



LM-79-08 Test Report

for

Revolution Lighting Technologies, Inc.

2280 Ward Ave. Simi Valley, CA 93065

LED Tube

Model: 202101-111

Laboratory: Leading Testing Laboratories

NVLAP CODE: 200960-0

3rd Floor, Bld. 2, NO. 96 Longchuanwu Rd Qianjiang Economy Dev. Zone, Yuhang Dist,
Hangzhou, Zhejiang Province, China 311100

Tel: +86 571 86376106

www.ledtestlab.com

Report No.: HZ18110016o

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: 202101-111

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)	Power Factor
125.1	1404.0	11.22	0.9798
CCT (K)	CRI	Stabilization Time (Light & Power)	
2948	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. 14, 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

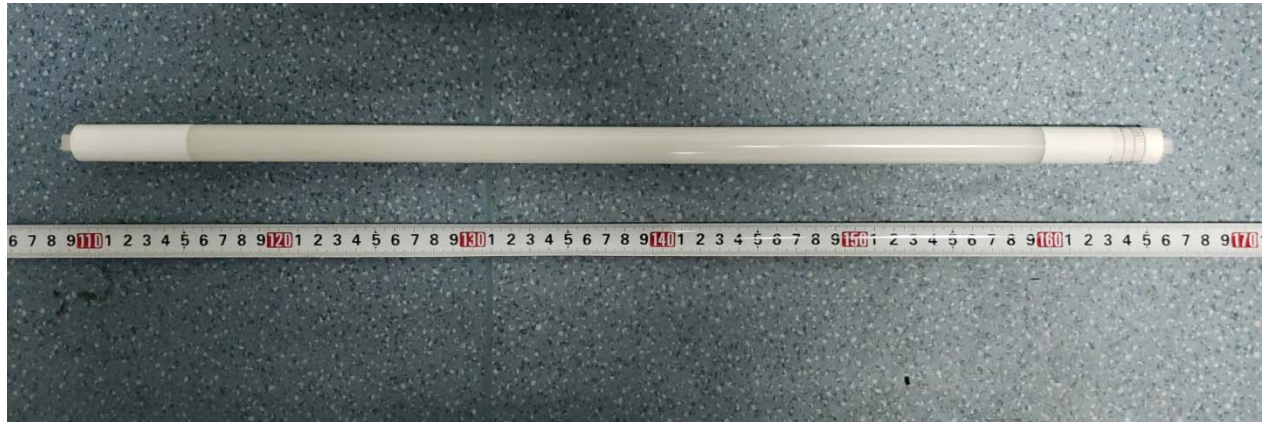


Figure 1- Overview of the sample

Equipment Under Test (EUT)

Name	: LED Tube
Model	: 202101-111
Electrical Ratings	: 120-277V, 60Hz
Product Description	: 3000K
Manufacturer	: Revolution Lighting Technologies, Inc.
Address	: 2280 Ward Ave. Simi Valley, CA 93065

TEST RESULTS

Test ambient temperature was 25.2°C.

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
Voltage frequency (Hz)	60	60
Test Current (A)	0.095	0.045
Power Factor	0.9798	0.9385
Test Power (W)	11.22	11.60
THD A%	18.44	25.61
Luminous Efficacy (lm/W)	125.1	121.1
Total Luminous Flux (lm)	1404.0	1405.0
Color Rendering Index (CRI)	82.6	
R9	7.3	
Correlated Color Temperature (CCT)(K)	2948	
Chromaticity Chroma x	0.4390	
Chromaticity Chroma y	0.4022	
Chromaticity Chroma u	0.2527	
Chromaticity Chroma v	0.3473	
Duv	0.0012	
Chromaticity Chroma u'	0.2527	
Chromaticity Chroma v'	0.5210	

Special Color Rendering Indices	
R1	81.8
R2	93.2
R3	93.6
R4	79.6
R5	82.3
R6	92.2
R7	80.8
R8	57.6
R9	7.3
R10	84.7
R11	79.2
R12	75.2
R13	84.8
R14	97.2

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 25.1 °C.

