



## LM-79-08 Test Report

for

### Revolution Lighting Technologies, Inc.

2280 Ward Ave. Simi Valley, CA 93065

### LED Tube

Model: 203101-111

### Laboratory: Leading Testing Laboratories

NVLAP CODE: 200960-0

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Report No.: HZ18110016m

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

Review by:

Engineer: April Zou  
Nov. 21, 2018

Approved by:



Manager: Jim Zhang  
Nov. 21, 2018

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: 203101-111

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)	Power Factor
130.9	1882.0	14.38	0.9812
CCT (K)	CRI	Stabilization Time (Light & Power)	
2925	82.6	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** : Nov. 12, 2018

**Date of Test** : Nov. 13, 2018

**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 Photo



Figure 1- Overview of the sample

### Equipment Under Test (EUT)

<b>Name</b>	: LED Tube
<b>Model</b>	: 203101-111
<b>Electrical Ratings</b>	: 120-277V, 60Hz
<b>Product Description</b>	: 3000K
<b>Manufacturer</b>	: Revolution Lighting Technologies, Inc.
<b>Address</b>	: 2280 Ward Ave. Simi Valley, CA 93065

## TEST RESULTS

Test ambient temperature was 25.0°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
Voltage frequency (Hz)	60	60
Test Current (A)	0.122	0.056
Power Factor	0.9812	0.9542
Test Power (W)	14.38	14.83
THD A%	18.32	21.05
Luminous Efficacy (lm/W)	130.9	127.6
Total Luminous Flux (lm)	1882.0	1893.0
Color Rendering Index (CRI)	82.6	
R9	7.1	
Correlated Color Temperature (CCT)(K)	2925	
Chromaticity Chroma x	0.4407	
Chromaticity Chroma y	0.4027	
Chromaticity Chroma u	0.2536	
Chromaticity Chroma v	0.3476	
Duv	0.0013	
Chromaticity Chroma u'	0.2536	
Chromaticity Chroma v'	0.5214	

Special Color Rendering Indices	
R1	81.7
R2	93
R3	93.7
R4	79.7
R5	82.2
R6	92.1
R7	80.8
R8	57.4
R9	7.1
R10	84.4
R11	79.4
R12	75
R13	84.7
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 24.7 °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)	0.123
Power Factor	0.9811
Power (W)	14.44
Luminous Efficacy (lm/W)	128.8
Total Luminous Flux (lm)	1859.3
Beam Angle (°)	103.8 (0°-180°) /126.8 (90°-270°)
Center Beam Candle Power (cd)	534
Maximum Beam Candle Power (cd)	534.3 (At: C=50.0, Gamma=2.0)
Spacing Criteria	1.20 (0°-180°) /1.29 (90°-270°)
Zonal Lumens in the 0°-60°Zone	64.95%
Zonal Lumens in the 60°-90°Zone	25.28%
Zonal Lumens in the 90°-120°Zone	7.42%
Zonal Lumens in the 120°-180°Zone	2.36%

