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/850-ID

Laboratory: Leading Testing Laboratories

NVLAP CODE: 200960-0

No.1805, DongLiu road, BinJiang District, Hangzhou, China

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Report No.: HZ16080008k

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/850-ID**

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)	Power Factor
123.4	2164.0	17.54	0.9642

CCT (K)	CRI	Stabilization Time (Light & Power)
5061	84.9	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

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Sample Photos

Figure 1- Overview of the sample

Equipment Under Test (EUT)	
Name	: LED LAMP
Model	: LT40W/850-ID
Electrical Ratings	: 120-277V, 60Hz, 18W
Product Description	: 2G11 base, fixed end caps, 5000K, Frosted lens
Manufacturer	: ESPEN TECHNOLOGY, INC.
Address	: SANTA FE SPRINGS CA 90670 USA 562-529-2938

TEST RESULTS

Test ambient temperature was 24.4℃.

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)	0.152	0.077
Power Factor	0.9642	0.8270
Test Power (W)	17.54	17.68
THD A%	23.66	17.89
Luminous Efficacy (lm/W)	123.4	123.2
Total Luminous Flux (lm)	2164.0	2179.0
Color Rendering Index (CRI)	84.9	
R9	16.9	
Correlated Color Temperature (CCT)(K)	5061	
Chromaticity Chroma x	0.3437	
Chromaticity Chroma y	0.3555	
Chromaticity Chroma u	0.2090	
Chromaticity Chroma v	0.3242	
Duv	0.0018	
Chromaticity Chroma u ’	0.2090	
Chromaticity Chroma v’	0.4863	

Special Color Rendering Indices	
R1	83.4
R2	90.4
R3	94.2
R4	84
R5	83.8
R6	85.8
R7	88
R8	70
R9	16.9
R10	76.5
R11	83.2
R12	64.3
R13	85.4
R14	97.1

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 24.3℃.

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)	0.152
Power Factor	0.9646
Test Power (W)	17.60
Luminous Efficacy (lm/W)	122.1
Total Luminous Flux (lm)	2148.6
Beam Angle (°)	113.5
Center Beam Candle Power (cd)	632
Spacing Criteria	1.21 (0°-180°)/ 1.25 (90°-270°)
Zonal Lumens in the 0°-60°Zone	65.28%
Zonal Lumens in the 60°-90°Zone	23.48%
Zonal Lumens in the 90°-120°Zone	6.93%
Zonal Lumens in the 120°-180°Zone	4.31%

