

## LM-79-08 TEST REPORT

for

### GREEN CREATIVE LTD

756 North Zhongshan Rd., Unit B301 Zhabei District, Shanghai

### LED Tube

**Model: 17PLL/830/GL/BYP**

### Laboratory: Leading Testing Laboratories

**NVLAP CODE: 200960-0**

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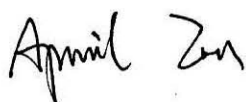
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Report No.: HZ19050020i

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

Review by:



Engineer: April Zou  
May 23, 2019

Approved by:



Manager: Jim Zhang  
May 23, 2019

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: 17PLL/830/GL/BYP

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)	Power Factor
133.1	2153.0	16.18	0.9769
CCT (K)	CRI	Stabilization Time (Light & Power)	
2993	81.4	60	

Table 1: Executive Data Summary

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

### Test specifications:

<b>Date of Receipt</b>	: May 16, 2019
<b>Date of Test</b>	: May 20, 2019
<b>Test item</b>	: Total Luminous Flux, Luminous Distribution Intensity, Luminous Efficacy, Correlated Color Temperature, Color Rendering Index, Chromaticity Coordinate, Electrical parameters
<b>Reference Standard</b>	: IESNA LM-79-2008 Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products ANSI/IES TM-30-18 IES Method for Evaluating Light Source Color Rendition

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## SAMPLE PHOTO

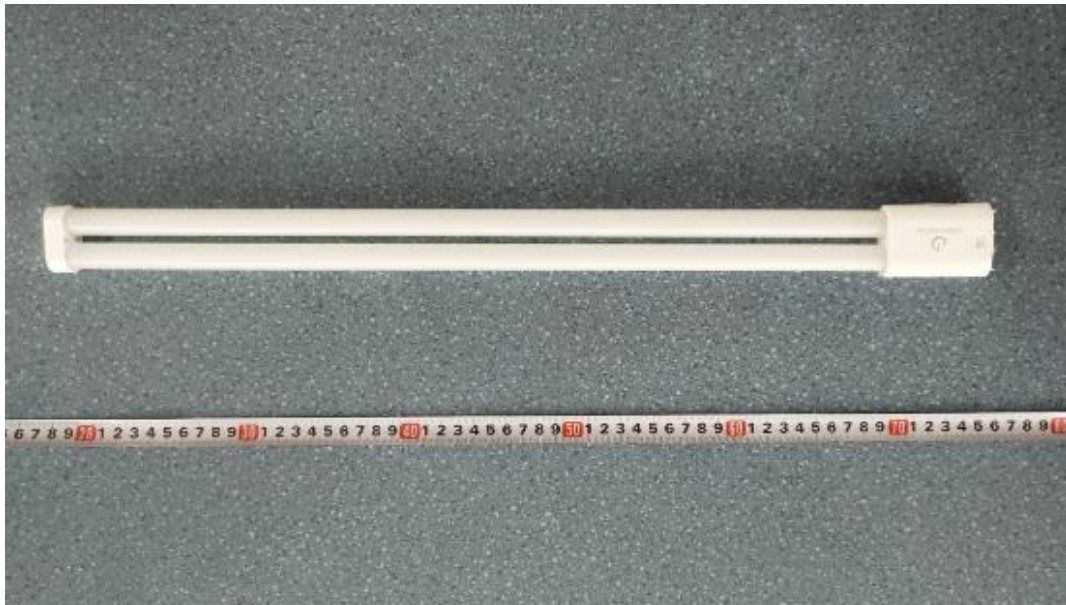


Figure 1- Overview of the sample

### Equipment Under Test(EUT)

<b>Name</b>	: LED Tube
<b>Model</b>	: 17PLL/830/GL/BYP
<b>Electrical Ratings</b>	: 120-277V, 60Hz, 17W
<b>Product Description</b>	: 3000K
<b>Manufacturer</b>	: GREEN CREATIVE LTD
<b>Address</b>	: 756 North Zhongshan Rd., Unit B301 Zhabei District, Shanghai

## TEST RESULTS

Test ambient temperature was 26.0°C.

Base orientation was light down. 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)	0.138	0.063
Power Factor	0.9769	0.9143
Test Power (W)	16.18	16.03
THD A%	20.22	24.32
Luminous Efficacy (lm/W)	133.1	134.3
Total Luminous Flux (lm)	2153.0	2153.0
Color Rendering Index (CRI)	81.4	
R9	0.2	
Correlated Color Temperature (CCT)(K)	2993	
Chromaticity Chroma x	0.4363	
Chromaticity Chroma y	0.4022	
Chromaticity Chroma u	0.2510	
Chromaticity Chroma v	0.3470	
Duv	0.0008	
Chromaticity Chroma u'	0.2510	
Chromaticity Chroma v'	0.5205	

Special Color Rendering Indices	
R1	79.8
R2	91.1
R3	95
R4	79
R5	80.4
R6	89.5
R7	80.9
R8	55.5
R9	0.2
R10	80.1
R11	78.5
R12	72.2
R13	82.6
R14	97.9

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 24.8°C.

The photometric distance is 30 m.

