



## LM-79-08 Test Report

for

### GREEN CREATIVE LTD

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

### PLS Lamp

**Model: 6PLS/840/HYB/GX23/R**

### Laboratory: Leading Testing Laboratories

**NVLAP CODE: 200960-0**

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Report No.: HZ17030063b

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

Review by:

*April Zou*

Engineer: April Zou  
Mar. 23, 2017

Approved by:



*Jim Zhang*

Manager: Jim Zhang  
Mar. 23, 2017

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: 3.5FBA10DIM/824/FT/A/R

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)	Power Factor
114.3	692.8	6.06	0.9749
CCT (K)	CRI	Stabilization Time (Light & Power)	
3970	82.7	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. 21, 2017

**Date of Test** : Mar. 21, 2017

**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)

<b>Name</b>	: PLS Lamp
<b>Model</b>	: 6PLS/840/HYB/GX23/R
<b>Electrical Ratings</b>	: 120-277V, 60Hz
<b>Product Description</b>	: CRI80, 4000K
<b>Manufacturer</b>	: GREEN CREATIVE LTD
<b>Address</b>	: 756 North Zhongshan Rd., Unit B301 Zhabei District, Shanghai

## TEST RESULTS

Test ambient temperature was 25.0°C.

Base orientation was Base up. 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 70 minutes.

### Sphere-Spectroradiometer Method

Parameter	Result	
Test Voltage (V)	120.0	277.0
Voltage frequency (Hz)	60	60
Test Current (A)	0.052	0.025
Power Factor	0.9749	0.8936
Test Power (W)	6.06	6.21
THD A%	20.38	26.44
Luminous Efficacy (lm/W)	114.3	111.3
Total Luminous Flux (lm)	692.8	691.3
Color Rendering Index (CRI)	82.7	
R9	8.3	
Correlated Color Temperature (CCT)(K)	3970	
Chromaticity Chroma x	0.3816	
Chromaticity Chroma y	0.3771	
Chromaticity Chroma u	0.2257	
Chromaticity Chroma v	0.3346	
Duv	0.0002	
Chromaticity Chroma u'	0.2257	
Chromaticity Chroma v'	0.5019	

Special Color Rendering Indices	
R1	81
R2	90
R3	95.2
R4	80.1
R5	80.8
R6	85.4
R7	85.3
R8	63.7
R9	8.3
R10	75.5
R11	78.3
R12	60.9
R13	83.5
R14	97.7
Rf	81
Rg	94

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 24.6°C.

The photometric distance is 2.47m.

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)	0.052
Power Factor	0.9758
Test Power (W)	6.06
Luminous Efficacy (lm/W)	115.6
Total Luminous Flux (lm)	700.5
Beam Angle (°)	112.6
Center Beam Candle Power (cd)	214
Spacing Criteria	1.18 (0°-180°)/ 1.26 (90°-270°)
Zonal Lumens in the 0°-60°Zone	67.07%
Zonal Lumens in the 60°-90°Zone	24.80%
Zonal Lumens in the 90°-120°Zone	6.97%
Zonal Lumens in the 120°-180°Zone	1.16%

