LM-79-08 Test Report

for

Revolution Lighting Technologies, Inc.

2280 Ward Ave. Simi Valley, CA 93065

LED Tube

Model: 203101-115

Laboratory: Leading Testing Laboratories

NVLAP CODE: 200960-0

3rd Floor, Bld. 2, NO. 96 Longchuanwu Rd Qianjiang Economy Dev. Zone, Yuhang Dist,
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Report No.: HZ18110016n

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

Review by: April Zou

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: **203101-115**

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)	Power Factor
126.7	1836.0	14.49	0.9798

CCT (K)	CRI	Stabilization Time (Light & Power)
4902	81.8	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

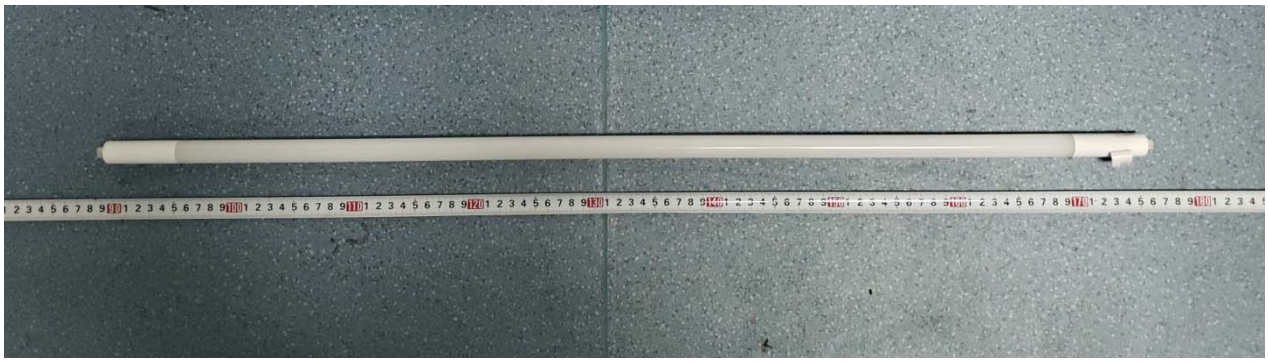


Figure 1- Overview of the sample

Equipment Under Test (EUT)	
Name	: LED Tube
Model	: 203101-115
Electrical Ratings	: 120-277V, 60Hz
Product Description	: 5000K
Manufacturer	: Revolution Lighting Technologies, Inc.
Address	: 2280 Ward Ave. Simi Valley, CA 93065

TEST RESULTS

Test ambient temperature was 25.1℃.

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)	0.123	0.056
Power Factor	0.9798	0.9576
Test Power (W)	14.49	14.86
THD A%	19.02	21.51
Luminous Efficacy (lm/W)	126.7	123.3
Total Luminous Flux (lm)	1836.0	1832.0
Color Rendering Index (CRI)	81.8	
R9	0.2	
Correlated Color Temperature (CCT)(K)	4902	
Chromaticity Chroma x	0.3487	
Chromaticity Chroma y	0.3626	
Chromaticity Chroma u	0.2097	
Chromaticity Chroma v	0.3270	
Duv	0.0039	
Chromaticity Chroma u ’	0.2097	
Chromaticity Chroma v’	0.4905	

Special Color Rendering Indices	
R1	79.2
R2	87.4
R3	93.5
R4	80.5
R5	79.5
R6	82.4
R7	87.1
R8	64.7
R9	0.2
R10	70.2
R11	79.2
R12	56.6
R13	81.4
R14	96.6

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 ℃.

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)	0.124
Power Factor	0.9794
Power (W)	14.60
Luminous Efficacy (lm/W)	124.3
Total Luminous Flux (lm)	1814.2
Beam Angle (°)	111.3（0^o-180^o）/145.9 (90^o-270^o)
Center Beam Candle Power (cd)	452
Maximum Beam Candle Power (cd)	452.1 (At: C=30.0, Gamma=2.5)
Spacing Criteria	1.24（0^o-180^o）/1.32 (90^o-270^o)
Zonal Lumens in the 0°-60°Zone	59.53%
Zonal Lumens in the 60°-90°Zone	27.64%
Zonal Lumens in the 90°-120°Zone	9.92%
Zonal Lumens in the 120°-180°Zone	2.91%