Table 3: Test data per Goniophotometer Method

Spectral Power Distribution - Sphere Spectroradiometer Method

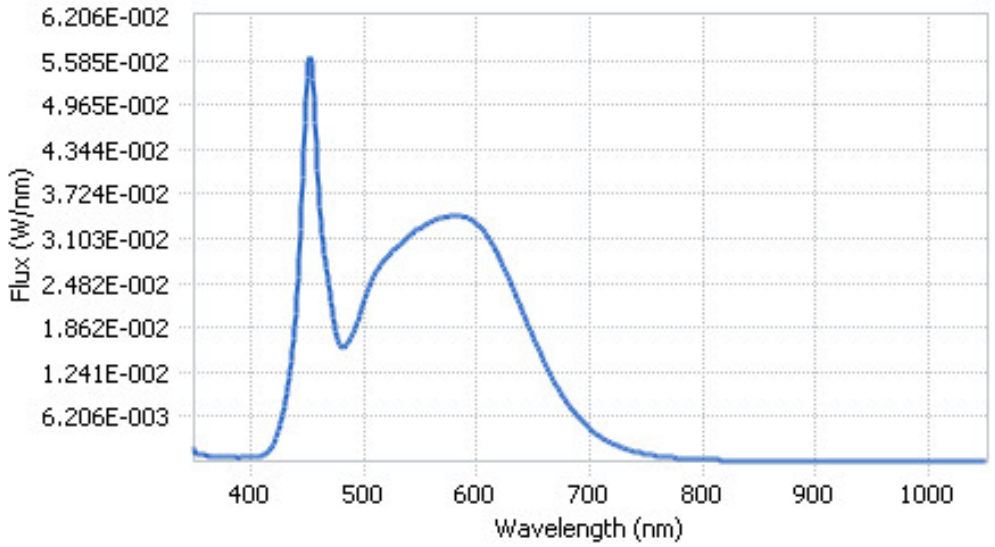
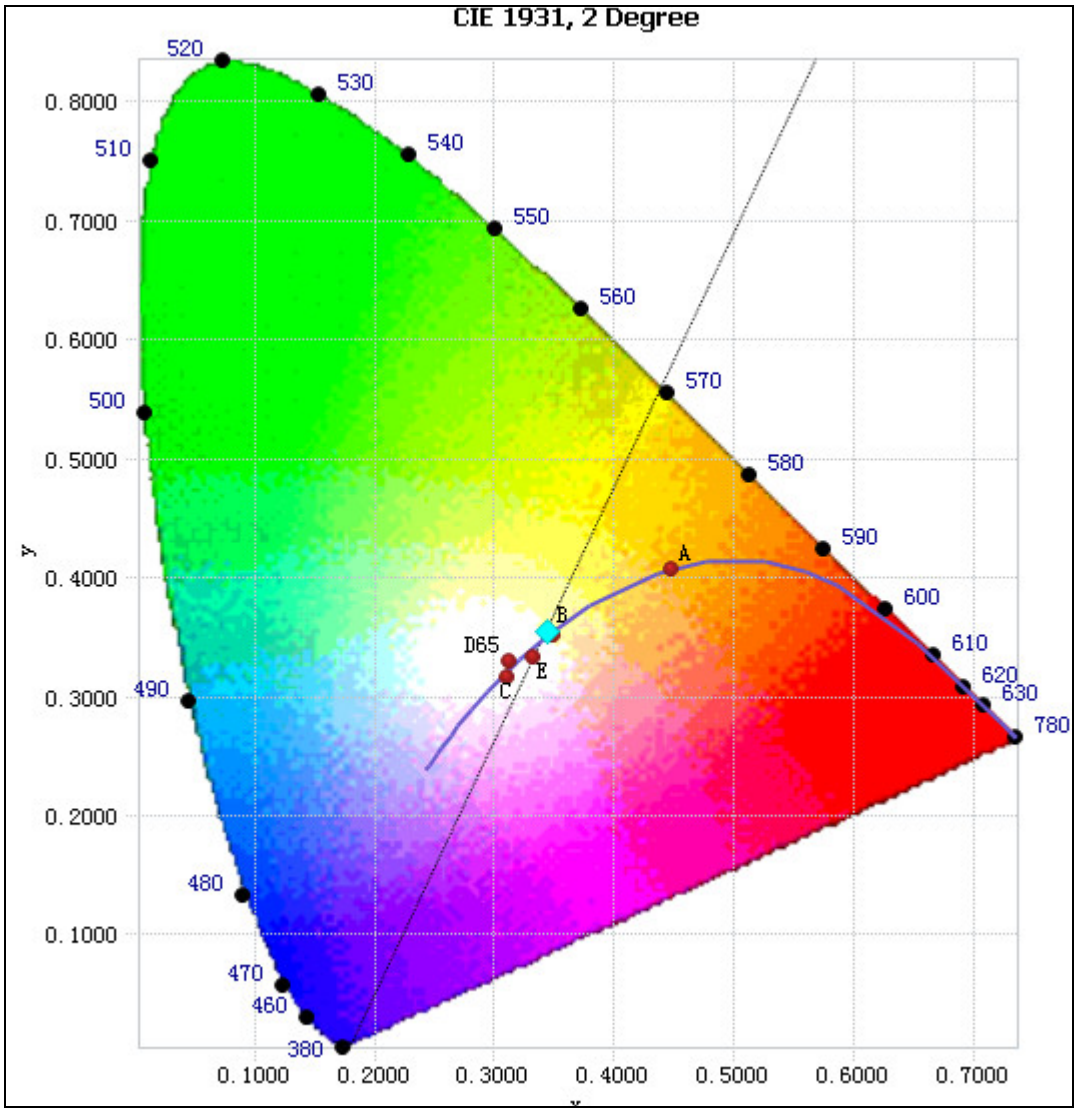


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	5.24E-04	485	1.63E-02	590	3.41E-02	695	5.26E-03
385	5.07E-04	490	1.77E-02	595	3.37E-02	700	4.53E-03
390	5.11E-04	495	1.97E-02	600	3.31E-02	705	3.88E-03
395	4.92E-04	500	2.23E-02	605	3.23E-02	710	3.33E-03
400	5.47E-04	505	2.45E-02	610	3.13E-02	715	2.87E-03
405	6.02E-04	510	2.63E-02	615	3.00E-02	720	2.49E-03
410	7.34E-04	515	2.76E-02	620	2.83E-02	725	2.12E-03
415	1.18E-03	520	2.84E-02	625	2.67E-02	730	1.82E-03
420	2.34E-03	525	2.90E-02	630	2.49E-02	735	1.57E-03
425	4.46E-03	530	2.97E-02	635	2.30E-02	740	1.35E-03
430	7.64E-03	535	3.03E-02	640	2.10E-02	745	1.16E-03
435	1.27E-02	540	3.13E-02	645	1.91E-02	750	9.99E-04
440	2.07E-02	545	3.19E-02	650	1.72E-02	755	8.65E-04
445	3.56E-02	550	3.24E-02	655	1.54E-02	760	7.53E-04
450	5.35E-02	555	3.30E-02	660	1.37E-02	765	6.48E-04
455	5.32E-02	560	3.34E-02	665	1.21E-02	770	5.61E-04
460	3.77E-02	565	3.37E-02	670	1.06E-02	775	4.80E-04
465	2.89E-02	570	3.39E-02	675	9.27E-03	780	4.18E-04
470	2.34E-02	575	3.42E-02	680	8.08E-03		
475	1.82E-02	580	3.41E-02	685	7.03E-03		
480	1.59E-02	585	3.42E-02	690	6.08E-03		