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)	0.138
Power Factor	0.9772
Power (W)	16.20
Luminous Efficacy (lm/W)	130.3
Total Luminous Flux (lm)	2111.4
Beam Angle ( ° )	101.4 (0°-180°) / 114.4 (90°-270°)
Center Beam Candle Power (cd)	626
Maximum Beam Candle Power (cd)	630.3 (At: C=270.0, Gamma=5.0)
Spacing Criteria	1.20 (0°-180°) / 1.33 (90°-270°)
Zonal Lumens in the 0 °-60 °Zone	66.08%
Zonal Lumens in the 60 °-90 °Zone	21.22%
Zonal Lumens in the 90 °-120 °Zone	7.23%
Zonal Lumens in the 120 °-180 °Zone	5.48%

Table 3: Test data per Goniophotometer Method

## Spectral Power Distribution - Sphere Spectroradiometer Method

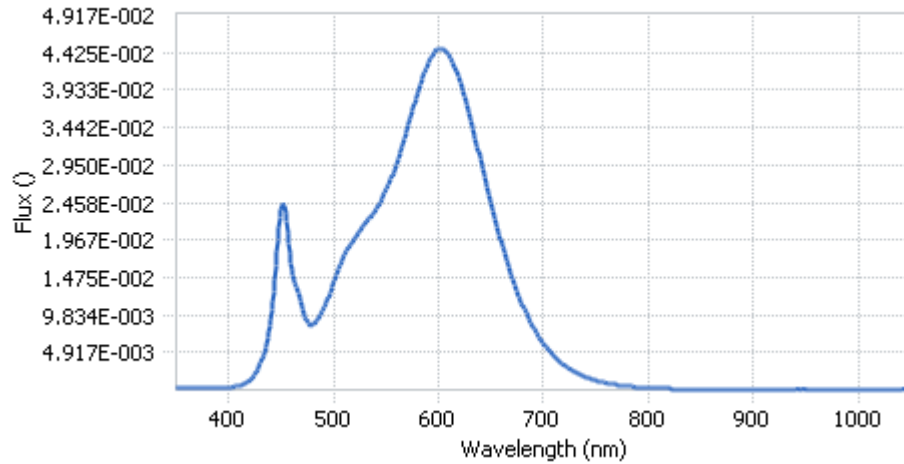


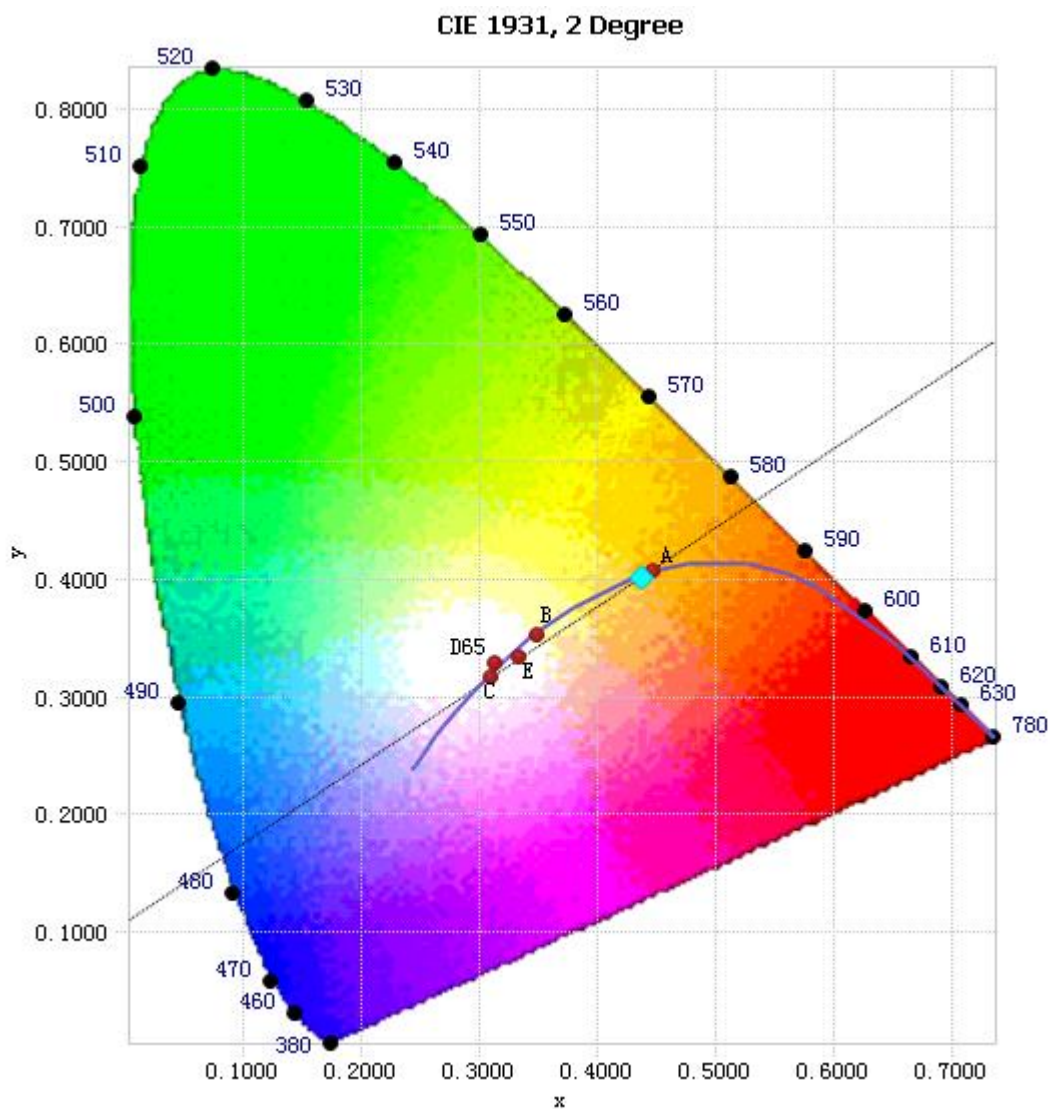
Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	2.90E-04	485	9.29E-03	590	4.28E-02	695	7.08E-03
385	2.95E-04	490	1.04E-02	595	4.40E-02	700	6.09E-03
390	3.10E-04	495	1.22E-02	600	4.46E-02	705	5.22E-03