Table 3: Test data per Goniophotometer Method

### Spectral Power Distribution - Sphere Spectroradiometer Method

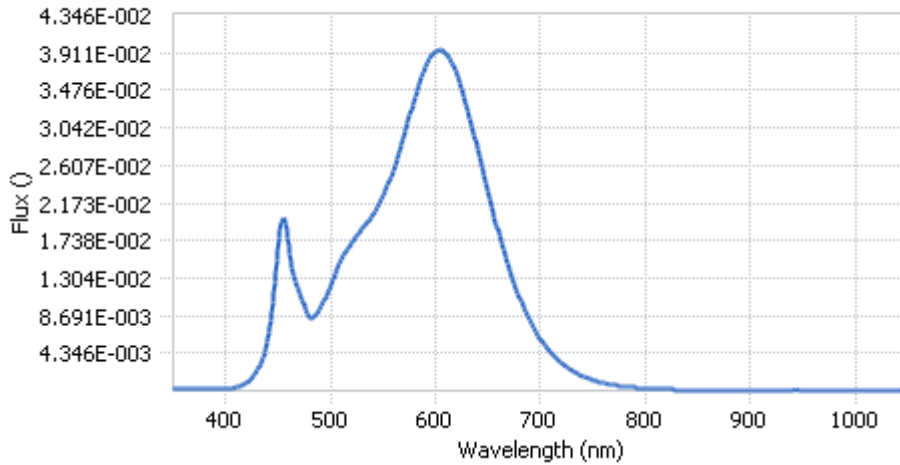
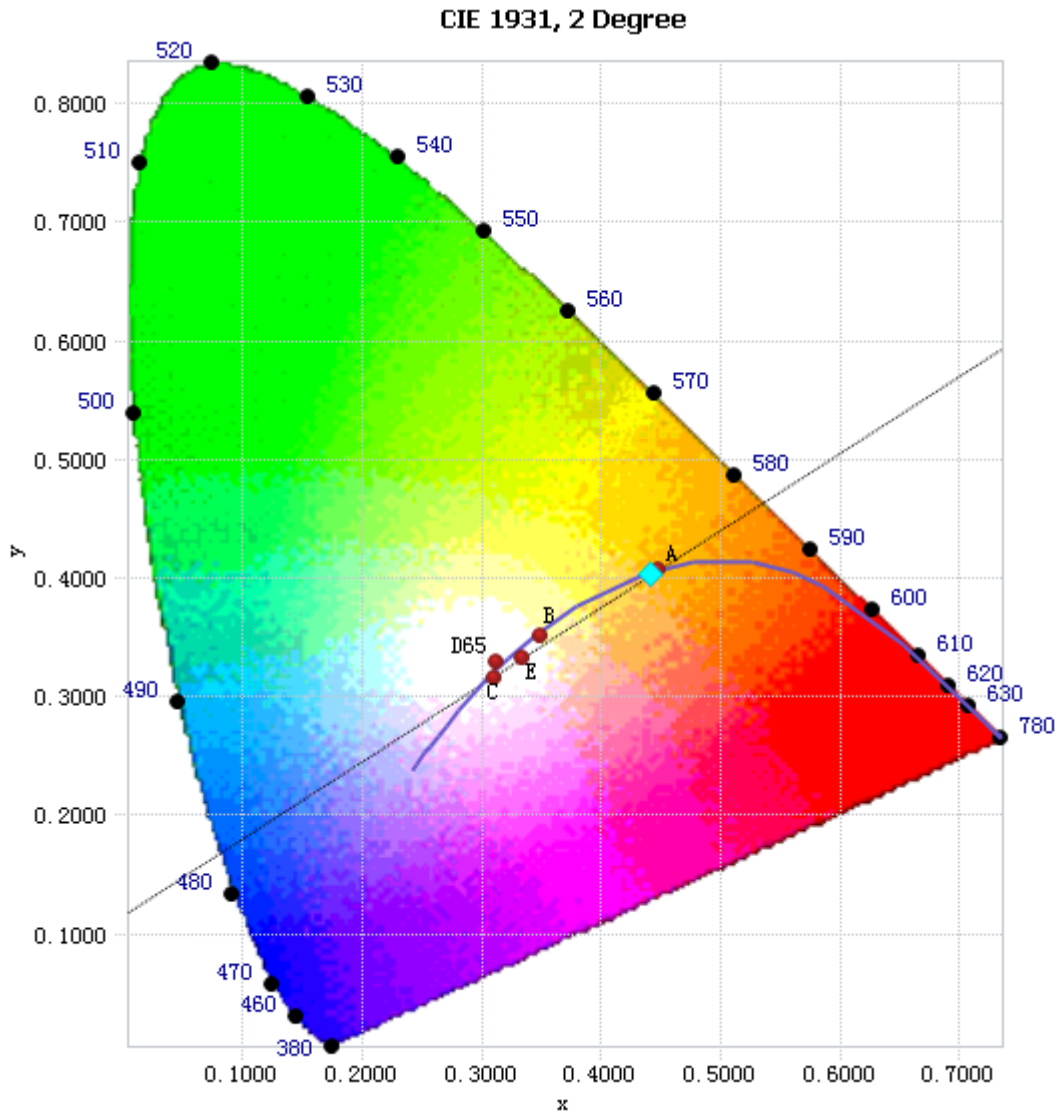