Table 3: Test data per Goniophotometer Method

## Spectral Power Distribution - Sphere Spectroradiometer Method

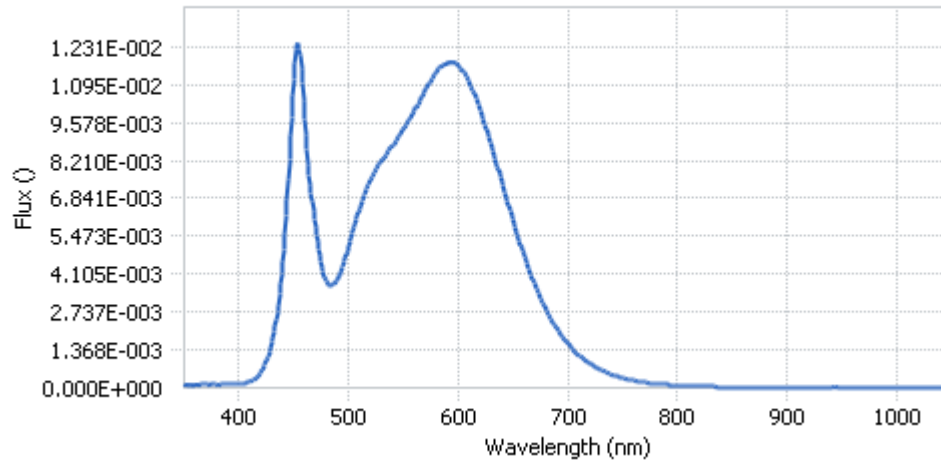


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	1.09E-04	485	3.69E-03	590	1.18E-02	695	1.85E-03
385	1.08E-04	490	3.93E-03	595	1.17E-02	700	1.60E-03
390	1.20E-04	495	4.44E-03	600	1.16E-02	705	1.38E-03
395	1.30E-04	500	5.12E-03	605	1.14E-02	710	1.19E-03
400	1.35E-04	505	5.81E-03	610	1.11E-02	715	1.02E-03
405	1.75E-04	510	6.45E-03	615	1.06E-02	720	8.83E-04
410	2.33E-04	515	7.04E-03	620	1.01E-02	725	7.54E-04
415	3.45E-04	520	7.50E-03	625	9.47E-03	730	6.52E-04
420	5.68E-04	525	7.89E-03	630	8.82E-03	735	5.58E-04
425	9.87E-04	530	8.19E-03	635	8.12E-03	740	4.82E-04
430	1.66E-03	535	8.49E-03	640	7.44E-03	745	4.14E-04
435	2.74E-03	540	8.77E-03	645	6.73E-03	750	3.61E-04
440	4.55E-03	545	9.06E-03	650	6.08E-03	755	3.10E-04
445	7.49E-03	550	9.35E-03	655	5.43E-03	760	2.66E-04
450	1.11E-02	555	9.67E-03	660	4.82E-03	765	2.30E-04
455	1.23E-02	560	1.00E-02	665	4.25E-03	770	1.98E-04
460	9.72E-03	565	1.04E-02	670	3.75E-03	775	1.70E-04
465	7.28E-03	570	1.08E-02	675	3.28E-03	780	1.46E-04
470	5.77E-03	575	1.11E-02	680	2.86E-03		
475	4.53E-03	580	1.14E-02	685	2.48E-03		
480	3.82E-03	585	1.16E-02	690	2.15E-03		