395	3.28E-04	500	1.42E-02	605	4.46E-02	710	4.44E-03
400	3.70E-04	505	1.60E-02	610	4.39E-02	715	3.79E-03
405	4.35E-04	510	1.76E-02	615	4.25E-02	720	3.22E-03
410	5.74E-04	515	1.90E-02	620	4.06E-02	725	2.75E-03
415	8.31E-04	520	2.00E-02	625	3.84E-02	730	2.35E-03
420	1.29E-03	525	2.09E-02	630	3.58E-02	735	2.00E-03
425	2.06E-03	530	2.18E-02	635	3.30E-02	740	1.71E-03
430	3.39E-03	535	2.28E-02	640	3.02E-02	745	1.45E-03
435	5.60E-03	540	2.37E-02	645	2.72E-02	750	1.23E-03
440	9.28E-03	545	2.48E-02	650	2.45E-02	755	1.06E-03
445	1.63E-02	550	2.62E-02	655	2.18E-02	760	9.12E-04
450	2.38E-02	555	2.79E-02	660	1.92E-02	765	7.75E-04
455	2.20E-02	560	2.97E-02	665	1.69E-02	770	6.66E-04
460	1.58E-02	565	3.19E-02	670	1.48E-02	775	5.71E-04
465	1.33E-02	570	3.42E-02	675	1.29E-02	780	4.91E-04
470	1.10E-02	575	3.66E-02	680	1.12E-02		
475	8.83E-03	580	3.90E-02	685	9.65E-03		
480	8.58E-03	585	4.12E-02	690	8.29E-03		