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	2.45E-04	485	8.68E-03	590	3.73E-02	695	6.93E-03
385	2.44E-04	490	9.50E-03	595	3.86E-02	700	5.97E-03
390	2.48E-04	495	1.07E-02	600	3.93E-02	705	5.11E-03
395	2.58E-04	500	1.22E-02	605	3.95E-02	710	4.37E-03
400	2.86E-04	505	1.38E-02	610	3.91E-02	715	3.74E-03
405	3.33E-04	510	1.51E-02	615	3.81E-02	720	3.21E-03
410	4.33E-04	515	1.62E-02	620	3.66E-02	725	2.74E-03
415	6.26E-04	520	1.71E-02	625	3.49E-02	730	2.34E-03
420	9.47E-04	525	1.79E-02	630	3.27E-02	735	2.00E-03
425	1.50E-03	530	1.88E-02	635	3.04E-02	740	1.70E-03
430	2.35E-03	535	1.95E-02	640	2.80E-02	745	1.45E-03
435	3.78E-03	540	2.04E-02	645	2.55E-02	750	1.25E-03
440	6.12E-03	545	2.14E-02	650	2.30E-02	755	1.06E-03
445	1.02E-02	550	2.26E-02	655	2.06E-02	760	9.15E-04
450	1.64E-02	555	2.40E-02	660	1.83E-02	765	7.82E-04
455	2.01E-02	560	2.56E-02	665	1.62E-02	770	6.71E-04
460	1.67E-02	565	2.75E-02	670	1.42E-02	775	5.76E-04
465	1.32E-02	570	2.96E-02	675	1.24E-02	780	4.98E-04
470	1.16E-02	575	3.18E-02	680	1.08E-02		
475	9.74E-03	580	3.39E-02	685	9.38E-03		
480	8.50E-03	585	3.58E-02	690	8.06E-03		

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

### Chromaticity Diagram - Sphere Spectroradiometer Method



Tristimulus values(x, y): (0.4407, 0.4027)