Table 3: Test data per Goniophotometer Method

Spectral Power Distribution - Sphere Spectroradiometer Method

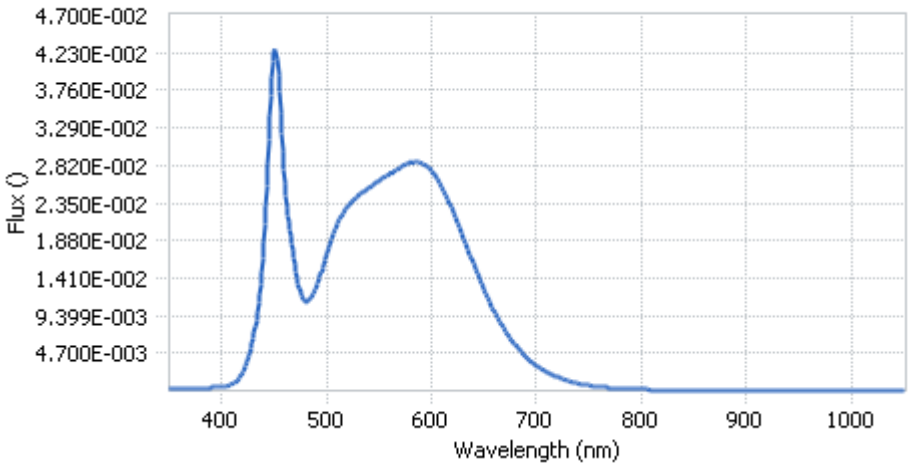
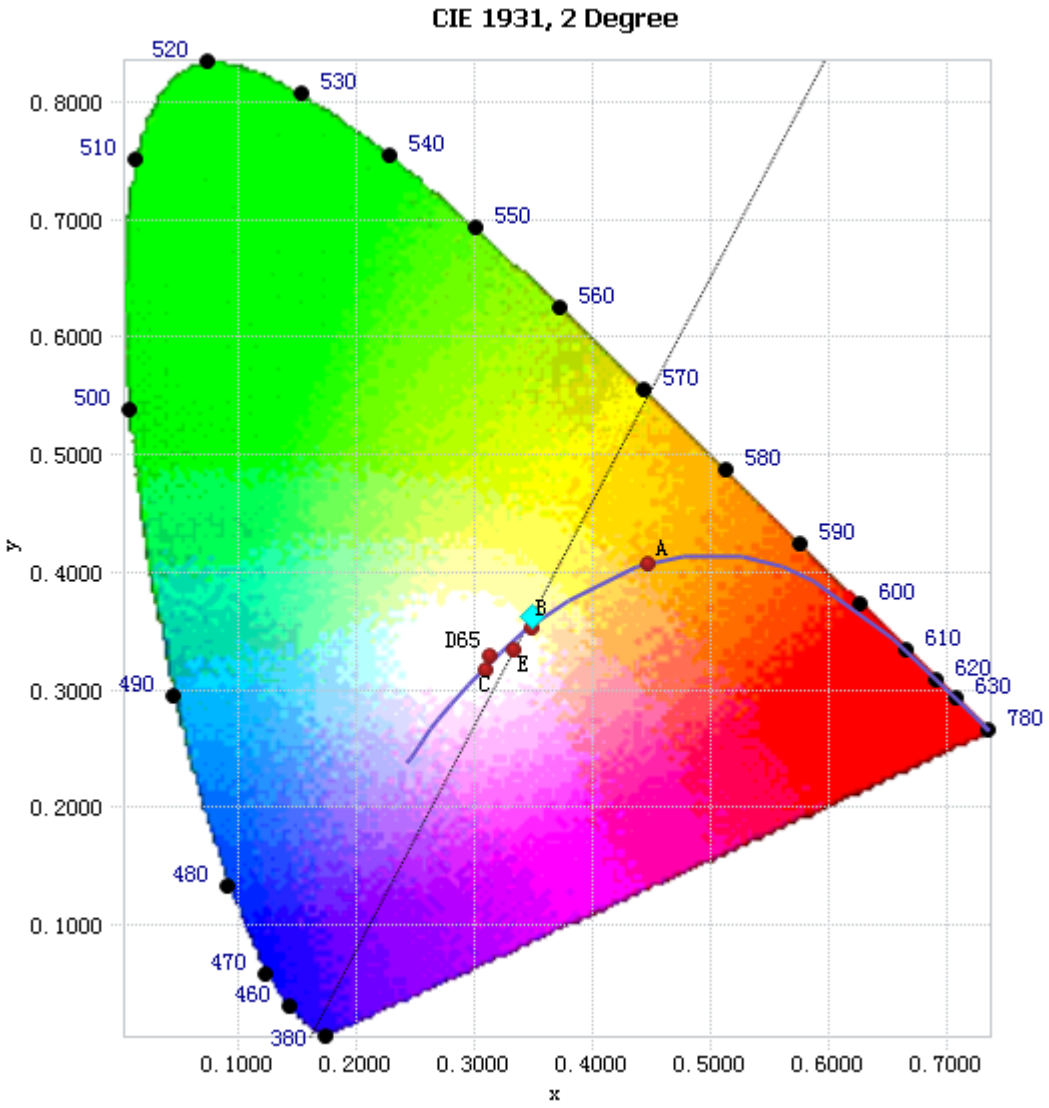