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

Chromaticity Diagram - Sphere Spectroradiometer Method



Tristimulus values(x, y): (0.3437, 0.3555)

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

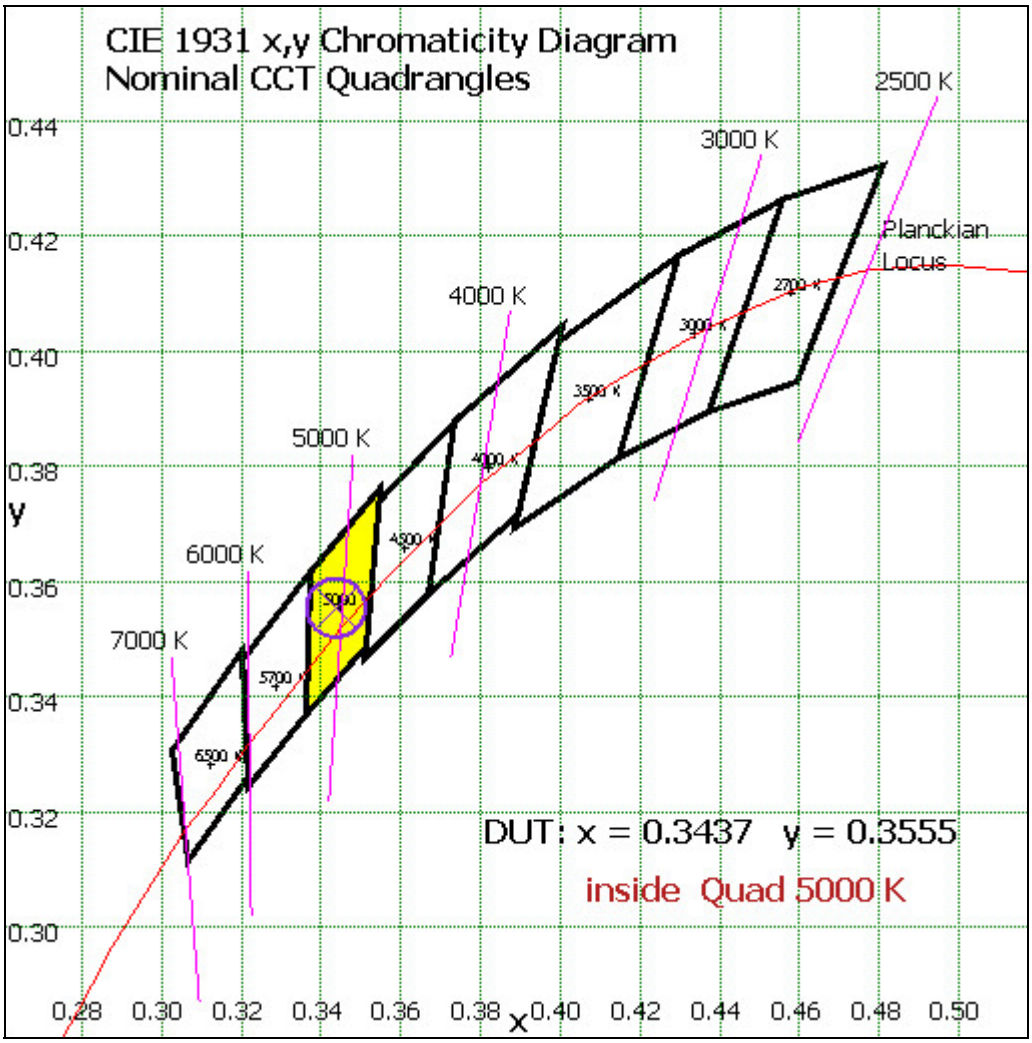


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

Zonal Lumen Tabulation- Goniophotometer Method

γ(°)	Lumens	% Total
0- 10	59.726	2.78%
10- 20	170.019	7.91%
20- 30	255.23	11.88%
30- 40	305.454	14.22%
40- 50	317.745	14.79%
50- 60	294.465	13.70%
60- 70	241.242	11.23%
70- 80	167.675	7.80%
80- 90	95.618	4.45%
90-100	61.594	2.87%
100-110	48.905	2.28%
110-120	38.297	1.78%
120-130	29.913	1.39%
130-140	23.546	1.10%
140-150	17.987	0.84%
150-160	12.506	0.58%
160-170	6.999	0.33%
170-180	1.689	0.08%
Total	2148.6	100%