The photometric distance is 2.47 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)	0.096
Power Factor	0.9797
Power (W)	11.28
Luminous Efficacy (lm/W)	123.4
Total Luminous Flux (lm)	1392.2
Beam Angle (°)	102.2 (0°-180°) /128.1(90°-270°)
Center Beam Candle Power (cd)	401
Maximum Beam Candle Power (cd)	401.3 (At: C=250.0, Gamma=1.5)
Spacing Criteria	1.20 (0°-180°) /1.30 (90°-270°)
Zonal Lumens in the 0°-60°Zone	64.74%
Zonal Lumens in the 60°-90°Zone	25.42%
Zonal Lumens in the 90°-120°Zone	7.55%
Zonal Lumens in the 120°-180°Zone	2.29%

Table 3: Test data per Goniophotometer Method

Spectral Power Distribution - Sphere Spectroradiometer Method

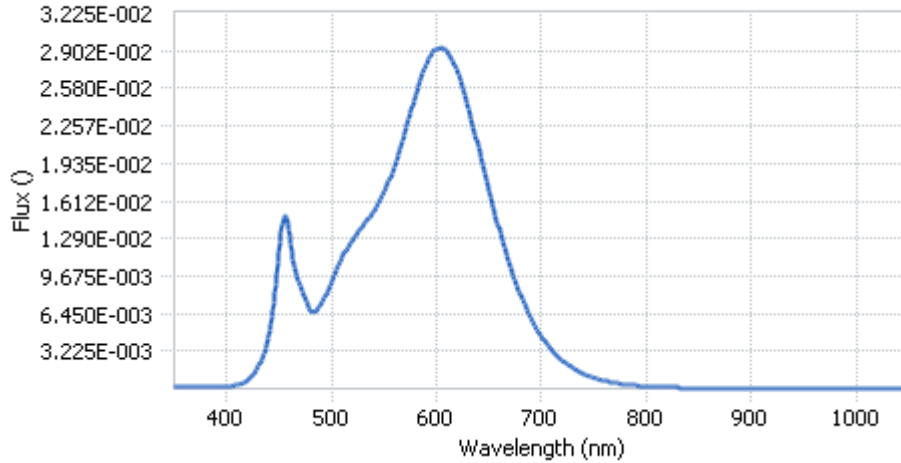


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	1.76E-04	485	6.70E-03	590	2.78E-02	695	5.19E-03
385	1.65E-04	490	7.26E-03	595	2.87E-02	700	4.48E-03
390	1.70E-04	495	8.14E-03	600	2.91E-02	705	3.85E-03
395	1.94E-04	500	9.23E-03	605	2.93E-02	710	3.28E-03
400	2.09E-04	505	1.03E-02	610	2.90E-02	715	2.81E-03
405	2.48E-04	510	1.13E-02	615	2.82E-02	720	2.40E-03
410	3.32E-04	515	1.21E-02	620	2.71E-02	725	2.07E-03
415	4.81E-04	520	1.29E-02	625	2.58E-02	730	1.77E-03
420	7.52E-04	525	1.34E-02	630	2.42E-02	735	1.50E-03
425	1.19E-03	530	1.40E-02	635	2.25E-02	740	1.28E-03
430	1.86E-03	535	1.46E-02	640	2.07E-02	745	1.10E-03
435	2.94E-03	540	1.52E-02	645	1.88E-02	750	9.38E-04
440	4.62E-03	545	1.60E-02	650	1.70E-02	755	8.08E-04
445	7.43E-03	550	1.69E-02	655	1.53E-02	760	6.92E-04
450	1.18E-02	555	1.79E-02	660	1.36E-02	765	5.88E-04
455	1.49E-02	560	1.92E-02	665	1.20E-02	770	5.07E-04
460	1.31E-02	565	2.06E-02	670	1.05E-02	775	4.38E-04
465	1.03E-02	570	2.21E-02	675	9.24E-03	780	3.75E-04
470	8.98E-03	575	2.36E-02	680	8.04E-03		
475	7.66E-03	580	2.53E-02	685	7.01E-03		
480	6.68E-03	585	2.67E-02	690	6.03E-03		

