72.4	85.0	94.5	100	102	101	94.6	84.7	71.9	56.9	40.8	24.5	9.79		
95	8.32	21.0	35.7	50.4	63.9	75.5	84.4	89.9	91.7	89.9	84.0	74.8	62.8	48.7	33.7	18.7	5.72		
100	8.09	18.1	31.4	45.0	57.7	68.6	76.9	81.9	83.8	81.9	76.5	67.7	56.4	43.3	29.4	15.7	5.24		
105	9.00	16.5	27.9	40.3	52.0	62.0	69.7	74.4	76.0	74.3	69.2	61.2	50.7	38.6	25.8	14.0	5.70		
110	10.3	16.2	25.3	36.1	46.7	55.9	63.0	67.2	68.7	67.1	62.5	55.0	45.3	34.4	23.2	13.6	6.14		
115	11.7	16.8	24.0	32.8	41.6	50.0	56.4	60.3	61.6	60.2	55.9	49.1	40.4	31.0	21.7	14.0	8.43		
120	13.3	17.5	23.3	30.6	38.0	44.8	50.2	53.5	54.8	53.4	49.6	43.8	36.7	28.7	21.1	14.7	10.1		
125	14.8	18.5	23.3	29.0	35.1	40.8	45.3	48.0	48.9	47.8	44.7	39.9	33.8	27.2	21.1	14.9	11.6		
130	16.3	19.5	23.5	28.1	32.9	37.4	41.2	43.4	44.2	43.3	40.6	36.5	31.6	26.3	21.3	16.1	13.2		
135	17.7	20.6	23.7	27.5	31.3	34.9	37.7	39.5	40.1	39.4	37.2	34.0	30.0	25.8	21.1	17.8	14.7		
140	19.0	21.6	24.0	27.0	30.0	32.8	35.0	36.4	36.8	36.2	34.6	32.0	28.9	25.3	21.2	18.9	16.2		
145	20.1	22.4	24.4	26.6	28.9	31.1	32.8	33.8	34.1	33.6	32.3	30.4	27.9	24.5	22.5	19.8	17.3		
150	21.0	23.0	24.6	26.3	28.0	29.6	30.8	31.5	31.8	31.4	30.5	28.9	26.5	24.7	23.0	20.9	18.1		
155	20.6	22.8	24.0	24.9	26.7	28.3	29.1	29.6	29.7	29.4	28.6	27.3	26.1	24.9	23.5	22.0	18.5		
160	20.4	22.8	24.1	24.6	25.2	26.5	27.5	27.7	27.8	27.7	27.2	26.6	25.8	25.0	24.3	22.8	19.6		
165	18.4	20.6	23.4	24.2	24.5	24.7	22.8	25.0	26.5	26.5	26.2	25.8	25.2	25.3	23.5	22.8	20.1		
170	16.3	15.9	16.2	18.0	20.0	23.1	24.8	23.6	22.3	24.3	24.6	24.3	24.8	24.7	20.3	16.8	15.3		
175	13.6	13.6	13.6	13.5	13.5	13.8	14.3	15.7	18.5	22.3	19.4	19.9	16.8	13.4	12.2	12.6	12.9		
180	16.6	16.4	15.8	14.6	12.6	10.4	7.72	7.01	4.96	3.93	4.46	7.15	7.73	10.3	12.4	14.5	15.7		

Table 7: Luminous Intensity Data

EQUIPMENT LIST

Test Equipment	Model	Equipment No.	Calibration Date	Calibration Due date
Goniophotometer system	GO-R5000	HZTE011-01	Jul. 17, 2015	Jul. 16, 2016
Digital Power Meter	PF2010A	HZTE028-01	Jul. 17, 2015	Jul. 16, 2016
AC Power Supply	PCR 500L	HZTE001-08	Jul. 17, 2015	Jul. 16, 2016
DC Power Supply	WY12010	HZTE004-03	Jul. 17, 2015	Jul. 16, 2016
Temperature Meter	TES1310	HZTE017-01	Jul. 17, 2015	Jul. 16, 2016
Standard source	D908	HZTE012-01	Jul. 23, 2015	Jul. 22, 2016
Integrate Sphere system	2M	HZTE015-01	Jul. 16, 2015	Jul. 15, 2016
Digital Power Meter	WT210	HZTE008-01	Jul. 17, 2015	Jul. 16, 2016
AC Power Supply	PCR 500L	HZTE001-07	Jul. 17, 2015	Jul. 16, 2016
DC Power Supply	6154	HZTE004-04	Jul. 17, 2015	Jul. 16, 2016
Temperature and humidity recorder	JR900	HZTE018-01	Jul. 21, 2015	Jul. 20, 2016
Standard source	SCL-1400	HZTE012-02	Oct. 21, 2015	Oct. 20, 2016

Table 8: Test Equipment List

TEST METHODS

Seasoning of SSL Product

For the purpose of rating new SSL products, SSL products shall be tested with no seasoning.
Therefore, no seasoning was performed.