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

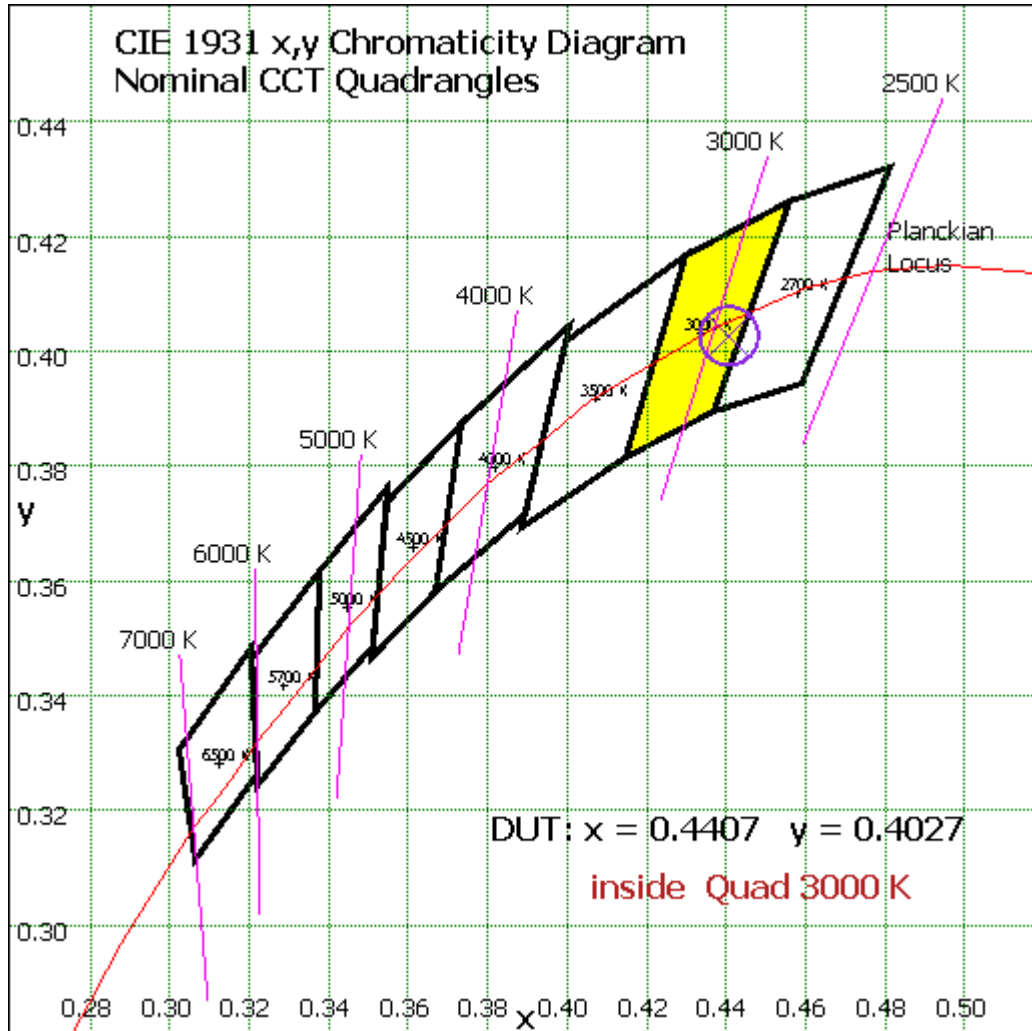


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

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

**Zonal Lumen Tabulation- Goniophotometer Method**

$\gamma(^{\circ})$	Lumens	% Total
0- 10	50.452	2.71%
10- 20	144.383	7.77%
20- 30	218.6	11.76%
30- 40	263.687	14.18%
40- 50	275.267	14.81%
50- 60	255.137	13.72%
60- 70	211.152	11.36%
70- 80	155.512	8.36%
80- 90	103.332	5.56%
90-100	66.8	3.59%
100-110	43.466	2.34%
110-120	27.652	1.49%
120-130	17.839	0.96%
130-140	11.578	0.62%
140-150	7.343	0.39%
150-160	4.371	0.24%
160-170	2.164	0.12%
170-180	0.541	0.03%
Total	1859.3	100%

$\gamma(^{\circ})$	Lumens	% Total
0- 60	1207.526	64.95%
60- 90	469.996	25.28%
0-90	1677.522	90.22%
90- 180	181.754	9.78%
0- 180	1859.3	100%