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

Chromaticity Diagram - Sphere Spectroradiometer Method

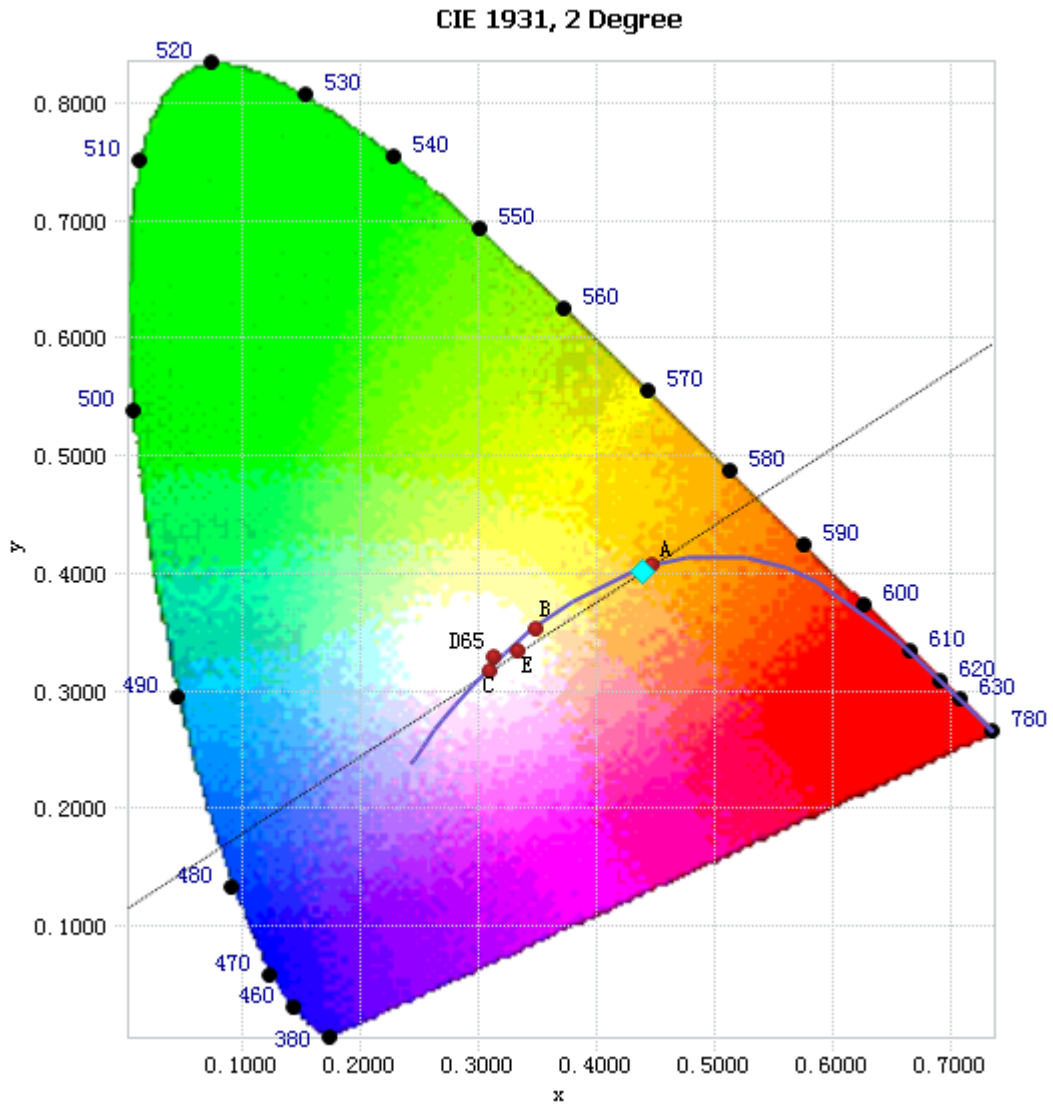


Chart 2: Chromaticity Diagram per Sphere - Spectroradiometer Method

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

Nominal CCT Quadrangles – Sphere Spectroradiometer Method

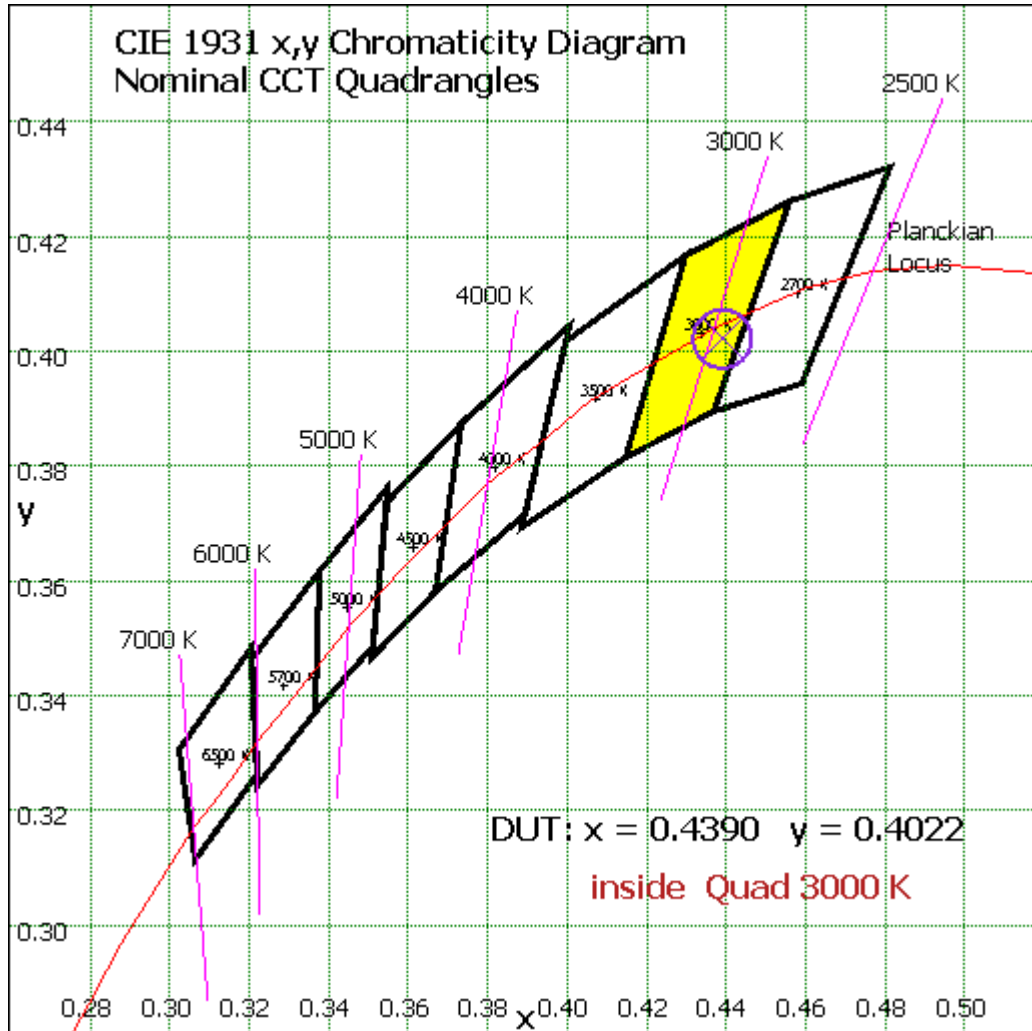


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

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	37.893	2.72%
10- 20	108.265	7.78%
20- 30	163.486	11.74%
30- 40	196.677	14.13%
40- 50	204.977	14.72%
50- 60	190.049	13.65%
60- 70	157.888	11.34%
70- 80	117.229	8.42%
80- 90	78.716	5.65%
90-100	51.232	3.68%
100-110	33.26	2.39%
110-120	20.631	1.48%
120-130	13.047	0.94%
130-140	8.414	0.60%
140-150	5.305	0.38%
150-160	3.154	0.23%
160-170	1.582	0.11%
170-180	0.368	0.03%
Total	1392.2	100%

$\gamma(^{\circ})$	Lumens	% Total
0- 60	901.347	64.74%
60- 90	353.833	25.42%
0-90	1255.18	90.16%
90- 180	136.993	9.84%
0- 180	1392.2	100%