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

## Chromaticity Diagram - Sphere Spectroradiometer Method

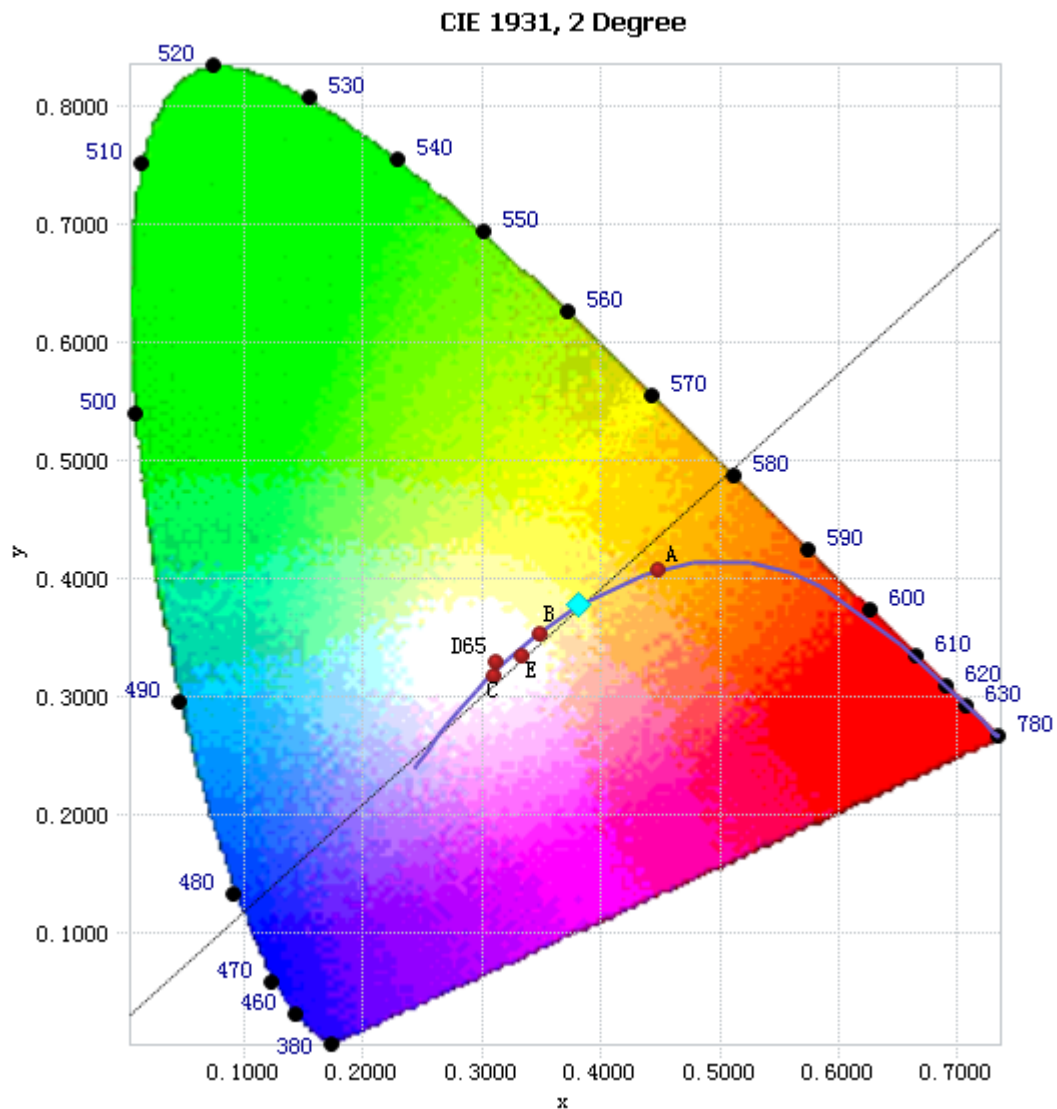


Chart 2: Chromaticity Diagram per Sphere - Spectroradiometer Method

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



## Nominal CCT Quadrangles – Sphere Spectroradiometer Method

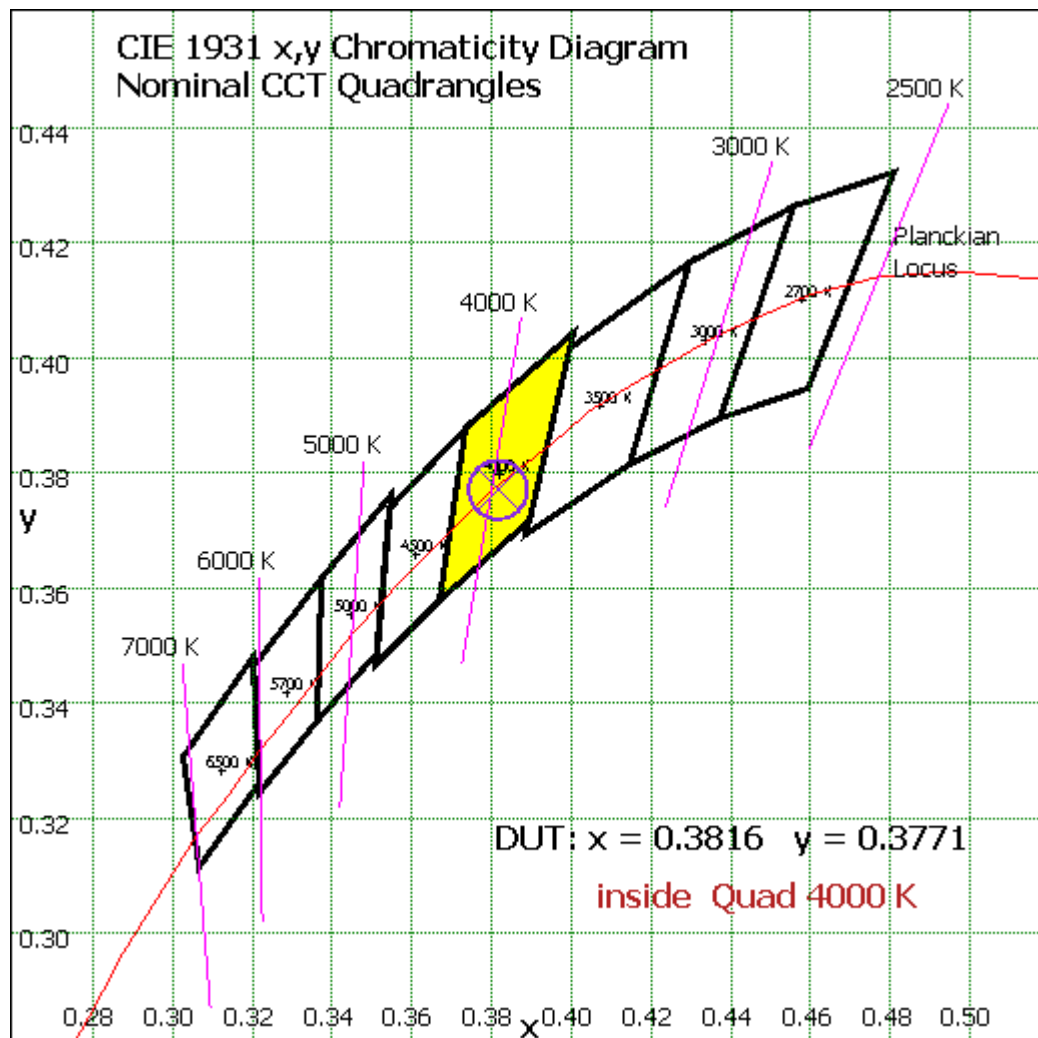


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

### Zonal Lumen Tabulation- Goniophotometer Method

$\gamma(^{\circ})$	Lumens	% Total
0- 10	20.216	2.89%
10- 20	57.483	8.21%
20- 30	86.029	12.28%