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



## Chromaticity Diagram - Sphere Spectroradiometer Method



Tristimulus values(x, y): (0.4363, 0.4022)

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

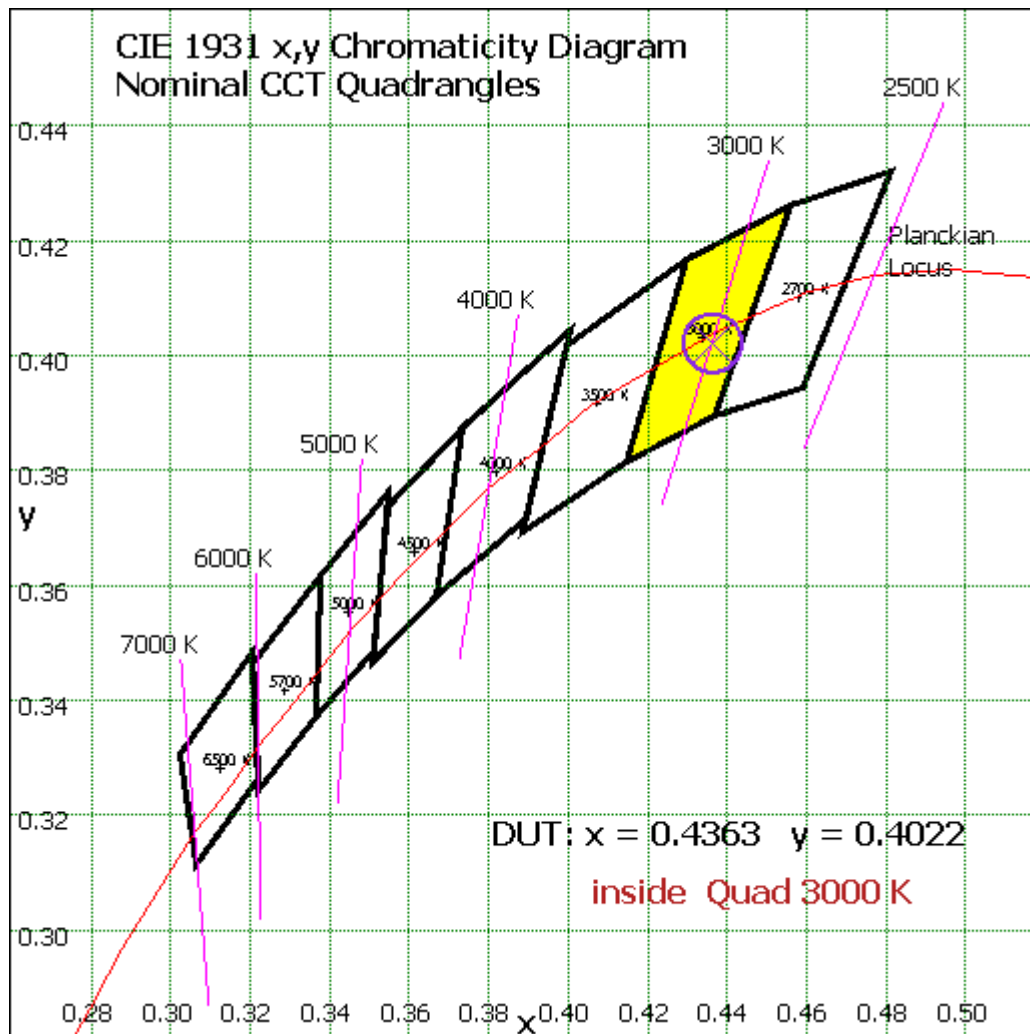
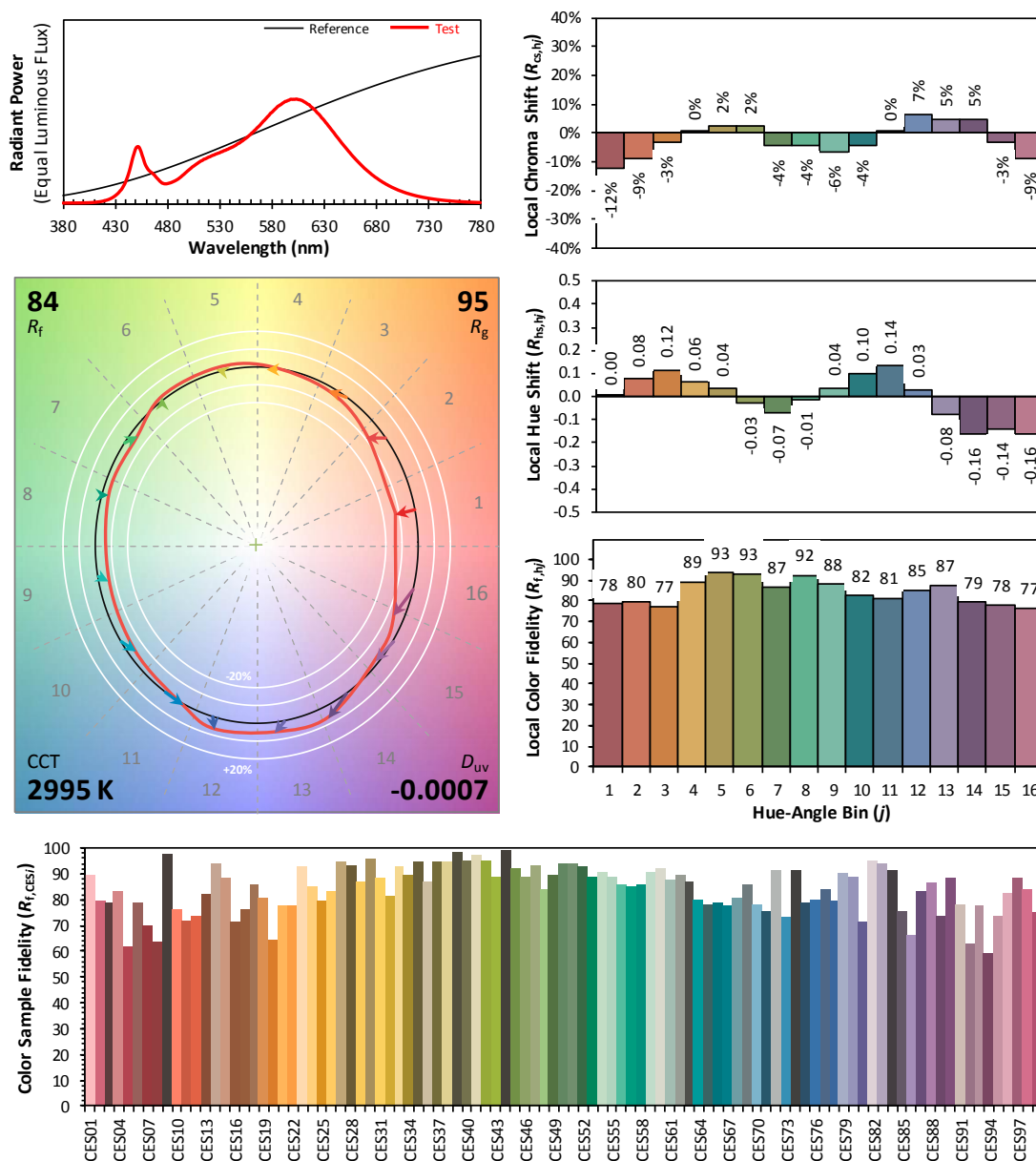


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

## Color Rendition Report – Sphere Spectroradiometer Method



**Notes:** This is a recommended method for displaying ANSI/IES TM-30-18 information.

$x$  0.4363

$y$  0.4022

$u'$  0.2510

$v'$  0.5205

Chart 4: Full Report Created with the IES TM-30 Calculator

Note: The values in this diagram might be a little different from the values in Table 2 due to rounding.