γ(°)	Lumens	% Total
0- 60	1402.639	65.28%
60- 90	504.535	23.48%
0-90	1907.174	88.76%
90- 180	241.436	11.24%
0- 180	2148.6	100%

Table 5: Zonal Lumen Data

Illuminance Plots- Goniophotometer Method

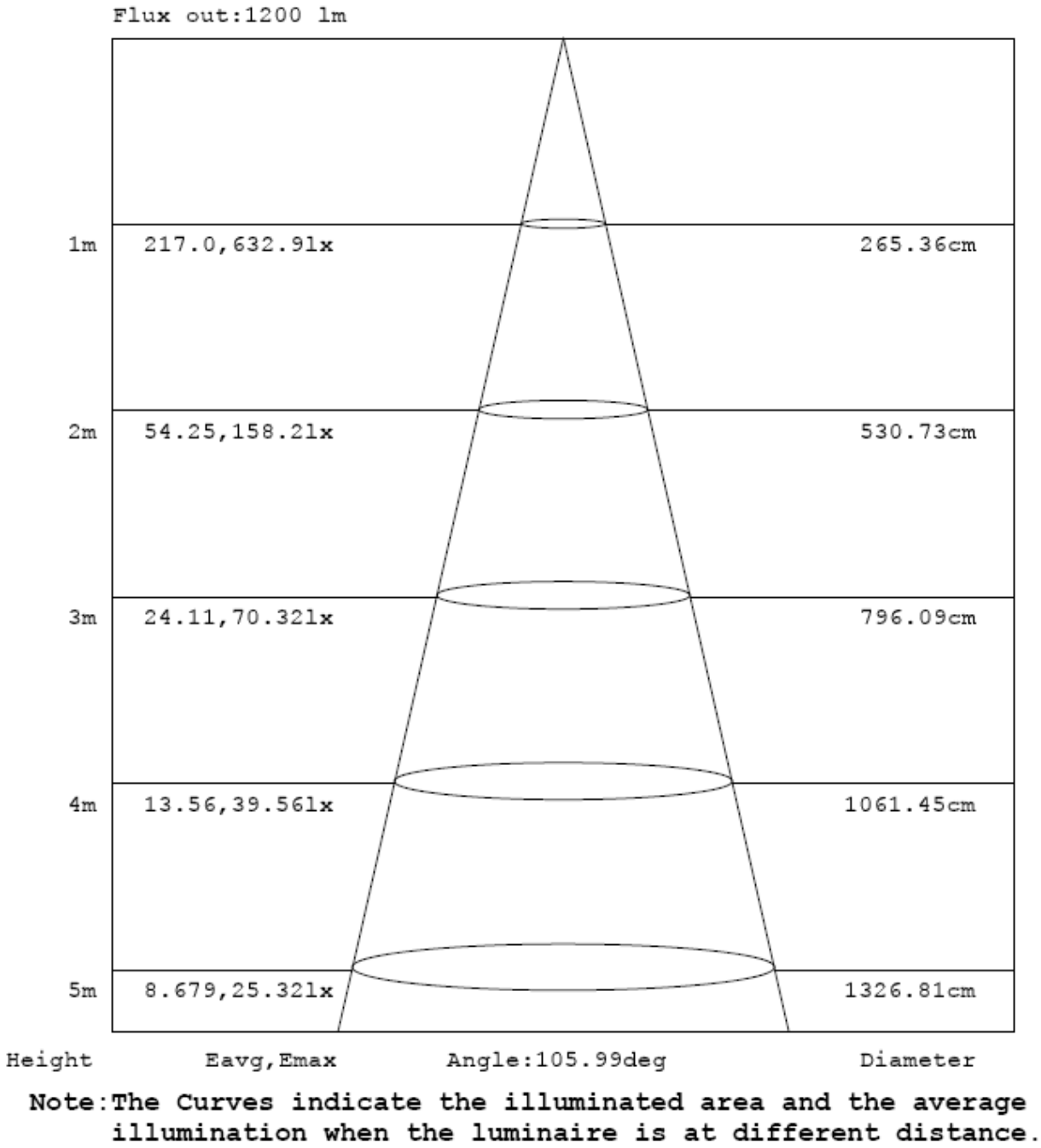


Chart 4: Beam Angle

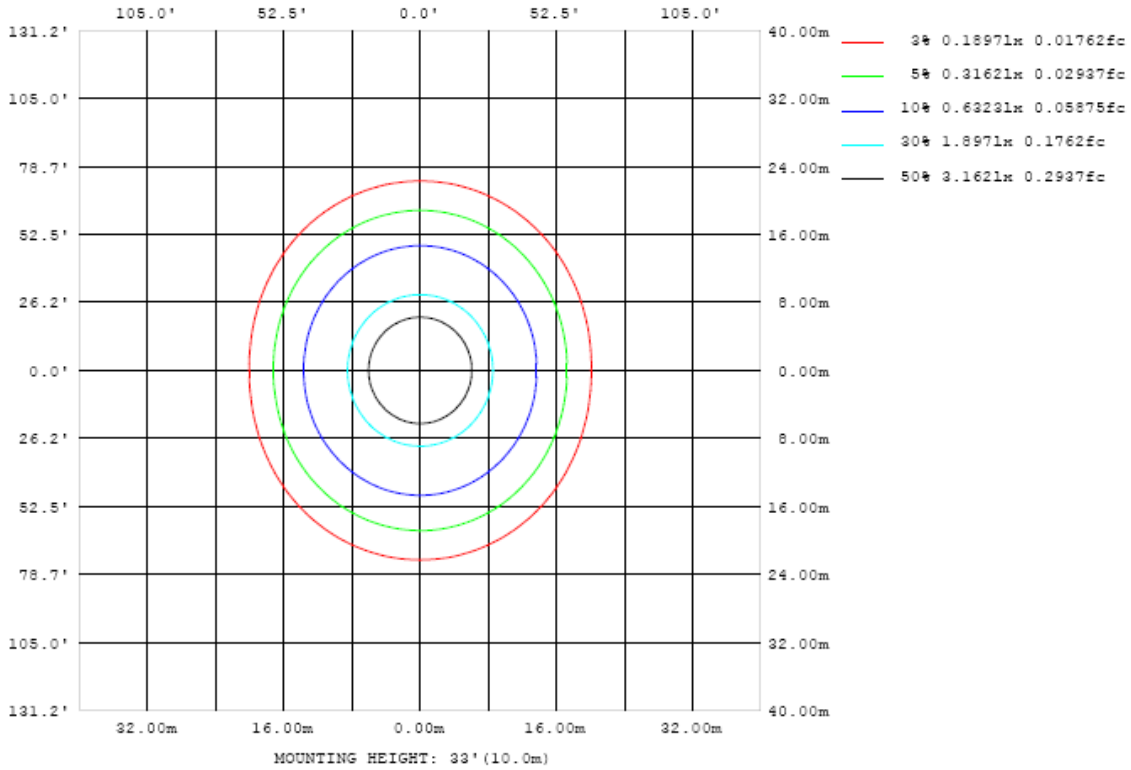


Chart 5: Illuminance Plot (Footcandles)