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	3.39E-04	485	1.16E-02	590	2.85E-02	695	3.64E-03
385	3.45E-04	490	1.29E-02	595	2.81E-02	700	3.14E-03
390	3.87E-04	495	1.49E-02	600	2.75E-02	705	2.69E-03
395	4.40E-04	500	1.71E-02	605	2.65E-02	710	2.31E-03
400	4.86E-04	505	1.92E-02	610	2.55E-02	715	1.98E-03
405	5.98E-04	510	2.09E-02	615	2.41E-02	720	1.70E-03
410	8.45E-04	515	2.21E-02	620	2.25E-02	725	1.47E-03
415	1.36E-03	520	2.32E-02	625	2.09E-02	730	1.25E-03
420	2.35E-03	525	2.38E-02	630	1.92E-02	735	1.08E-03
425	3.99E-03	530	2.45E-02	635	1.76E-02	740	9.14E-04
430	6.60E-03	535	2.50E-02	640	1.59E-02	745	7.82E-04
435	1.10E-02	540	2.54E-02	645	1.42E-02	750	6.81E-04
440	1.86E-02	545	2.58E-02	650	1.27E-02	755	5.84E-04
445	3.13E-02	550	2.63E-02	655	1.12E-02	760	5.06E-04
450	4.24E-02	555	2.67E-02	660	9.87E-03	765	4.37E-04
455	3.74E-02	560	2.71E-02	665	8.66E-03	770	3.74E-04
460	2.59E-02	565	2.76E-02	670	7.54E-03	775	3.20E-04
465	2.02E-02	570	2.79E-02	675	6.56E-03	780	2.77E-04
470	1.57E-02	575	2.83E-02	680	5.70E-03		
475	1.22E-02	580	2.86E-02	685	4.95E-03		
480	1.12E-02	585	2.88E-02	690	4.25E-03		

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

Chromaticity Diagram - Sphere Spectroradiometer Method



Tristimulus values(x, y): (0.3487, 0.3626)