30- 40	102.421	14.62%
40- 50	105.959	15.13%
50- 60	97.7	13.95%
60- 70	80.256	11.46%
70- 80	57.518	8.21%
80- 90	35.949	5.13%
90-100	23.025	3.29%
100-110	15.783	2.25%
110-120	10.016	1.43%
120-130	5.01	0.72%
130-140	1.941	0.28%
140-150	0.745	0.11%
150-160	0.288	0.04%
160-170	0.097	0.01%
170-180	0.021	0.00%
Total	700.5	100%

$\gamma(^{\circ})$	Lumens	% Total
0- 60	469.808	67.07%
60- 90	173.723	24.80%
0-90	643.531	91.87%
90- 180	56.926	8.13%
0- 180	700.5	100%

Table 5: Zonal Lumen Data

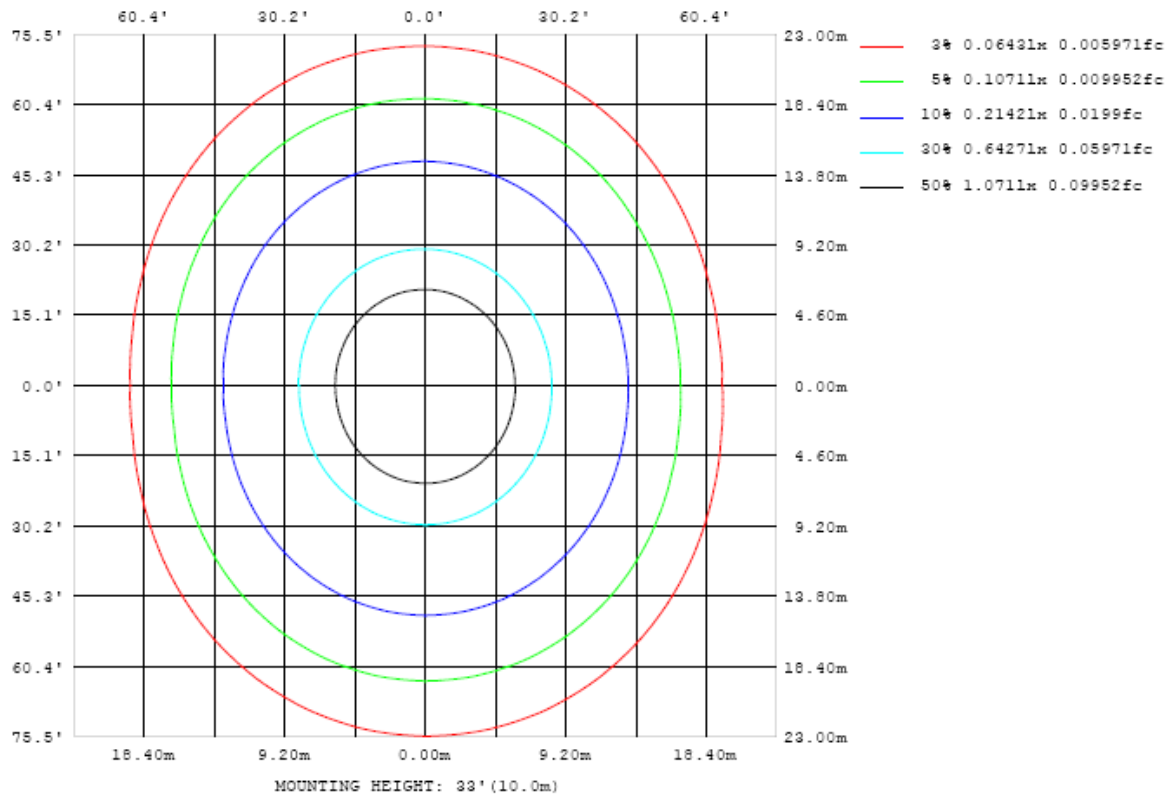


Chart 4: Illuminance Plot (Footcandles)