Luminous Intensity Distribution Plots- Goniophotometer Method

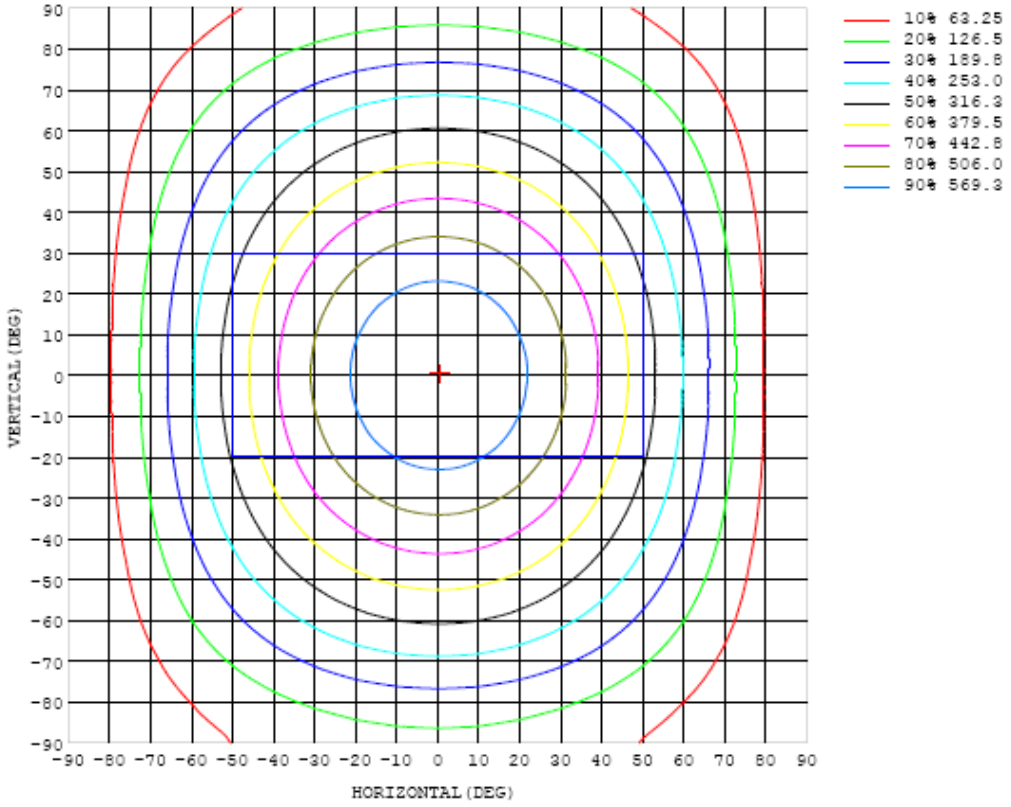


Chart 6: Isocandela Plot

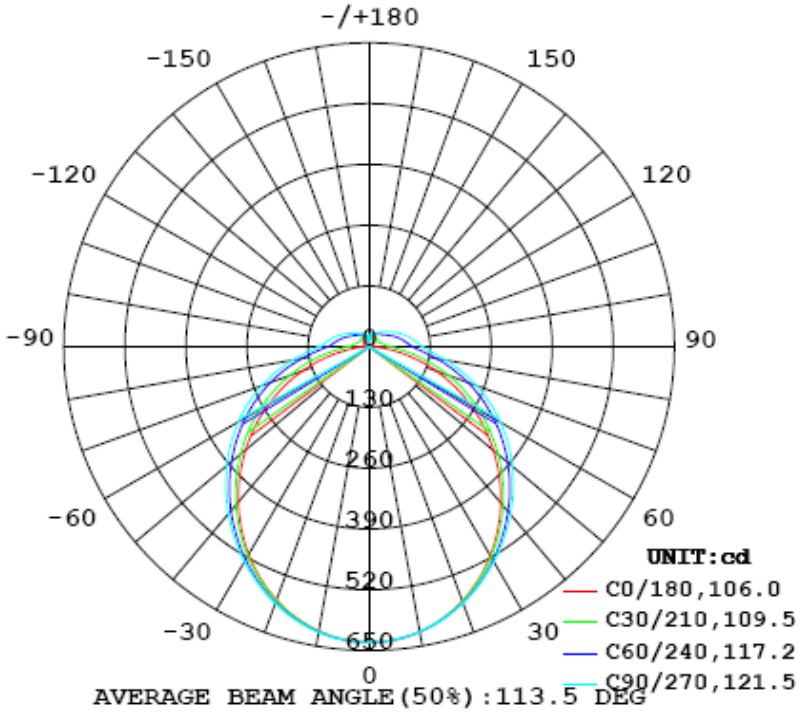


Chart 7: Polar Candela Distribution

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	632	632	632	632	632	632	632	632	632	632	632	632	632	632	632	632	632	632	632
5	629	629	630	629	629	629	629	629	629	629	629	628	628	629	628	628	628	628	628
10	619	619	619	619	619	619	619	620	619	619	619	619	618	618	618	618	617	618	618
15	602	602	602	603	603	603	604	604	604	604	603	603	602	602	601	601	600	600	600
20	579	579	579	580	581	582	583	584	584	583	583	582	581	580	579	578	577	576	576
25	550	550	551	552	554	555	557	558	559	559	558	557	555	553	551	549	548	547	547
30	516	516	518	519	522	525	527	530	531	531	530	528	526	523	520	517	515	513	513
35	478	478	480	483	487	491	495	498	500	500	499	497	493	489	484	480	477	475	475
40	436	437	440	443	449	454	460	465	467	468	466	463	458	453	446	441	437	434	433
45	392	393	396	402	409	416	423	429	432	434	432	428	421	414	407	400	394	390	389
50	346	347	352	359	367	376	385	392	397	398	396	391	383	375	365	357	349	344	344
55	298	300	306	314	325	335	346	354	359	361	359	353	344	334	323	313	304	298	296
60	250	252	259	269	282	294	306	315	321	323	321	314	304	293	280	268	257	250	248
65	201	204	212	224	238	252	265	275	281	283	281	274	264	251	237	223	211	202	199
70	152	156	166	180	195	210	224	234	241	243	241	234	223	209	194	179	165	154	151
75	104	109	121	137	153	169	183	194	201	203	201	194	182	168	153	136	120	108	104
80	59.2	65.7	79.8	96.6	114	131	145	156	163	165	163	156	145	131	114	96.9	79.8	65.2	59.7
85	23.3	30.8	46.4	63.9	81.9	98.7	113	125	132	134	131	125	114	99.4	82.8	65.1	47.7	31.8	24.2
90	1.72	9.75	25.8	44.0	61.8	78.6	93.0	104	111	114	111	105	94.3	80.5	64.1	46.9	29.0	12.9	3.77