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

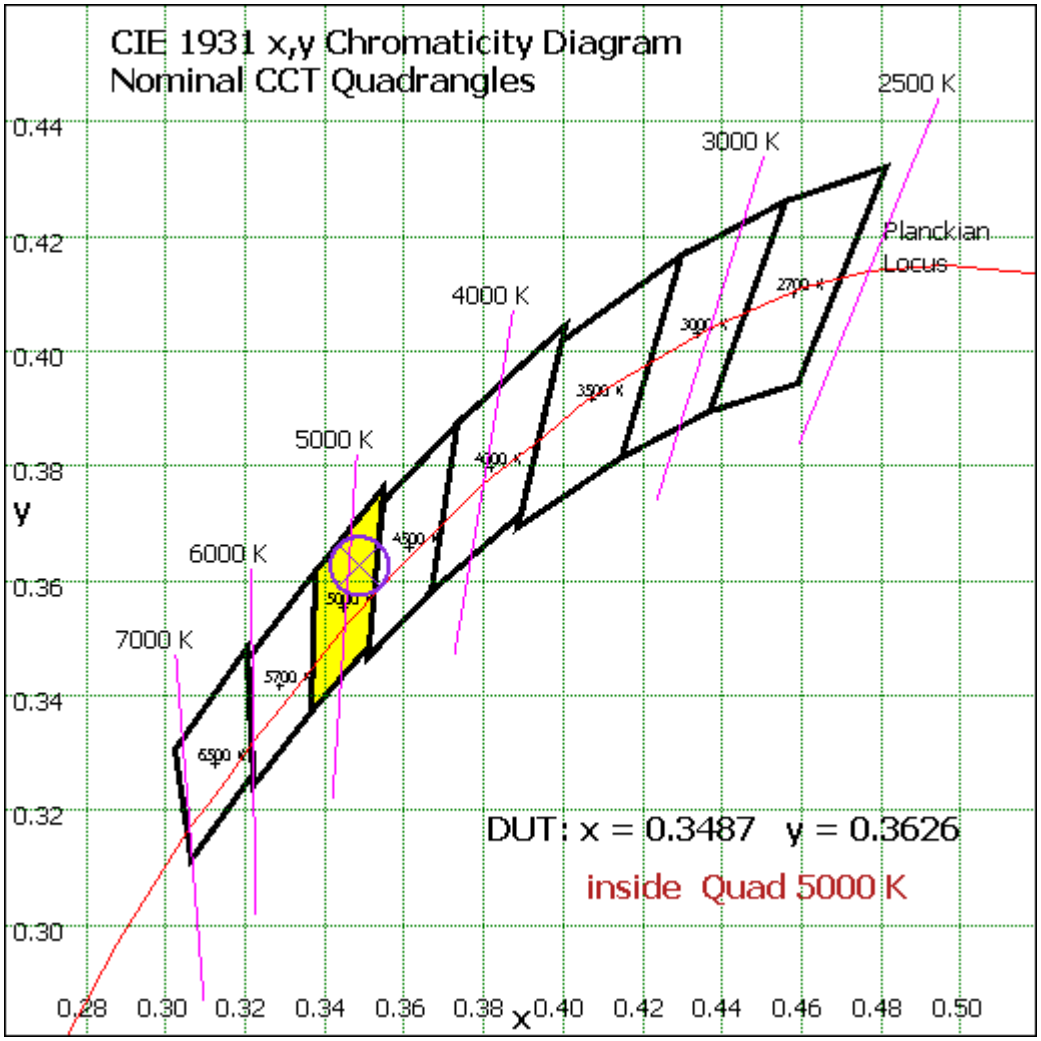


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

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

Zonal Lumen Tabulation- Goniophotometer Method

γ(°)	Lumens	% Total
0- 10	42.8	2.36%
10- 20	123.216	6.79%
20- 30	188.888	10.41%
30- 40	232.559	12.82%
40- 50	250.332	13.80%
50- 60	242.172	13.35%
60- 70	212.047	11.69%
70- 80	167.847	9.25%
80- 90	121.46	6.70%
90-100	85.018	4.69%
100-110	57.849	3.19%
110-120	37.128	2.05%
120-130	23.226	1.28%
130-140	14.17	0.78%
140-150	8.306	0.46%
150-160	4.555	0.25%
160-170	2.09	0.12%
170-180	0.523	0.03%
Total	1814.2	100%

γ(°)	Lumens	% Total
0- 60	1079.967	59.53%
60- 90	501.354	27.64%
0-90	1581.321	87.16%
90- 180	232.865	12.84%
0- 180	1814.2	100%