## Luminous Intensity Distribution Plots- Goniophotometer Method

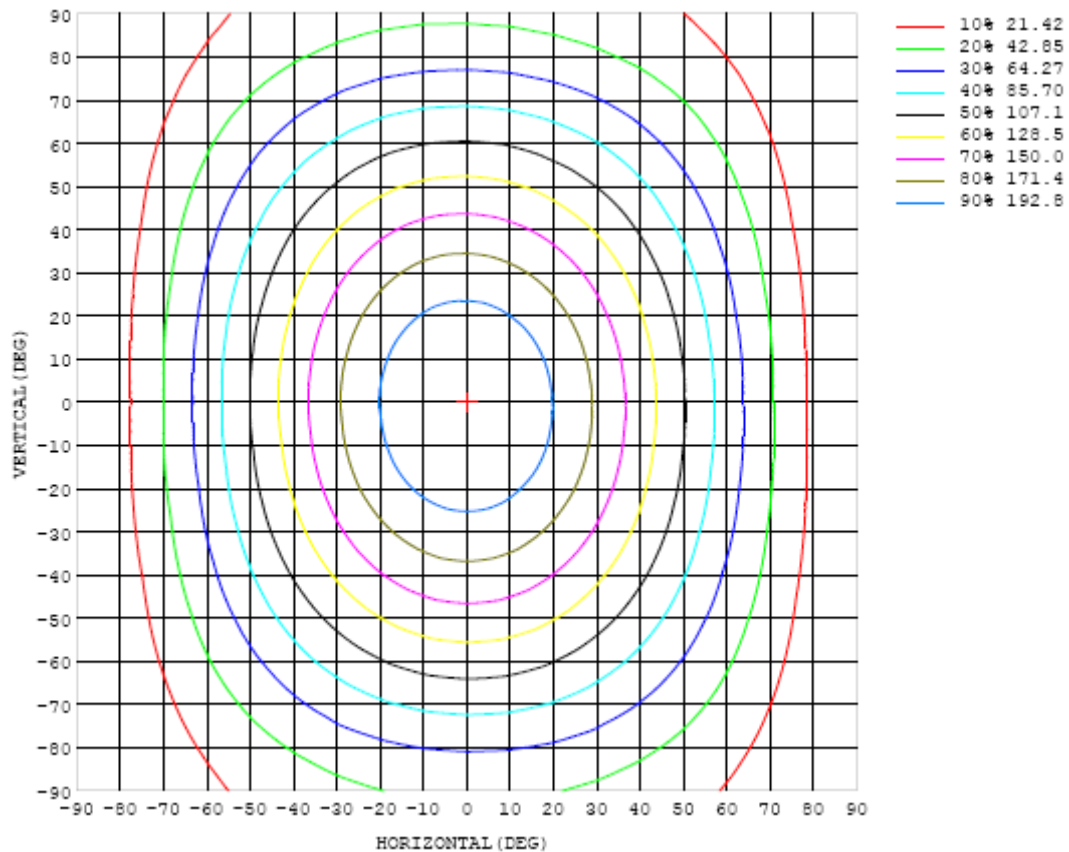


Chart 5: Isocandela Plot

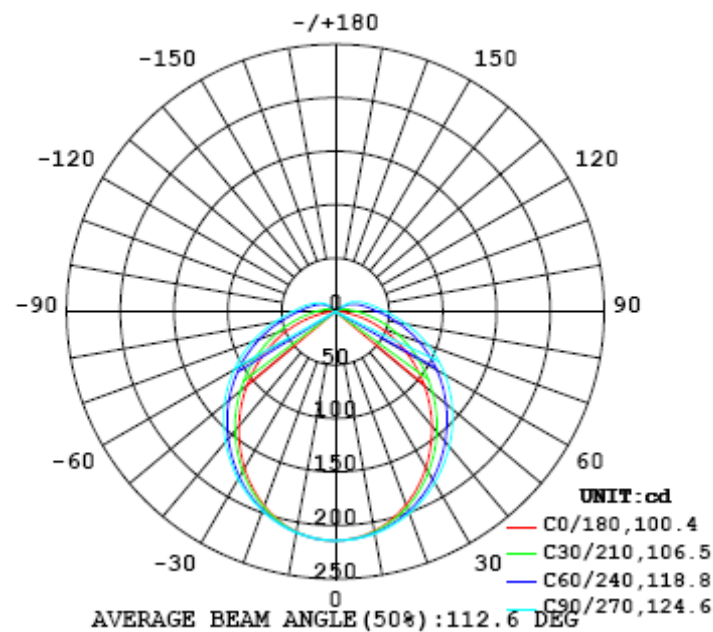


Chart 6: Polar Candela Distribution

## 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	214	214	214	214	214	214	214	214	214	214	214	214	214	214	214	214	214	214	214
5	213	212	213	213	213	213	213	213	213	214	213	213	213	213	213	213	213	213	213
10	208	208	209	209	209	210	210	211	211	211	211	211	211	210	210	209	209	209	209
15	201	202	202	203	204	205	205	206	207	207	207	206	206	205	204	203	203	202	202
20	192	193	194	195	196	197	199	200	200	201	201	200	199	198	196	195	194	193	193
25	181	182	183	185	187	189	191	192	193	193	193	192	191	189	187	185	183	182	182
30	168	169	171	173	176	178	181	183	184	185	184	183	181	178	176	173	171	169	169
35	154	155	157	160	164	167	170	173	175	175	175	173	170	167	163	160	157	155	155
40	140	141	143	147	151	155	159	162	164	165	164	162	158	154	150	146	142	140	140
45	124	125	128	133	137	142	147	151	153	154	153	150	146	141	136	131	127	124	124
50	108	110	113	118	124	129	134	139	141	142	141	138	133	128	122	116	111	108	107
55	92.2	94.0	98.1	104	110	116	122	126	129	130	129	125	120	114	108	101	95.9	92.0	91.0
60	76.3	78.4	83.1	89.2	96.0	103	109	114	117	118	116	113	107	101	93.5	86.6	80.5	76.0	74.7
65	60.4	63.1	68.4	75.1	82.4	89.6	96.0	101	104	105	104	99.8	94.2	87.2	79.7	72.1	65.3	60.1	58.8
70	45.0	48.6	54.5	61.7	69.3	76.6	83.1	88.2	91.2	91.9	90.5	86.7	81.1	74.1	66.2	58.4	51.2	45.3	43.1
75	30.5	34.5	41.2	49.1	57.0	64.2	70.5	75.5	78.3	79.0	77.7	74.0	68.4	61.6	53.8	45.5	37.5	30.8	28.5
80	17.3	21.8	29.2	37.5	45.4	52.7	58.8	63.2	65.9	66.6	65.3	61.9	56.7	49.9	42.0	33.6	25.4	18.2	15.8
85	6.78	11.7	19.3	27.6	35.3	42.3	48.2	52.6	55.1	55.7	54.5	51.3	46.3	39.8	32.2	24.2	15.9	8.70	6.28