95	0.70	6.09	20.1	36.6	53.5	68.9	82.8	93.7	101	103	101	94.5	84.3	71.3	56.3	39.9	23.7	9.71	4.10
100	1.73	5.21	17.2	32.5	48.2	62.6	75.5	85.6	91.9	94.2	92.0	86.2	76.9	64.8	50.9	35.7	20.9	9.03	5.15
105	3.18	6.57	15.2	28.7	43.2	56.9	68.4	77.7	83.4	85.5	83.6	78.3	69.8	58.8	45.8	32.0	19.0	10.4	6.75
110	5.00	7.95	13.5	25.6	38.5	51.0	61.6	70.0	75.3	77.2	75.5	70.7	62.9	53.0	41.0	28.9	17.6	11.7	8.73
115	7.06	9.29	15.4	22.1	34.5	45.4	55.4	62.7	67.5	69.3	67.8	63.4	56.7	47.4	37.1	26.3	19.2	13.2	10.9
120	9.24	9.68	16.5	22.5	31.0	41.0	49.3	56.1	59.9	61.7	60.5	56.8	50.6	43.0	34.3	26.6	19.9	14.7	13.1
125	11.5	11.0	17.7	23.5	29.0	36.5	44.7	50.3	53.9	55.2	54.1	51.0	46.0	39.5	32.9	26.5	20.8	16.3	15.2
130	13.7	12.3	18.9	23.8	29.3	34.4	39.6	45.4	48.6	49.7	48.9	46.3	42.3	37.4	31.8	26.5	21.8	17.8	17.1
135	15.9	14.6	19.8	24.2	28.9	33.6	37.7	41.2	43.6	45.0	44.6	42.6	39.4	35.4	30.9	26.6	22.8	19.2	19.0
140	17.9	17.4	19.8	24.6	28.4	32.3	35.9	38.8	40.8	41.5	41.1	39.5	37.0	33.8	30.2	26.7	23.6	20.4	20.6
145	19.8	18.9	20.8	24.9	28.0	31.0	33.9	36.2	37.7	38.3	37.9	36.7	34.8	32.3	29.5	26.9	24.3	21.4	21.8
150	21.0	19.4	21.7	24.2	27.6	29.9	32.1	33.9	35.0	35.5	35.2	34.3	32.8	31.0	28.9	26.9	24.6	21.9	22.5
155	21.6	19.5	22.8	24.6	26.6	29.0	30.6	31.8	32.7	33.0	32.8	32.1	31.1	29.8	28.4	26.9	24.5	21.9	22.7
160	21.8	18.7	23.9	24.8	26.0	27.4	28.9	30.1	30.7	30.9	30.8	30.3	29.6	28.7	27.6	25.9	25.4	22.0	22.5
165	19.5	17.7	22.4	25.8	25.5	25.9	27.1	27.9	28.4	28.7	28.7	28.5	28.0	26.8	25.9	26.5	24.6	19.3	20.2
170	15.9	13.7	14.9	17.7	24.3	26.8	26.5	25.7	25.6	25.7	25.8	25.8	25.6	24.2	21.7	20.0	17.0	16.0	17.1
175	13.2	12.1	11.8	11.3	11.0	12.7	17.7	22.2	24.0	24.1	21.3	16.4	14.9	14.2	14.0	13.9	13.9	13.9	13.9
180	16.8	16.6	16.0	14.8	13.0	10.8	6.47	5.82	0.00	0.00	0.00	1.29	6.72	9.50	12.1	14.8	16.1	16.8	16.8