### Zonal Lumen Tabulation- Goniophotometer Method

$\gamma(^{\circ})$	Lumens	% Total
0- 10	59.144	2.80%
10- 20	168.481	7.98%
20- 30	254.163	12.04%
30- 40	307.011	14.54%
40- 50	320.509	15.18%
50- 60	285.898	13.54%
60- 70	214.81	10.17%
70- 80	144.886	6.86%
80- 90	88.282	4.18%
90-100	59.662	2.83%
100-110	49.519	2.35%
110-120	43.432	2.06%
120-130	38.428	1.82%
130-140	31.271	1.48%
140-150	22.26	1.05%
150-160	14.136	0.67%
160-170	7.646	0.36%
170-180	1.899	0.09%
Total	2111.4	100%

$\gamma(^{\circ})$	Lumens	% Total
0- 60	1395.206	66.08%
60- 90	447.978	21.22%
0-90	1843.184	87.30%
90- 180	268.253	12.70%
0- 180	2111.4	100%

Table 5: Zonal Lumen

## Illuminance Plots- Goniophotometer Method

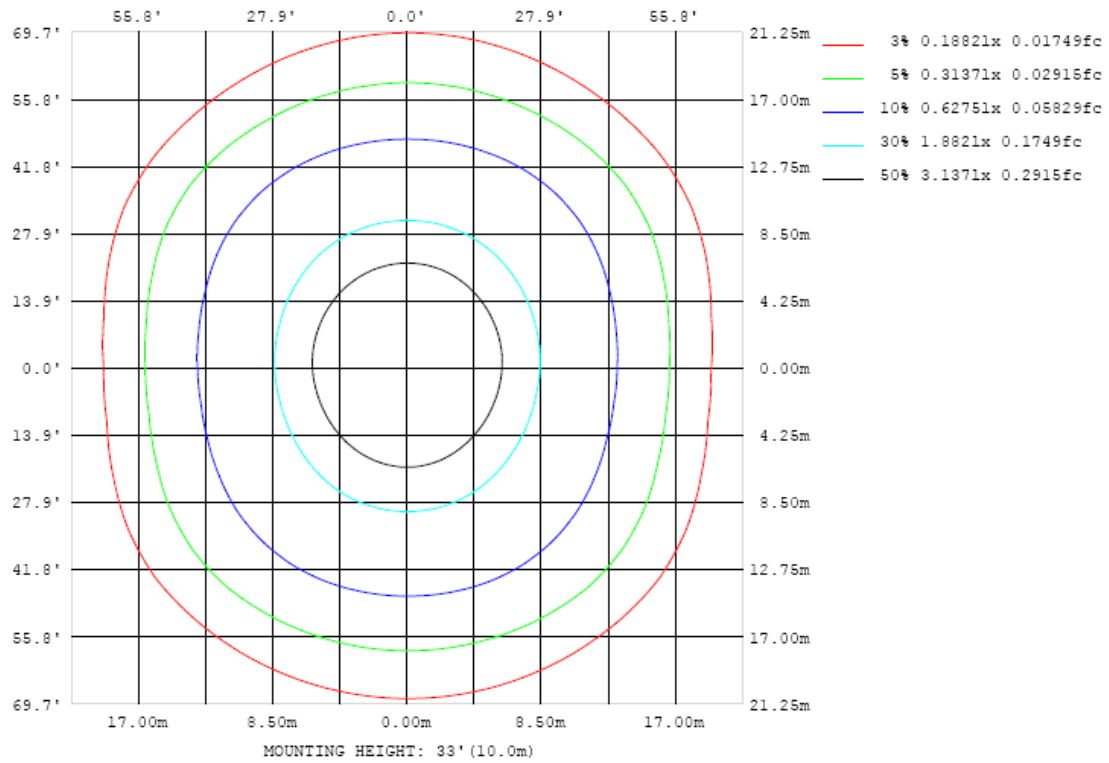


Chart 5: Illuminance Plot (Footcandles)