Sphere-Spectroradiometer Method- Photometric and Electrical Measurements

A Labsphere Model CDS 2100 Spectroradiometer and Two Meter Sphere was used to measure correlated color temperature, chromaticity coordinates, and the color rendering index for each SSL unit. The coating reflectance of each sphere is 98%. The measure geometry is 4π. Self-absorption correction is conducted in testing. Bandwidth of spectroradiometer is 350nm-1050nm.
Ambient temperature was measured at a position inside the sphere. Each SSL unit was operated on the client provided driver at the rated input voltage in its designated orientation.
The stabilization time typically ranges from 30 min (small integrated LED lamps) to 2 or more hours for large SSL luminaires). It can be judged that stability is reached when the variation (maximum – minimum) of at least 3 readings of the light output and electrical power over a period of 30 min, taken 15 minutes apart, is less than 0.5 %.
Electrical measurements including voltage, current, and power were measured using the Yokogawa Power Analyzer.
The standard reference of the integrated sphere system is halogen incandescent lamp, the intensity distribution type is omni-directional, and is traceable to the National Institute of Standards and Technology.
The uncertainty of integrating sphere system reported in this document is expended uncertainty is 1.06% with a coverage factor k=2.

Goniophotometer Method

Photometric and Electrical Measurements

An EVERFINE Type C Model GO-R5000 Goniophotometer was used to measure the intensity at each angle of distribution for each sample. The photometric distance is 2.475m for near-field measurement or 30m for far-field measurement. Bandwidth of spectroradiometer is 380nm-780nm.
Ambient temperature was measured at the same height of the sample mounted on the Goniophotometer equipment. Each SSL unit was operated on the client provided driver at the rated input voltage in its designated orientation.
The stabilization time typically ranges from 30 min (small integrated LED lamps) to 2 or more hours for large SSL luminaires). It can be judged that stability is reached when the variation (maximum – minimum) of at least 3 readings of the light output and electrical power over a period of 30 min, taken 15 minutes apart, is less than 0.5 %.
Electrical measurements including voltage, current, and power were measured using the Everfine Digital Power Meter.
Some graphics were created with Photometric Plus software.
The standard reference of the Goniophotometer system is halogen incandescent lamp, the intensity distribution type is omni-directional, and is traceable to the National Institute of Metrology P.R. China.
The uncertainty of goniophotometer system reported in this document is expended uncertainty is 1.94% with a coverage factor k=2.

Color Characteristics Measurements

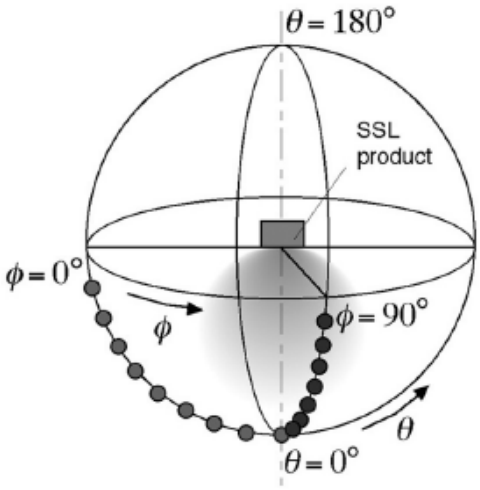
The color characteristics of SSL products include chromaticity coordinates, correlated color temperature, and color rendering index. These characteristics of SSL products may be spatially non-uniform, and thus, in order that they can be specified accurately, the color quantities shall be measured as values that are spatially average, weighted to intensity, over the angular range where light is intentionally emitted from the SSL product. The color characteristics measurements are using gonio-spectroradiometer.

Color Spatial Uniformity

The characteristics of SSL products may be spatially non-uniform, the chromaticity coordinate shall be measured at two vertical planes (C=0°/180° and C=90°/270°) and at 10° or less intervals for vertical angle until the light output dropped to below 10% of the peak intensity. The averaged weighted chromaticity coordinate was calculated from these points. The data was then analyzed to check for delta color differences of the u', v' chromaticity coordinates. The spatial non-uniformity of chromaticity, Δu'v', is determined as the maximum deviation (distance on the CIE (u', v') diagram) among all measured points from the spatially averaged

chromaticity coordinate.

The geometry for the chromaticity measurement using gonio-spectroradiometer is shown as following.



*** End of Report ***