90	1.05	5.64	12.6	20.2	27.5	34.0	39.6	43.7	45.9	46.5	45.4	42.6	38.1	32.2	25.3	17.7	10.1	3.36	1.16
95	0.13	2.96	8.58	15.4	22.1	28.0	33.1	36.9	39.0	39.7	38.8	36.3	32.3	26.9	20.4	13.6	6.89	1.96	0.49
100	0.25	1.88	6.05	12.0	18.1	23.6	28.2	31.7	33.8	34.4	33.7	31.4	27.6	22.7	16.9	10.7	5.23	1.55	0.34
105	0.19	1.85	4.60	9.10	14.7	19.8	24.1	27.3	29.2	29.9	29.1	27.1	23.6	19.0	13.7	8.39	3.91	1.02	0.21
110	0.14	1.01	3.68	7.10	11.5	16.3	20.3	23.3	25.1	25.7	25.1	23.1	20.0	15.7	10.6	5.77	2.35	0.61	0.14
115	0.16	0.73	2.36	4.83	8.26	12.7	16.7	19.6	21.3	21.9	21.3	19.5	16.4	11.6	6.55	3.39	1.31	0.29	0.03
120	0.23	0.63	1.66	3.36	5.34	8.10	12.1	15.5	17.3	17.9	17.2	15.1	11.1	6.45	3.66	2.09	0.88	0.23	0.07
125	0.32	0.60	1.28	2.38	3.72	5.20	6.83	9.13	11.3	11.9	10.9	8.47	5.96	3.84	2.41	1.43	0.63	0.20	0.09
130	0.39	0.58	1.05	1.78	2.67	3.50	4.43	5.53	6.33	6.45	5.93	4.96	3.73	2.51	1.64	1.01	0.48	0.18	0.11
135	0.43	0.56	0.89	1.39	1.98	2.53	3.04	3.56	3.89	3.92	3.71	3.22	2.50	1.72	1.13	0.72	0.37	0.17	0.14
140	0.37	0.48	0.72	1.08	1.48	1.81	2.05	2.29	2.52	2.60	2.49	2.20	1.77	1.24	0.80	0.54	0.30	0.17	0.16
145	0.25	0.25	0.39	0.62	0.88	1.13	1.36	1.57	1.72	1.79	1.76	1.61	1.32	0.94	0.60	0.41	0.26	0.18	0.18
150	0.23	0.20	0.29	0.45	0.63	0.81	0.96	1.09	1.20	1.24	1.21	1.10	0.92	0.69	0.48	0.34	0.24	0.19	0.19
155	0.19	0.19	0.25	0.35	0.46	0.58	0.68	0.77	0.84	0.86	0.85	0.78	0.68	0.54	0.40	0.28	0.23	0.23	0.24
160	0.18	0.18	0.22	0.28	0.35	0.42	0.48	0.54	0.58	0.60	0.60	0.56	0.50	0.42	0.35	0.29	0.23	0.24	0.26
165	0.19	0.19	0.21	0.23	0.27	0.31	0.35	0.38	0.40	0.41	0.41	0.40	0.37	0.33	0.30	0.27	0.24	0.24	0.24
170	0.20	0.20	0.21	0.22	0.24	0.25	0.27	0.28	0.29	0.29	0.29	0.27	0.19	0.19	0.21	0.21	0.19	0.20	0.21
175	0.21	0.21	0.21	0.20	0.20	0.21	0.21	0.19	0.19	0.23	0.23	0.23	0.23	0.21	0.19	0.19	0.19	0.19	0.19
180	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17