Table 5: Zonal Lumen Data

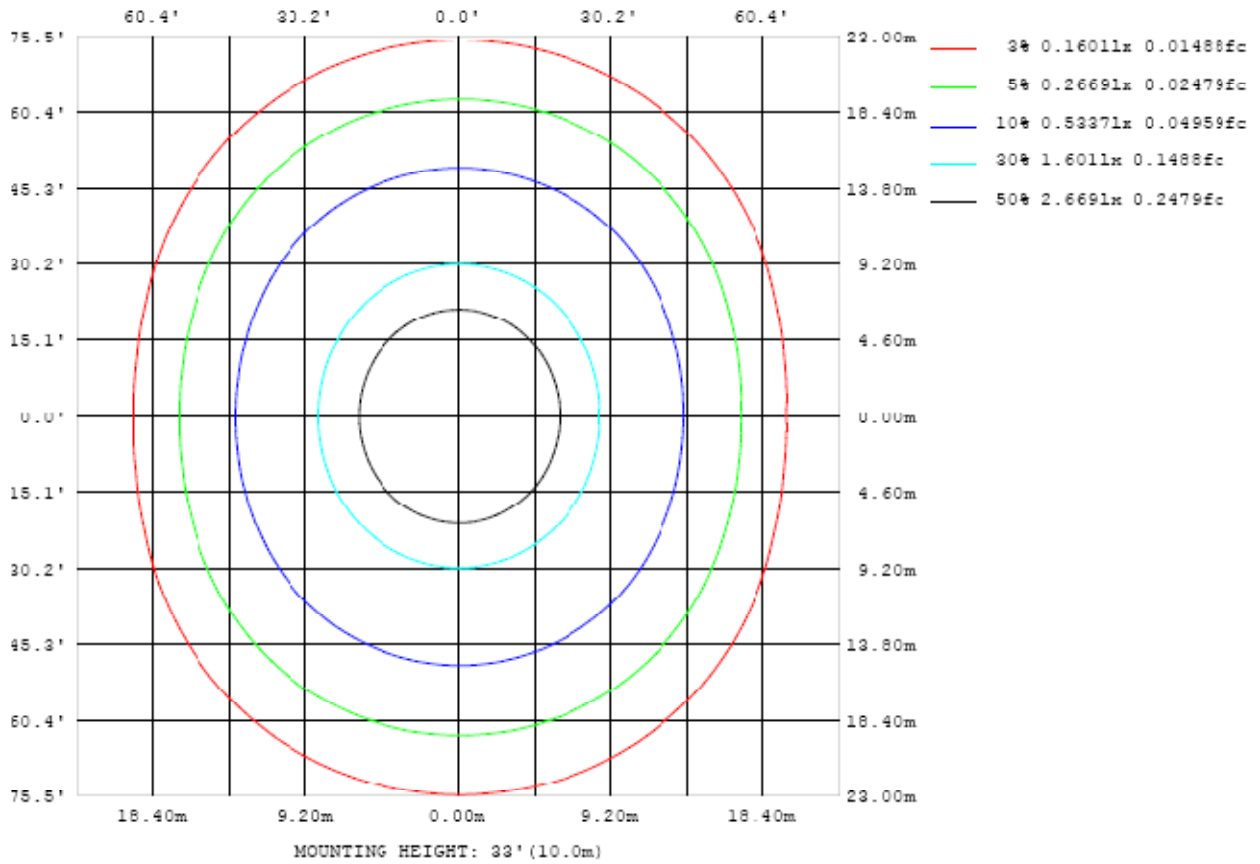


Chart 4: Beam Angle

**Luminous Intensity Distribution Plots- Goniophotometer Method**

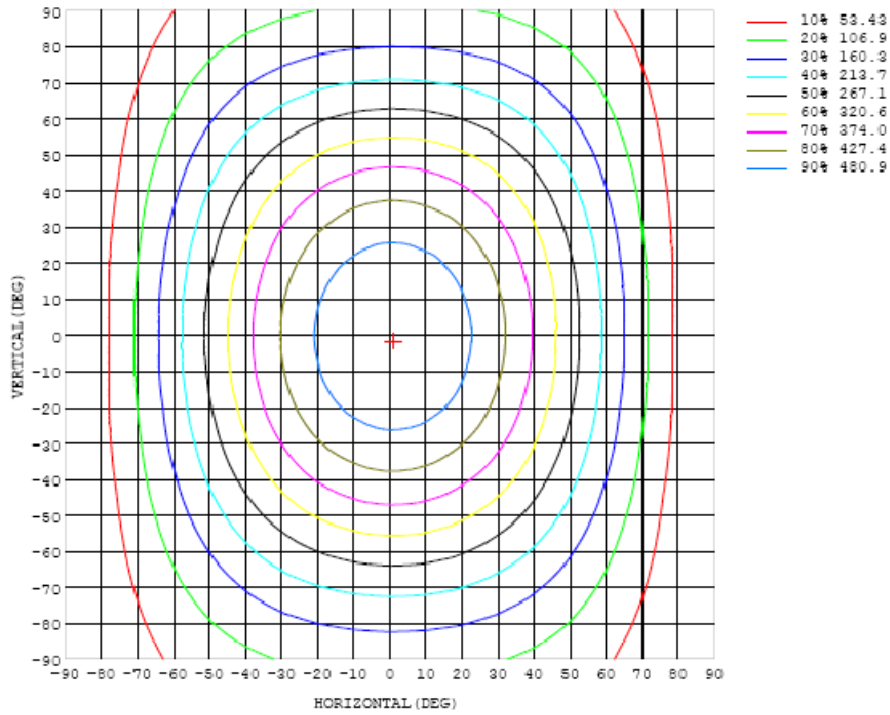


Chart 5: Illuminance Plot (Footcandles)