## Luminous Intensity Distribution Plots- Goniophotometer Method

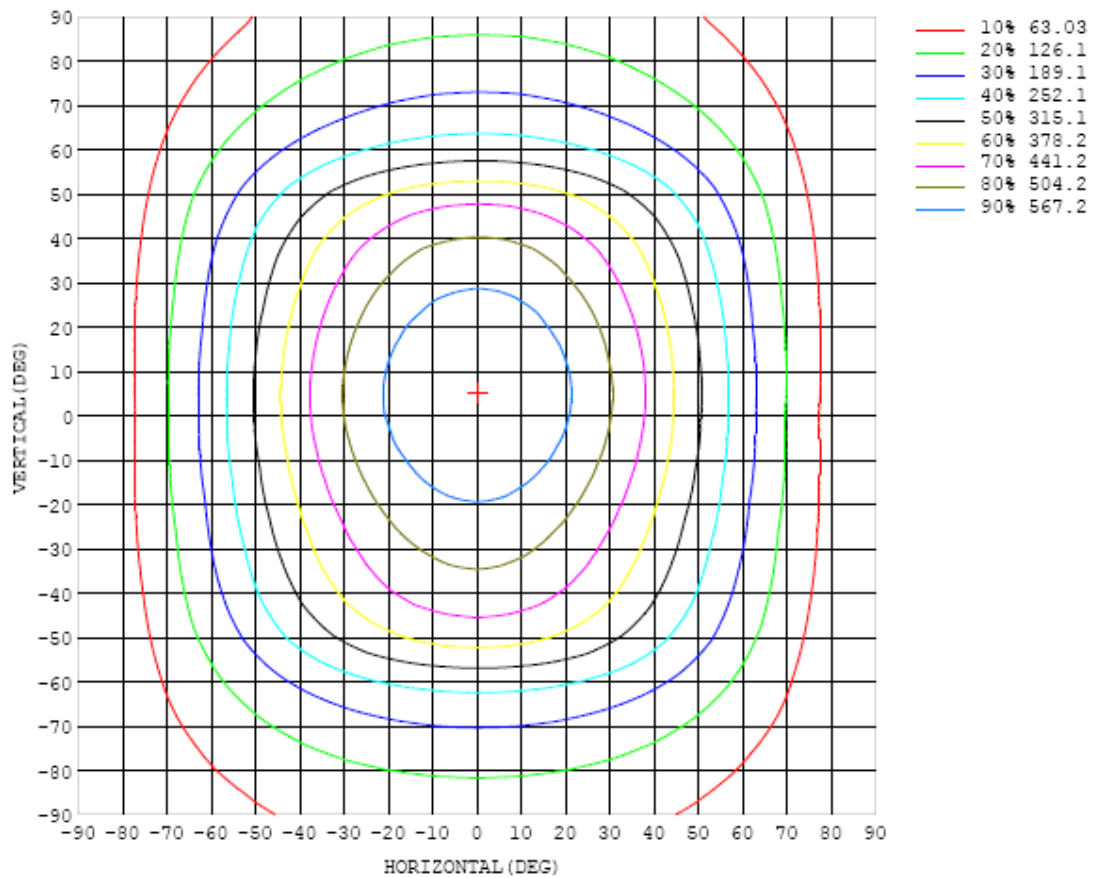


Chart 6: Isocandela Plot

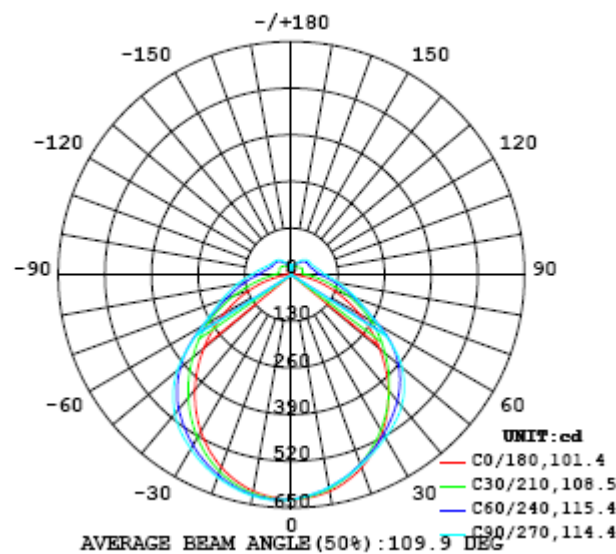


Chart 7: Polar Candela Distribution

## Luminous Intensity Data- Goniophotometer Method

Table--1

UNIT: cd

C (DEG) y (DEG)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
0	626	626	626	626	626	626	626	626	626	626	626	626	626	626	626	626	626	626	626
5	623	622	619	619	618	617	616	617	616	616	617	617	617	618	618	619	621	621	623
10	613	610	608	606	604	603	602	602	601	602	602	602	602	603	602	604	607	608	613
15	596	592	589	586	585	584	584	584	584	584	584	584	584	584	585	587	588	591	595
20	572	568	564	562	561	561	562	564	565	565	565	564	563	562	561	561	564	566	571
25	542	537	533	532	533	536	538	542	544	545	544	542	540	536	533	531	532	535	541
30	507	501	498	500	502	508	513	520	522	524	524	519	514	507	502	498	497	499	505
35	466	461	459	463	469	479	487	496	501	503	501	495	488	478	468	461	457	458	464
40	421	416	417	423	435	447	459	470	475	477	475	470	460	447	433	422	415	413	418
45	372	369	372	383	398	415	428	438	443	445	442	437	428	414	398	381	370	366	370
50	322	319	326	341	361	378	389	397	401	403	401	396	389	377	361	340	325	316	319
55	270	269	280	299	320	334	343	346	344	343	343	344	342	333	319	299	279	267	268
60	219	220	235	257	274	284	283	281	279	278	278	279	281	282	273	256	234	218	217
65	169	173	192	212	224	227	228	229	229	229	228	228	227	225	222	211	192	172	168
70	122	129	150	166	174	181	185	189	191	192	191	188	184	179	173	164	150	129	122
75	80.3	90.2	110	123	134	144	151	157	160	161	160	157	151	143	133	122	109	90.7	79.6
80	44.2	57.1	72.6	87.6	102	114	123	129	133	134	133	129	123	113	102	87.8	72.5	57.3	43.4
85	16.1	27.3	43.8	60.4	75.5	88.9	99.1	107	111	112	111	106	99.5	89.1	76.1	61.3	44.5	27.8	16.1