Table 5: Zonal Lumen Data

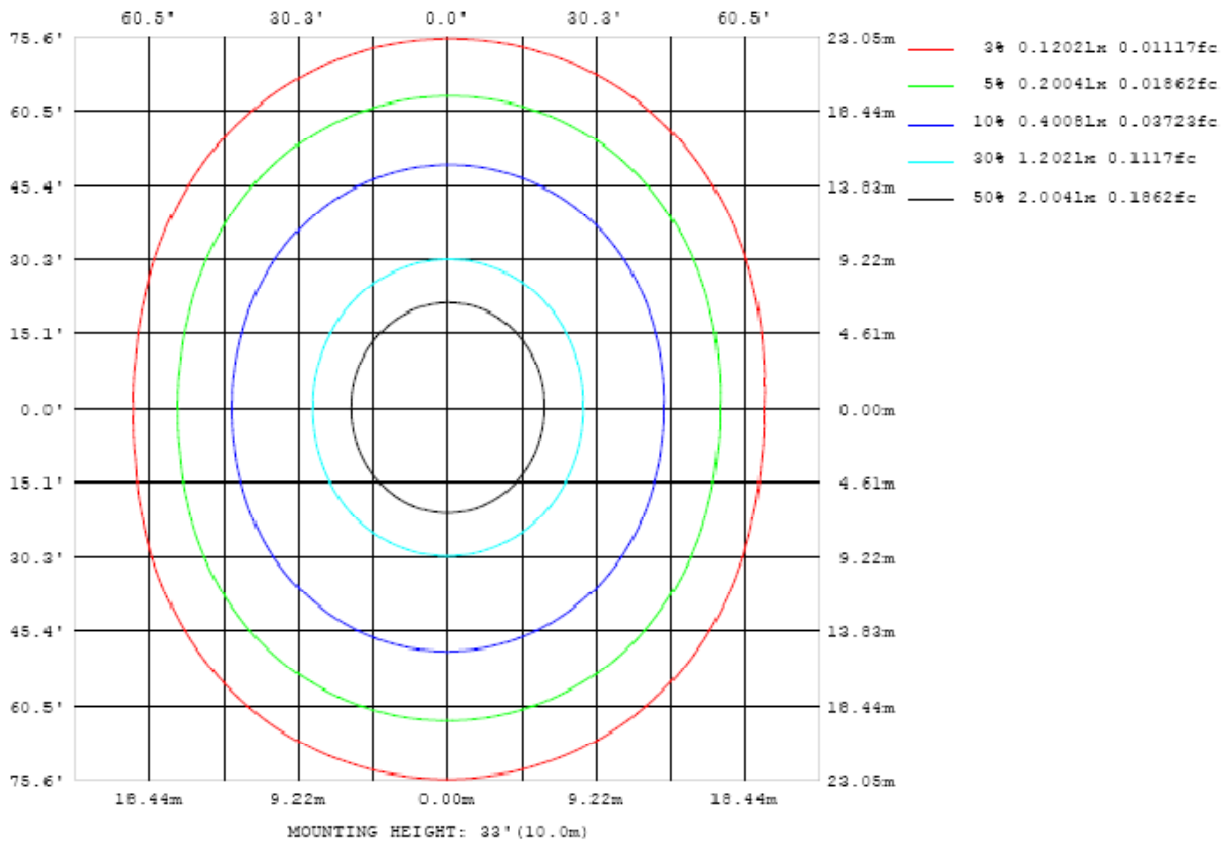


Chart 4: Beam Angle

Luminous Intensity Distribution Plots- Goniophotometer Method

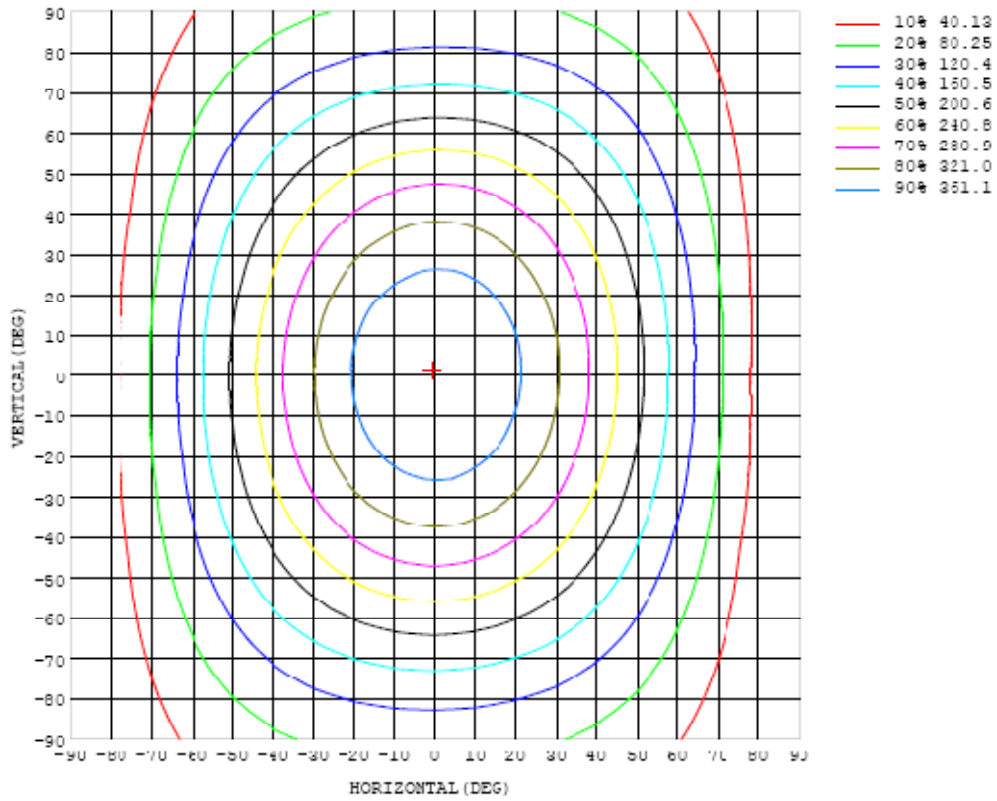


Chart 5: Illuminance Plot (Footcandles)