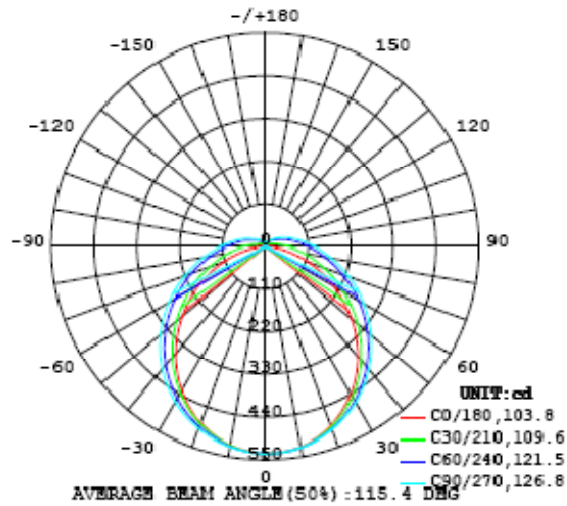


Chart 6: Polar Candela Distribution

**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	534	534	534	534	534	534	534	534	534	534	534	534	534	534	534	534	534	534	534
5	531	531	532	533	532	532	532	533	533	532	533	531	530	531	531	530	530	530	528
10	524	523	525	525	526	525	526	527	527	526	525	524	524	524	523	521	521	519	520
15	511	511	511	513	514	515	515	517	517	517	515	514	513	512	509	507	506	505	506
20	492	493	494	496	498	500	501	503	503	502	501	500	498	495	492	489	487	485	485
25	469	469	471	475	477	481	483	485	486	485	484	481	479	475	470	466	462	460	459
30	440	441	443	448	452	457	460	464	465	464	463	459	456	451	445	439	434	431	429
35	406	408	411	417	424	429	434	439	441	441	439	435	430	423	415	408	401	397	396
40	370	372	376	384	392	399	406	412	415	415	412	407	401	393	383	375	366	361	359
45	330	332	338	347	357	367	375	382	386	385	384	378	371	361	349	339	328	322	319
50	289	291	299	310	322	333	343	351	355	356	353	346	339	328	314	301	289	281	278
55	246	249	258	271	286	299	310	318	323	324	321	315	306	293	279	263	249	240	236
60	203	207	217	233	249	265	276	286	291	292	289	282	273	259	243	226	210	199	194
65	160	165	178	196	214	231	244	254	259	260	257	250	240	226	209	190	172	158	153
70	118	124	140	161	181	199	212	222	228	229	226	219	209	195	177	157	136	119	113
75	78.1	86.1	106	129	151	169	183	193	198	199	197	190	180	166	148	126	104	83.3	74.1
80	42.4	52.9	75.8	101	123	142	156	165	171	172	170	163	154	140	121	99.8	75.5	52.4	39.4
85	13.8	26.8	52.2	77.3	99.8	118	131	141	146	147	145	139	130	117	98.9	77.5	53.3	28.3	12.5
90	0.46	11.4	34.6	60.9	90.1	97.6	110	120	124	126	124	110	110	96.9	79.9	60.0	36.6	13.0	0.16