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	632	632	632	632	632	632	632	632	632	632	632	632	632	632	632	632	632		
5	629	629	629	629	629	629	629	629	629	630	630	629	629	630	630	630	630		
10	618	618	618	619	619	620	620	620	620	620	620	620	620	620	620	620	619		
15	600	601	601	602	603	604	604	604	605	605	605	604	604	604	604	603	602		
20	577	578	578	580	581	582	583	584	585	585	584	584	583	582	581	580	580		
25	548	549	550	552	554	556	558	559	560	560	559	558	556	555	553	552	551		
30	514	516	517	520	523	526	529	530	531	531	530	528	526	523	521	519	517		
35	476	478	481	485	489	493	497	499	500	500	498	495	491	488	484	481	479		
40	435	438	442	447	452	458	462	465	467	466	464	460	455	450	445	441	438		
45	391	395	400	407	414	421	427	430	432	431	428	423	417	410	403	398	394		
50	345	350	357	366	374	383	389	394	396	395	391	384	377	368	360	353	348		
55	299	305	313	323	334	344	352	357	359	358	353	345	336	326	316	307	301		
60	251	259	269	281	293	304	313	319	321	320	314	306	295	283	271	261	254		
65	203	212	224	238	252	264	274	280	283	281	275	265	254	240	227	215	205		
70	156	167	181	196	211	224	234	241	243	241	235	225	212	198	182	168	157		
75	110	123	138	155	170	184	194	201	204	202	195	185	171	156	140	124	111		
80	66.9	81.8	98.8	116	132	146	156	163	166	164	157	147	133	117	99.9	82.6	67.8		
85	32.4	48.2	65.5	82.8	98.8	113	123	130	132	130	124	113	99.2	83.0	65.6	47.8	31.9		
90	12.2	27.0	43.5	59.9	75.1	88.2	98.1	104	106	104	98.1	87.9	74.6	58.9	42.1	25.2	9.93		
95	8.94	21.9	37.0	52.1	66.0	77.9	86.9	92.5	94.4	92.3	86.4	76.8	64.4	49.9	34.4	18.9	5.73		
100	8.71	18.9	32.6	46.5	59.4	70.6	79.0	84.1	86.0	84.0	78.4	69.4	57.7	44.2	29.9	15.9	5.26		
105	9.65	17.3	28.9	41.6	53.5	63.7	71.5	76.2	77.9	76.1	70.9	62.6	51.8	39.4	26.3	14.2	6.06		
110	10.9	17.1	26.3	37.2	48.0	57.4	64.5	68.8	70.4	68.7	63.9	56.2	46.3	35.0	23.5	13.8	7.43		
115	12.4	17.5	24.9	33.8	42.9	51.4	57.8	61.8	63.2	61.6	57.2	50.2	41.2	31.5	22.1	14.3	8.75		
120	13.9	18.3	24.3	31.6	39.1	46.0	51.4	55.0	56.2	54.8	50.8	44.8	37.4	29.3	21.5	14.8	10.3		
125	15.5	19.2	24.1	30.0	36.1	41.9	46.4	49.2	50.2	49.0	45.8	40.8	34.5	27.7	21.5	16.3	12.1		
130	17.0	20.2	24.2	29.0	33.8	38.5	42.2	44.6	45.4	44.4	41.7	37.4	32.3	26.9	21.4	17.6	13.9		
135	18.4	21.3	24.5	28.3	32.2	35.8	38.6	40.5	41.2	40.3	38.1	34.8	30.8	26.4	22.3	18.8	14.4		
140	19.6	22.2	24.7	27.7	30.8	33.7	35.9	37.4	37.9	37.2	35.4	32.8	29.6	26.1	22.8	20.0	14.2		
145	20.6	23.1	25.0	27.3	29.6	31.8	33.6	34.7	35.1	34.5	33.2	30.9	28.6	25.9	23.6	20.8	16.3		
150	21.3	23.5	25.2	26.9	28.7	30.3	31.5	32.3	32.5	32.1	31.2	29.7	27.9	25.8	24.2	21.7	17.7		
155	21.0	23.2	24.9	25.6	27.4	28.9	29.8	30.4	30.6	30.3	29.6	28.6	27.3	26.1	24.5	20.9	18.7		
160	20.9	22.4	24.5	25.3	25.8	27.3	28.4	28.8	28.9	28.8	28.4	27.7	27.1	26.2	25.1	21.6	19.3		
165	19.0	20.7	22.8	24.2	25.4	25.6	23.4	26.1	27.6	27.5	27.2	26.9	26.8	26.3	22.0	22.5	20.0		
170	16.5	16.2	16.7	18.5	19.9	22.2	24.7	24.3	23.2	25.5	25.7	24.5	23.2	23.8	20.5	17.3	15.7		
175	13.9	13.9	13.9	13.8	13.8	14.1	14.3	16.8	18.8	22.8	19.5	20.7	17.6	14.2	12.9	13.0	13.3		
180	16.9	16.7	16.0	14.8	12.7	10.4	7.72	2.46	4.99	3.81	4.44	7.13	7.78	10.5	12.7	14.8	16.0		

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

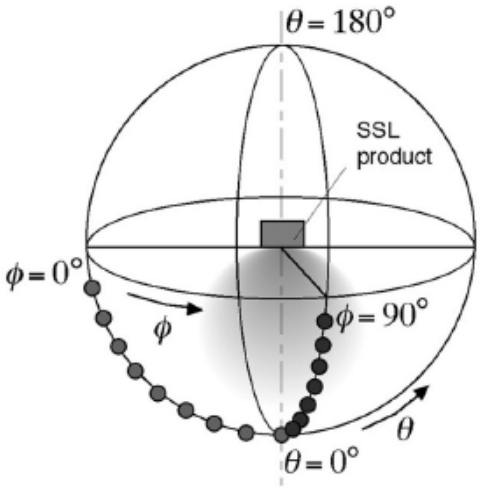
The color characteristics of SSL products include chromaticity coordinates, correlated color temperature, and color rendering index. These characteristics of SSL products may be spatially non-uniform, and thus, in order that they can be specified accurately, the color quantities shall be measured as 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 ***