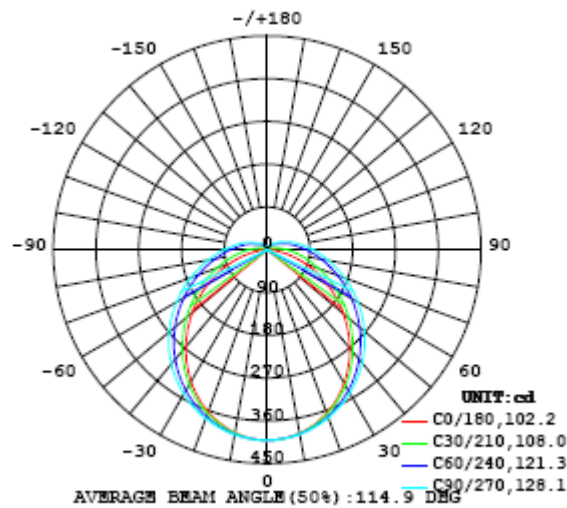


Chart 6: Polar Candela Distribution

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	401	401	401	401	401	401	401	401	401	401	401	401	401	401	401	401	401	401	401
5	398	398	398	398	399	399	399	399	399	399	399	399	399	399	399	398	398	398	398
10	392	392	392	393	393	393	394	394	395	394	394	394	393	393	392	392	392	391	391
15	382	381	381	382	383	384	385	386	387	387	386	385	385	383	382	381	379	379	379
20	366	366	366	368	370	372	374	376	377	376	376	374	373	371	368	366	365	363	364
25	347	347	348	350	353	356	359	361	363	363	363	361	358	355	351	348	345	344	343
30	324	325	326	329	334	338	342	345	347	348	347	344	341	337	332	327	323	321	320
35	298	299	301	306	312	317	322	326	329	330	329	326	322	316	310	304	298	295	294
40	270	271	275	280	287	294	300	306	310	311	310	306	300	294	286	278	272	267	267
45	240	242	246	253	262	270	279	284	290	290	289	284	277	270	260	251	243	230	237
50	209	211	216	225	235	245	255	261	266	267	265	261	254	245	234	223	214	207	205
55	178	180	186	196	208	220	229	237	242	244	242	238	230	220	208	195	185	177	174
60	146	149	157	168	182	194	205	213	219	221	219	214	206	195	182	168	156	146	144
65	115	118	128	141	156	169	181	189	195	197	195	190	182	171	157	142	128	117	113
70	85.1	89.1	101	116	132	146	158	166	171	173	172	167	159	148	133	117	102	88.2	82.9
75	56.8	62.3	75.7	92.6	110	124	136	144	150	152	150	145	137	126	112	95.1	77.8	62.3	54.5
80	30.0	37.0	54.4	72.4	89.7	104	116	124	129	131	130	125	110	106	92.0	75.6	57.7	39.7	29.1
85	10.5	18.6	36.8	55.7	72.6	87.2	98.1	106	111	113	111	107	99.9	89.3	75.8	59.4	40.9	22.2	9.27
90	0.84	7.53	23.9	41.9	58.4	72.0	82.5	89.9	94.4	96.1	95.1	91.3	84.3	74.4	61.6	45.9	28.3	11.1	0.55