95	0.32	4.81	22.9	44.3	64.2	80.2	92.3	101	105	107	105	100	92.1	80.0	64.4	46.1	25.2	6.82	0.32
100	0.46	3.23	15.1	33.4	51.3	66.0	77.0	84.9	89.2	90.6	89.2	84.6	77.2	66.4	52.3	35.2	17.2	4.67	0.36
105	0.78	2.77	11.2	24.7	40.2	54.1	64.3	71.5	75.5	76.9	75.4	71.3	64.8	54.8	41.4	26.4	13.1	3.90	0.97
110	1.21	2.95	9.08	19.3	31.2	43.0	52.7	59.8	63.5	64.8	63.5	59.9	53.4	43.8	32.7	21.3	10.8	3.90	1.45
115	1.66	3.33	7.83	16.0	25.4	34.6	42.5	48.5	52.4	53.6	52.5	48.9	43.3	36.0	27.0	17.6	9.45	4.11	1.95
120	2.11	3.76	7.26	13.6	21.2	28.8	35.2	40.2	43.3	44.5	43.5	40.7	36.3	30.0	22.5	15.1	8.66	4.40	2.48
125	2.62	3.99	7.01	11.8	18.0	24.2	29.6	33.8	36.4	37.3	36.6	34.2	30.4	25.2	19.2	13.3	8.19	4.64	3.01
130	3.10	4.58	6.98	10.7	15.5	20.5	24.9	28.4	30.6	31.4	30.8	28.8	25.7	21.4	16.6	11.9	7.82	4.54	3.51
135	3.50	4.98	7.01	9.89	13.6	17.5	21.0	23.9	25.7	26.4	25.9	24.3	21.7	18.4	14.6	10.9	7.67	4.99	3.83
140	3.89	5.25	7.05	9.30	12.1	15.2	17.9	20.2	21.6	22.2	21.8	20.5	18.5	15.9	12.9	10.00	7.51	5.60	4.17
145	4.27	5.50	7.06	8.83	11.0	13.3	15.4	17.1	18.2	18.7	18.4	17.4	15.8	13.8	11.6	9.27	7.28	5.85	4.48
150	4.67	5.22	7.10	8.51	10.0	11.7	13.2	14.5	15.3	15.7	15.5	14.7	13.6	12.1	10.5	8.51	6.92	5.90	4.74
155	5.08	5.51	7.19	8.11	9.18	10.4	11.4	12.3	12.9	13.2	13.0	12.5	11.8	10.7	9.23	7.90	7.50	5.78	5.04
160	5.48	4.91	6.64	7.97	8.57	9.23	10.0	10.7	11.0	11.2	11.1	10.8	10.3	9.31	8.47	7.91	7.22	5.48	4.72
165	5.00	4.38	5.20	6.51	8.27	8.66	9.05	9.42	9.67	9.77	9.73	9.47	8.95	7.92	7.04	6.39	5.74	4.73	4.42
170	4.54	4.16	4.44	4.45	4.91	6.78	8.09	8.37	8.43	8.50	8.48	7.50	6.08	5.49	5.28	4.96	4.65	4.40	4.42
175	4.45	4.48	4.86	5.13	5.16	5.08	5.47	5.50	5.31	4.87	3.86	4.93	5.26	5.48	5.14	5.06	4.95	4.81	4.60
180	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99