90	0.31	9.22	24.2	40.6	56.3	69.6	80.2	87.9	92.3	93.7	92.3	88.1	80.8	70.3	57.5	42.0	25.7	10.4	0.34
95	1.16	6.19	19.2	34.4	49.4	62.5	72.3	79.9	84.0	85.5	84.2	80.1	73.2	63.6	50.9	36.2	21.2	8.13	1.99
100	2.34	8.50	18.3	31.6	45.2	57.3	67.0	73.6	77.7	79.2	77.6	74.0	67.7	58.7	47.0	33.8	20.9	10.9	3.54
105	3.63	10.6	20.3	31.1	42.8	53.6	62.3	68.3	72.0	73.2	72.1	68.6	63.2	54.9	44.7	33.4	23.4	12.7	5.34
110	5.47	9.02	22.5	32.4	42.3	51.2	58.5	64.0	67.0	68.1	67.2	64.5	59.5	52.6	44.3	35.2	26.3	12.5	7.47
115	7.39	9.87	23.5	33.8	43.0	50.7	56.4	60.7	63.3	64.3	63.5	61.1	57.5	52.2	45.4	37.4	27.1	13.3	9.62
120	9.21	12.4	22.6	34.6	43.5	50.8	56.1	59.8	61.7	62.5	61.9	60.4	57.3	52.6	46.5	38.0	25.2	14.7	11.7
125	10.9	14.1	21.5	33.9	43.3	50.5	55.6	59.2	61.2	62.1	61.5	59.9	57.0	52.6	46.2	36.8	24.2	16.8	13.7
130	12.0	16.1	20.6	31.4	42.0	49.1	54.5	57.9	60.1	60.8	60.4	58.8	55.9	51.3	44.3	34.0	23.8	18.7	15.4
135	13.2	17.8	21.7	29.1	38.2	46.7	52.0	55.6	57.8	58.7	58.2	56.4	53.4	48.9	41.1	31.6	24.2	20.2	16.4
140	14.1	19.1	22.4	27.0	34.7	42.0	48.3	52.0	54.0	54.9	54.4	52.7	49.7	44.3	37.3	29.9	25.1	21.8	17.5
145	14.7	19.6	22.9	26.7	31.7	37.5	42.4	46.1	48.6	49.6	48.9	46.9	43.7	39.4	34.2	29.2	25.5	22.5	18.4
150	15.7	20.1	23.8	26.8	29.4	33.7	37.5	40.2	42.0	42.7	42.2	40.9	38.5	35.4	31.7	28.4	25.8	23.4	19.1
155	16.1	20.5	24.8	26.3	28.9	31.0	33.1	35.3	36.7	37.2	36.9	35.9	34.2	32.2	30.2	27.9	26.1	24.1	19.5
160	15.7	21.4	24.5	26.5	27.9	29.6	31.0	31.9	32.6	32.9	32.6	32.3	31.6	30.5	28.9	27.6	25.3	23.7	19.5
165	15.1	17.9	22.8	26.1	27.5	28.4	29.0	29.7	30.3	30.5	30.3	29.9	29.5	28.9	28.1	26.7	25.1	22.0	18.6
170	13.9	14.2	15.4	17.6	25.2	27.4	28.2	28.5	28.6	28.8	28.7	28.5	28.3	25.6	23.5	21.8	20.0	18.4	17.6
175	13.3	13.3	13.3	13.2	13.1	14.7	19.1	23.5	26.9	28.2	24.9	18.6	17.2	16.8	16.6	16.6	16.7	16.7	16.8
180	6.20	6.21	6.23	6.27	6.32	6.38	6.45	6.52	6.60	6.68	6.68	6.68	6.68	6.67	6.67	6.66	6.66	6.66	6.66