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	214	214	214	214	214	214	214	214	214	214	214	214	214	214	214	214	214		
5	213	213	213	213	213	213	213	213	213	213	213	213	213	213	212	213	213		
10	209	209	209	209	210	210	210	210	210	210	210	209	209	209	208	208	208		
15	202	203	203	204	204	205	205	205	205	205	204	204	203	203	202	202	201		
20	193	194	195	196	197	197	198	198	198	198	197	196	195	194	193	193	192		
25	182	183	184	186	187	189	190	190	190	190	189	187	186	184	183	182	181		
30	170	171	172	174	177	179	180	181	181	180	179	177	175	173	171	169	169		
35	155	157	159	162	165	167	169	170	170	170	168	165	163	160	157	156	154		
40	141	142	145	148	152	155	157	159	159	158	156	153	150	146	143	141	140		
45	125	127	131	135	139	142	145	147	147	146	143	140	137	133	129	126	124		
50	109	112	115	120	125	129	133	135	135	133	131	127	123	118	114	111	109		
55	92.6	95.6	100	106	111	116	119	121	122	120	117	113	109	104	98.8	95.0	92.4		
60	76.6	80.3	85.2	91.3	97.0	102	106	108	109	107	104	99.8	94.5	88.7	83.5	79.2	76.6		
65	60.9	65.0	70.7	77.0	83.2	88.5	92.6	94.8	95.3	94.1	90.8	86.3	81.1	75.0	69.2	64.1	60.9		
70	45.7	50.7	56.9	63.5	69.9	75.4	79.4	81.6	82.0	80.7	77.5	72.9	67.7	61.5	55.4	49.6	45.6		
75	31.5	37.3	44.1	50.8	57.3	62.7	66.5	68.7	69.1	67.9	65.0	60.7	55.2	49.0	42.4	36.1	31.4		
80	19.3	25.7	32.7	39.6	46.0	51.2	55.1	57.1	57.3	56.3	53.4	49.2	44.0	37.7	30.9	24.0	18.6		
85	10.1	16.7	23.8	30.6	36.6	41.6	45.2	47.2	47.4	46.4	43.7	39.5	34.4	28.3	21.5	14.5	8.37		
90	4.88	11.2	18.0	24.4	30.0	34.6	37.9	39.6	39.7	38.7	36.2	32.4	27.4	21.5	15.1	8.57	2.82		
95	2.81	7.87	14.0	20.0	25.2	29.5	32.5	34.0	34.1	33.1	30.7	27.0	22.5	17.1	11.2	5.47	1.26		
100	1.91	5.89	11.2	16.6	21.4	25.3	28.1	29.5	29.7	28.7	26.4	23.1	18.9	13.8	8.53	3.76	0.79		
105	1.29	4.43	8.94	13.7	18.1	21.7	24.3	25.6	25.8	24.9	22.8	19.7	15.8	11.2	6.63	2.63	0.46		
110	0.69	3.07	7.12	11.4	15.3	18.6	20.9	22.1	22.2	21.4	19.5	16.7	13.1	9.09	5.11	1.81	0.26		
115	0.36	1.72	5.05	9.31	12.8	15.8	17.9	19.0	19.1	18.3	16.6	14.0	10.8	7.28	3.48	1.13	0.30		
120	0.25	0.89	3.13	7.01	10.5	13.2	15.1	16.1	16.2	15.5	13.9	11.6	8.78	5.09	1.86	0.63	0.32		
125	0.21	0.64	1.80	4.40	7.83	10.6	12.4	13.3	13.5	12.8	11.4	9.29	6.18	2.94	1.35	0.75	0.36		
130	0.19	0.48	1.22	2.64	4.72	7.28	9.44	10.5	10.6	10.0	8.57	6.11	3.60	1.50	0.93	0.70	0.39		
135	0.19	0.37	0.92	1.82	2.98	4.32	5.58	6.54	6.81	6.20	5.00	3.63	2.20	1.34	0.93	0.56	0.41		
140	0.20	0.31	0.72	1.40	2.07	2.84	3.53	3.98	4.11	3.81	3.18	2.47	1.75	1.14	0.76	0.47	0.36		
145	0.22	0.27	0.52	1.05	1.55	2.01	2.39	2.67	2.74	2.58	2.29	1.94	1.35	0.88	0.62	0.43	0.34		
150	0.24	0.26	0.40	0.74	1.12	1.42	1.67	1.84	1.90	1.84	1.66	1.41	0.97	0.70	0.53	0.40	0.33		
155	0.27	0.29	0.38	0.54	0.76	0.96	1.11	1.21	1.25	1.21	1.10	0.94	0.67	0.52	0.41	0.32	0.26		
160	0.31	0.32	0.36	0.42	0.52	0.62	0.70	0.76	0.79	0.77	0.71	0.54	0.45	0.37	0.29	0.25	0.24		
165	0.27	0.28	0.32	0.34	0.37	0.39	0.42	0.46	0.47	0.42	0.39	0.39	0.37	0.31	0.27	0.25	0.24		
170	0.25	0.26	0.27	0.28	0.27	0.24	0.24	0.24	0.28	0.31	0.31	0.30	0.29	0.28	0.26	0.25	0.24		
175	0.19	0.21	0.21	0.21	0.20	0.20	0.21	0.22	0.21	0.23	0.24	0.23	0.22	0.22	0.23	0.23	0.20		
180	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17		