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	534	534	534	534	534	534	534	534	534	534	534	534	534	534	534	534	534
5	529	529	530	529	531	531	530	531	531	530	531	532	532	530	532	531	532
10	519	521	521	521	523	523	524	525	524	524	524	526	525	525	524	524	524
15	505	506	506	509	510	511	512	514	514	514	514	515	514	513	511	511	511
20	485	486	488	491	494	495	498	500	500	500	499	500	499	496	495	494	493
25	460	462	465	468	473	476	479	482	483	483	482	482	479	476	473	470	469
30	431	433	437	443	449	453	458	462	464	463	461	460	455	451	446	443	441
35	398	400	406	413	421	427	434	438	440	439	437	434	430	423	417	411	409
40	360	365	372	381	391	399	406	411	413	413	411	407	400	392	383	376	373
45	322	327	336	348	359	369	377	382	384	384	381	376	368	358	348	339	334
50	281	287	299	312	324	336	345	351	353	353	349	344	334	323	311	300	293
55	239	247	261	276	290	302	311	317	320	320	316	310	300	286	273	259	251
60	198	208	222	239	255	267	278	284	286	286	282	276	264	250	235	219	208
65	157	169	186	204	221	234	244	250	254	253	248	241	230	214	197	180	167
70	118	133	152	171	189	202	211	217	220	219	215	208	197	181	162	143	127
75	81.4	99.6	121	142	158	171	180	186	188	188	184	177	166	150	130	108	88.9
80	49.5	70.8	93.8	114	132	144	153	158	161	160	156	150	138	122	101	78.2	55.8
85	24.9	48.0	71.0	91.5	108	120	129	134	136	135	131	125	113	97.6	77.5	53.8	29.8
90	10.7	31.5	53.2	72.5	90.1	99.6	100	112	114	113	110	103	92.6	77.4	50.4	36.0	14.1
95	4.63	20.7	39.8	57.5	71.9	82.6	90.1	94.4	96.1	95.5	91.9	85.6	75.5	61.3	43.8	24.0	6.29
100	3.13	13.5	29.8	46.5	58.8	68.6	76.6	79.6	81.1	80.4	77.2	71.1	61.7	48.7	32.9	16.0	3.86
105	2.81	10.1	22.0	35.5	47.8	57.0	63.5	67.4	68.7	68.0	64.8	59.0	50.1	38.2	24.3	11.4	3.20
110	3.03	8.35	17.4	27.9	37.8	46.6	52.8	56.6	57.9	57.1	53.9	48.3	39.9	29.5	18.7	8.94	3.18
115	3.36	7.40	14.3	22.7	30.8	37.6	42.8	46.2	47.5	46.7	43.5	38.7	32.0	23.8	15.2	7.62	3.41
120	3.79	6.97	12.3	19.0	25.6	31.3	35.6	38.2	39.2	38.6	36.0	32.0	26.3	19.7	12.7	7.03	3.67
125	4.24	6.73	10.9	16.2	21.6	26.2	29.8	32.0	32.9	32.2	30.1	26.7	22.0	16.6	11.1	6.76	4.06
130	4.64	6.64	9.97	14.0	18.4	22.1	25.1	26.9	27.6	27.1	25.3	22.5	18.7	14.2	9.99	6.69	4.51
135	5.00	6.64	9.19	12.4	15.8	18.8	21.3	22.7	23.3	22.9	21.4	19.1	16.1	12.5	9.29	6.68	4.98
140	5.44	6.76	8.66	11.1	13.7	16.1	18.1	19.3	19.7	19.3	18.2	16.3	13.8	11.2	8.78	6.69	5.32
145	5.79	6.83	8.29	10.1	12.1	13.8	15.4	16.3	16.7	16.4	15.5	14.0	12.2	10.2	8.33	6.89	5.80
150	6.07	6.90	7.92	9.32	10.7	12.0	13.1	13.8	14.0	13.8	13.1	12.1	10.8	9.37	8.07	7.00	6.15
155	6.45	7.01	7.62	8.46	9.62	10.5	11.3	11.7	11.9	11.8	11.3	10.6	9.72	8.73	7.93	7.16	6.47
160	6.13	7.12	7.46	7.73	8.27	9.34	9.77	10.1	10.2	10.1	9.88	9.41	8.90	8.37	7.79	7.16	6.65
165	5.42	6.25	6.81	7.33	7.56	7.99	8.75	8.89	8.97	8.96	8.84	8.64	8.37	8.00	7.57	7.14	6.46
170	4.57	5.06	5.38	5.75	6.48	7.16	7.49	7.77	8.09	8.10	8.03	7.94	7.80	7.55	7.33	7.19	5.62
175	4.40	4.55	4.50	4.47	4.44	4.63	5.31	6.11	6.62	7.05	7.33	7.49	7.47	7.06	6.16	5.19	4.75
180	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99

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	2M	HZTE015-01	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.

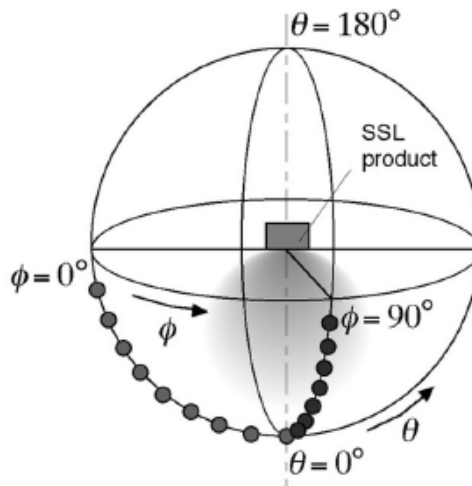
### **Color Spatial Uniformity**

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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