Table 6: Luminous Intensity Data

Table--2

UNIT: cd

C (DEG) y (DEG)	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350		
0	626	626	626	626	626	626	626	626	626	626	626	626	626	626	626	626	626		
5	624	625	626	627	628	629	630	629	630	629	630	629	628	628	627	624	624		
10	615	617	619	621	622	624	624	625	626	626	625	624	623	622	620	619	616		
15	599	601	605	608	610	612	613	615	615	616	614	613	610	609	606	601	598		
20	576	579	584	588	592	594	598	600	601	600	599	597	593	589	586	580	576		
25	546	551	557	562	569	574	579	582	583	582	579	576	569	563	558	552	548		
30	511	517	524	533	542	549	555	559	561	560	556	551	542	534	527	520	513		
35	470	478	487	498	510	520	529	534	537	535	530	522	511	501	490	481	473		
40	425	434	448	461	476	489	499	503	506	505	500	490	478	464	450	438	429		
45	378	389	404	422	440	451	460	465	466	465	461	453	442	426	408	391	380		
50	327	341	360	381	396	406	413	416	416	416	414	408	398	385	363	344	330		
55	276	292	315	334	346	351	351	348	347	349	352	353	349	337	318	295	279		
60	226	245	268	283	288	286	285	285	286	287	287	289	291	286	271	248	229		
65	178	200	219	227	230	233	237	240	241	240	238	236	233	231	222	204	180		
70	134	156	169	177	185	192	200	205	207	206	202	195	187	180	172	159	136		
75	93.9	113	126	138	151	161	170	176	178	177	171	163	153	141	128	116	96.1		
80	59.1	75.2	91.2	107	122	135	145	151	153	152	146	136	124	109	93.3	77.4	60.9		
85	28.7	46.3	64.5	82.2	98.3	111	122	128	130	129	123	113	99.8	83.8	66.2	48.0	30.2		
90	11.3	28.5	46.8	64.4	80.2	92.9	102	108	110	109	103	94.0	80.9	65.3	47.6	29.2	11.8		
95	8.11	23.0	39.8	56.2	70.8	82.6	91.3	96.6	98.4	97.0	91.9	83.4	71.5	56.9	40.3	23.2	7.67		
100	11.3	21.7	36.0	50.2	63.2	73.8	81.4	86.0	87.8	86.4	81.9	74.4	63.6	50.4	35.7	20.9	9.54		
105	12.8	23.6	35.0	46.9	57.9	66.7	73.2	77.2	78.6	77.4	73.5	66.9	57.7	46.4	33.8	21.8	11.1		
110	14.7	26.1	36.7	45.9	54.5	61.9	67.4	70.5	71.8	70.8	67.4	61.8	54.0	44.5	34.1	23.4	12.9		
115	16.5	26.8	37.0	46.6	53.7	58.9	62.9	65.5	66.5	65.6	62.9	58.4	52.4	44.3	33.8	23.5	15.1		
120	18.0	27.3	38.0	45.9	53.2	57.9	61.2	62.8	63.5	62.9	60.9	57.2	51.7	43.0	34.9	23.2	14.8		
125	19.3	27.3	37.2	46.0	52.2	56.8	59.7	61.3	61.9	61.1	59.2	55.7	49.9	43.4	33.5	23.5	16.3		
130	21.0	27.0	35.5	43.8	50.5	55.2	58.0	59.5	59.8	58.9	57.1	53.9	49.1	41.4	31.9	24.3	18.0		
135	22.3	26.9	33.9	40.5	47.8	52.6	55.5	57.0	57.5	56.7	54.8	51.4	46.0	38.3	30.6	24.1	19.7		
140	23.3	26.0	32.2	37.5	42.9	48.6	52.1	53.6	53.9	53.0	50.7	47.3	41.4	35.4	29.8	23.5	21.2		
145	24.2	25.8	30.5	35.2	38.9	42.8	46.3	48.1	48.7	47.8	45.3	41.9	37.4	33.2	28.6	23.7	22.2		
150	24.7	26.1	28.2	33.0	35.9	38.4	41.0	42.2	42.6	42.0	40.4	38.0	34.7	31.5	27.9	25.0	23.1		
155	24.0	26.7	27.6	29.4	32.6	35.1	37.0	37.7	38.1	37.6	36.6	35.1	32.5	30.2	27.4	25.9	22.1		
160	22.5	26.6	27.9	28.2	28.7	30.1	33.7	34.6	34.8	34.5	33.9	32.9	31.2	29.1	28.1	26.7	22.8		
165	18.7	24.6	27.2	28.2	28.5	28.7	27.6	31.2	32.2	32.1	31.8	31.1	29.7	28.9	28.2	26.0	20.4		
170	17.4	17.7	19.7	21.7	23.2	25.9	28.4	27.9	27.4	28.4	29.8	30.0	29.2	28.3	24.1	16.7	15.2		
175	16.8	16.8	16.8	16.7	16.7	16.8	17.0	17.7	22.3	26.9	24.5	21.4	17.9	13.6	13.0	13.2	13.4		
180	6.66	6.66	6.66	6.67	6.67	6.68	6.68	6.68	6.68	6.60	6.52	6.45	6.38	6.32	6.27	6.23	6.21		

Table 7: Luminous Intensity Data



## EQUIPMENT LIST

Test Equipment	Model	Equipment No.	Calibration Date	Calibration Due date
Goniophotometer system	GO-R5000	HZTE011-01	Aug. 14, 2018	Aug. 13, 2019
Digital Power Meter	PF2010A	HZTE028-01	Sep. 12, 2018	Sep. 11, 2019
AC Power Supply	DPS1060	HZTE001-06	Aug. 09, 2018	Aug. 08, 2019
DC Power Supply	WY12010	HZTE004-03	Aug. 09, 2018	Aug. 08, 2019
Temperature recorder	JM624U	HZTE018-08	Aug. 09, 2018	Aug. 08, 2019
Temperature and humidity recorder	JR900	HZTE018-01	Aug. 09, 2018	Aug. 08, 2019
Standard source	D908	HZTE012-01	Aug. 14, 2018	Aug. 13, 2019
Integrate Sphere system	3M	HZTE015-04	Aug. 16, 2018	Aug. 15, 2019
Digital Power Meter	WT210	HZTE008-01	Aug. 02, 2018	Aug. 01, 2019
AC Power Supply	PCR 500L	HZTE001-07	Aug. 09, 2018	Aug. 08, 2019
DC Power Supply	IT6154	HZTE004-04	Aug. 09, 2018	Aug. 08, 2019
Standard source	SCL-1400	HZTE012-02	Aug. 16, 2018	Aug. 15, 2019
Temperature and humidity recorder	JR900	HZTE018-02	Aug. 09, 2018	Aug. 08, 2019
Temperature Meter	TES1310	HZTE017-01	Aug. 09, 2018	Aug. 08, 2019

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  $4\pi$ . 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 expanded uncertainty is 2.1% 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 expanded uncertainty is 2.3% 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 ( $C=0^\circ/180^\circ$  and  $C=90^\circ/270^\circ$ ) and at  $10^\circ$  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,  $\Delta u'v'$ , 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 \*\*\*

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