Table 7: Luminous Intensity Data

## EQUIPMENT LIST

Test Equipment	Model	Equipment No.	Calibration Date	Calibration Due date
Goniophotometer system	GO-R5000	HZTE011-01	Jul. 27, 2016	Jul. 26, 2017
Digital Power Meter	PF2010A	HZTE028-01	Jul. 27, 2016	Jul. 26, 2017
AC Power Supply	PCR 500L	HZTE001-08	Jul. 27, 2016	Jul. 26, 2017
DC Power Supply	WY12010	HZTE004-03	Jul. 27, 2016	Jul. 26, 2017
Temperature Meter	TES1310	HZTE017-01	Jul. 27, 2016	Jul. 26, 2017
Standard source	D908	HZTE012-01	Jul. 27, 2016	Jul. 26, 2017
Integrate Sphere system	2M	HZTE015-01	Jul. 27, 2016	Jul. 26, 2017
Digital Power Meter	WT210	HZTE008-01	Jul. 27, 2016	Jul. 26, 2017
AC Power Supply	PCR 500L	HZTE001-07	Jul. 27, 2016	Jul. 26, 2017
DC Power Supply	6154	HZTE004-04	Jul. 27, 2016	Jul. 26, 2017
Temperature and humidity recorder	JR900	HZTE018-01	Jul. 27, 2016	Jul. 26, 2017
Standard source	SCL-1400	HZTE012-02	Jul. 27, 2016	Jul. 26, 2017

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 FA19 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 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 FA19 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 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 ( $C=0^\circ/180^\circ$  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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