95	0.36	3.00	15.0	30.8	46.3	59.4	68.9	76.0	80.1	81.8	81.0	77.3	70.9	62.0	49.6	34.9	19.1	5.30	0.38
100	0.45	1.77	9.73	22.7	36.3	48.4	57.7	63.9	67.8	69.4	68.7	65.4	59.7	51.0	39.7	26.4	12.9	3.68	0.50
105	0.53	1.61	6.98	16.5	27.9	38.9	47.7	53.9	57.7	59.3	58.5	55.4	49.7	41.4	31.0	19.5	9.68	2.89	0.77
110	0.81	1.83	5.45	12.7	21.5	30.3	38.1	44.1	47.9	49.4	48.6	45.5	40.1	32.5	24.2	15.6	7.92	2.90	1.11
115	1.10	2.15	4.72	10.4	17.4	24.4	30.6	35.2	38.3	39.6	38.9	36.3	32.2	26.6	19.8	12.8	6.92	3.07	1.47
120	1.40	2.43	4.55	8.74	14.4	20.1	25.1	29.0	31.5	32.6	32.1	30.1	26.7	22.0	16.5	10.9	6.29	3.26	1.85
125	1.69	2.73	4.54	7.66	12.1	16.8	20.9	24.1	26.3	27.1	26.8	25.1	22.3	18.4	14.0	9.61	5.95	3.51	2.24
130	2.08	3.05	4.63	7.07	10.4	14.2	17.5	20.2	22.0	22.7	22.4	21.0	18.7	15.6	12.1	8.64	5.73	3.77	2.62
135	2.42	3.34	4.77	6.62	9.21	12.1	14.8	17.0	18.4	19.0	18.7	17.6	15.7	13.3	10.6	7.88	5.59	3.96	2.88
140	2.75	3.57	4.86	6.35	8.33	10.5	12.6	14.3	15.5	15.9	15.7	14.8	13.3	11.4	9.26	7.18	5.46	4.11	3.14
145	3.08	3.63	4.89	6.12	7.60	9.24	10.8	12.1	13.0	13.4	13.2	12.5	11.4	9.91	8.28	6.71	5.47	4.29	3.43
150	3.33	3.69	4.91	5.94	7.01	8.10	9.30	10.3	10.9	11.2	11.1	10.6	9.70	8.67	7.49	6.39	5.49	4.36	3.59
155	3.56	3.49	4.60	5.80	6.52	7.35	8.12	8.76	9.23	9.44	9.36	9.01	8.46	7.72	6.94	6.16	5.45	4.24	3.72
160	3.84	3.49	4.73	5.59	6.17	6.58	7.21	7.62	7.91	8.04	7.99	7.79	7.45	6.96	6.44	5.95	5.31	4.03	3.72
165	3.84	2.93	3.97	5.10	5.81	6.19	6.48	6.72	6.90	6.99	6.94	6.82	6.63	6.37	5.96	5.45	4.95	3.67	3.64
170	3.37	2.82	2.99	3.10	3.50	4.24	5.63	6.04	6.08	6.13	6.14	6.83	6.09	4.49	4.20	3.84	3.51	3.29	3.35
175	2.65	2.67	2.67	2.69	2.72	2.73	2.75	2.76	2.93	1.64	2.67	3.20	3.29	3.28	3.28	3.25	3.25	3.25	3.23
180	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75

Table 6: Luminous Intensity Data

Table--2 UNIT: cd

C (DEG) T (DEG)	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350		
0	401	401	401	401	401	401	401	401	401	401	401	401	401	401	401	401	401		
5	398	398	399	399	399	399	399	399	399	399	400	400	399	399	399	399	399		
10	391	392	392	392	393	394	394	394	395	396	395	395	395	394	393	393	393		
15	379	380	381	383	385	386	387	387	388	388	388	387	386	385	384	383	381		
20	364	365	367	369	372	374	376	377	378	378	377	376	374	372	370	368	366		
25	344	346	348	352	356	359	362	364	365	365	364	362	359	356	353	350	348		
30	321	324	328	332	337	342	346	349	350	350	349	346	341	337	333	329	326		
35	296	299	304	310	316	323	327	332	333	333	331	327	321	315	309	304	301		
40	268	272	278	285	294	301	307	312	314	313	310	306	299	291	284	278	273		
45	238	243	250	260	269	277	285	290	292	292	288	283	275	267	258	249	244		
50	207	213	222	233	243	253	261	267	270	269	265	259	251	240	229	220	213		
55	176	183	193	205	217	228	236	243	245	244	240	234	224	213	201	190	182		
60	146	153	165	178	191	203	212	218	220	219	215	208	198	186	173	161	151		
65	115	125	138	152	166	178	187	193	195	195	190	184	173	160	146	132	121		
70	86.2	97.2	112	128	142	154	162	168	171	170	166	159	149	136	120	105	92.2		
75	59.0	72.7	89.2	106	120	131	140	145	147	147	143	137	126	113	96.8	80.0	65.0		
80	35.3	51.2	68.9	85.5	99.8	111	119	124	127	126	122	116	105	91.9	76.0	58.4	41.4		
85	17.5	34.2	52.2	68.6	82.2	92.8	101	105	107	107	103	97.0	87.3	74.3	58.6	40.8	22.9		
90	7.06	22.3	39.1	54.5	67.4	77.4	84.4	88.9	90.7	90.1	87.0	81.2	71.9	59.5	44.6	27.7	11.1		
95	2.99	14.5	29.1	43.2	55.2	64.5	71.1	75.1	76.7	76.1	73.2	67.5	59.1	47.6	33.8	18.8	5.24		
100	1.98	8.98	21.6	34.2	45.2	53.7	59.9	63.5	65.1	64.5	61.7	56.4	48.4	38.0	25.5	12.3	3.02		
105	1.79	6.76	15.6	26.6	36.7	44.7	50.3	53.8	55.2	54.7	52.0	47.0	39.6	29.9	18.6	8.56	2.34		
110	2.04	5.64	12.1	20.2	28.7	36.3	41.8	45.2	46.5	45.9	43.3	38.6	31.3	22.6	13.8	6.62	2.29		
115	2.32	5.08	10.0	16.4	22.8	28.4	33.3	36.7	37.9	37.4	34.7	30.0	24.3	17.8	11.2	5.52	2.48		
120	2.65	4.88	8.68	13.5	18.8	23.4	27.0	29.4	30.2	29.7	27.7	24.4	19.9	14.6	9.41	5.05	2.71		
125	3.01	4.78	7.77	11.6	15.8	19.5	22.4	24.3	25.0	24.6	22.9	20.2	16.6	12.3	8.07	4.86	2.89		
130	3.29	4.76	7.17	10.2	13.4	16.4	18.8	20.3	20.9	20.6	19.2	17.0	13.9	10.6	7.28	4.85	3.17		
135	3.48	4.77	6.71	9.05	11.5	13.8	15.8	17.1	17.6	17.3	16.2	14.3	11.9	9.25	6.79	4.85	3.48		
140	3.66	4.62	6.28	8.08	10.00	11.8	13.3	14.4	14.8	14.5	13.6	12.2	10.3	8.32	6.44	4.78	3.80		
145	3.94	4.72	5.93	7.38	8.84	10.2	11.3	12.1	12.4	12.2	11.5	10.5	9.09	7.62	5.86	4.64	4.04		
150	4.22	4.76	5.51	6.77	7.86	8.88	9.73	10.3	10.6	10.4	9.86	9.07	8.06	6.89	5.67	4.74	4.21		
155	4.50	5.09	5.46	6.01	6.87	7.72	8.34	8.75	8.89	8.81	8.46	7.92	7.20	6.40	5.44	4.82	4.40		
160	4.50	5.12	5.41	5.64	6.08	6.63	7.04	7.39	7.51	7.47	7.23	6.97	6.45	5.77	5.29	4.87	4.48		
165	4.30	5.02	5.22	5.39	5.62	5.91	6.08	6.31	6.36	6.39	6.31	6.05	5.74	5.49	5.29	4.96	4.44		
170	3.57	4.16	4.61	5.06	5.35	5.10	5.02	5.48	5.63	5.63	5.59	5.51	5.41	5.30	5.11	4.81	3.92		
175	3.20	3.20	3.26	3.37	3.50	3.79	4.32	4.72	4.86	4.91	4.93	4.93	4.86	4.65	4.05	3.13	2.70		
180	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75		

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 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 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

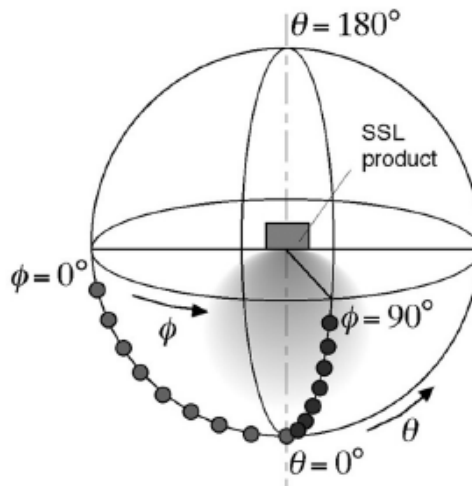
The color characteristics of SSL products include chromaticity coordinates, correlated color temperature, and color rendering index. These characteristics of SSL products may be spatially non-uniform, and thus, in order that they can be specified accurately, the color quantities shall be measured as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