Table 5: Zonal Lumen Data

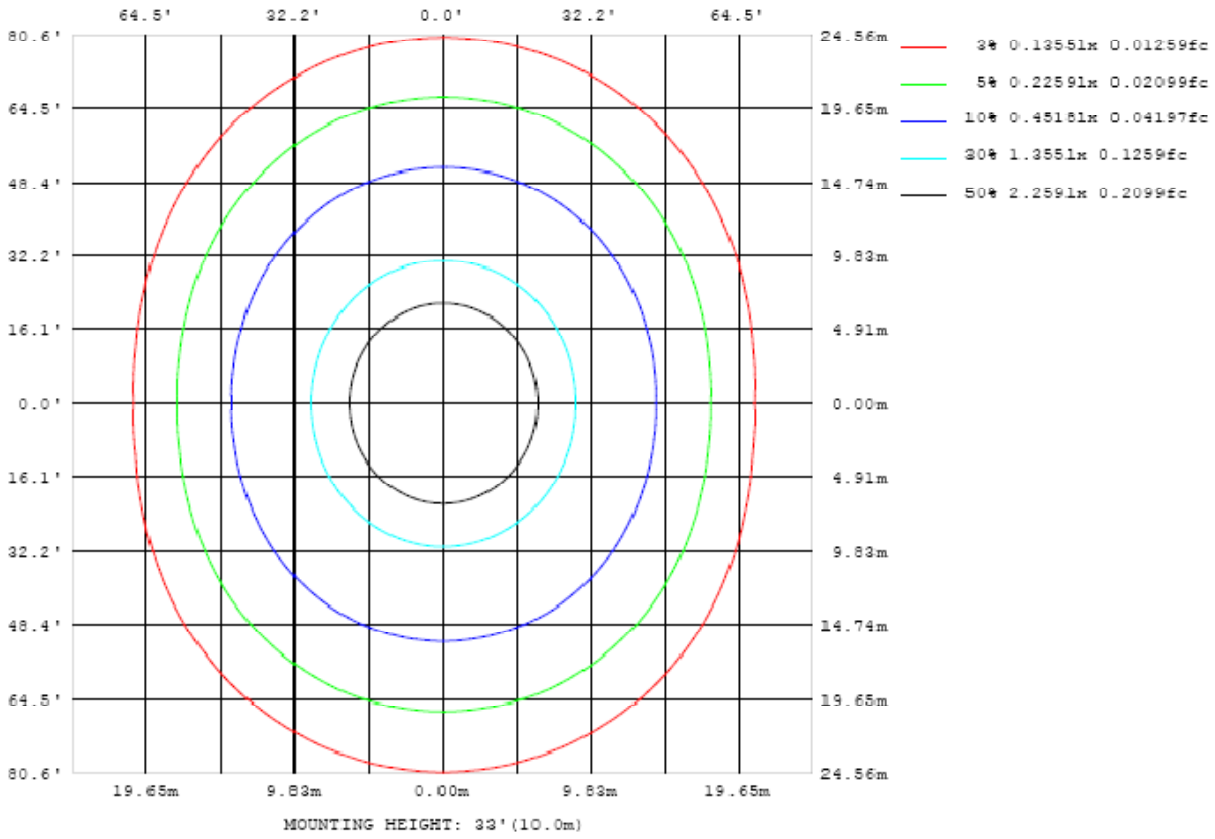


Chart 4: Beam Angle

Luminous Intensity Distribution Plots- Goniophotometer Method

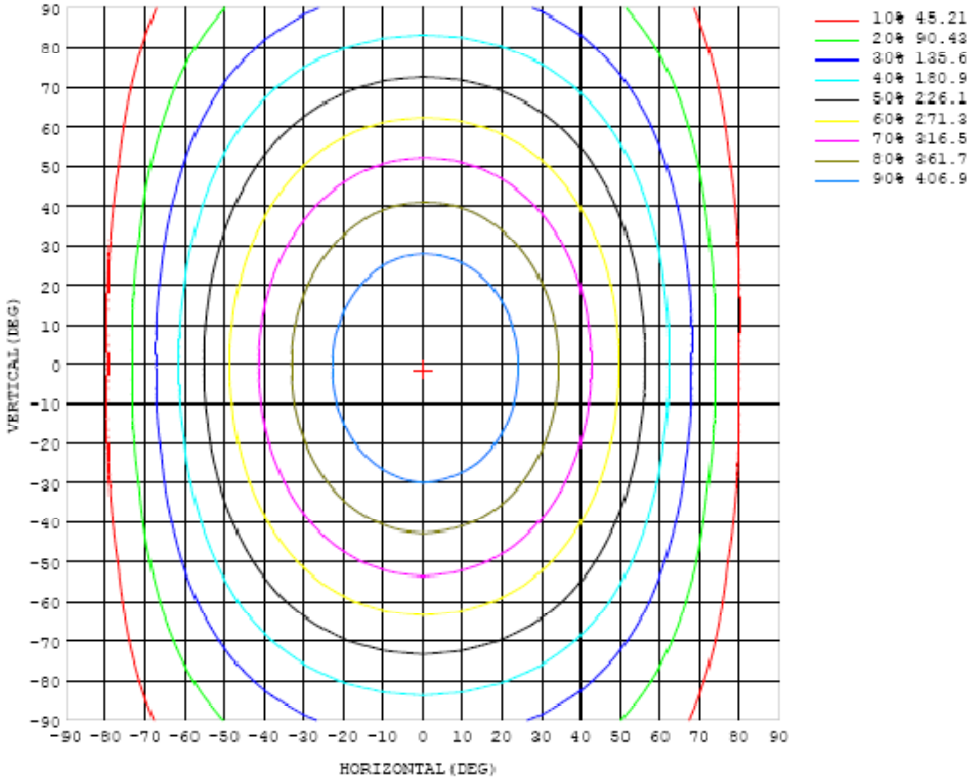


Chart 5: Illuminance Plot (Footcandles)

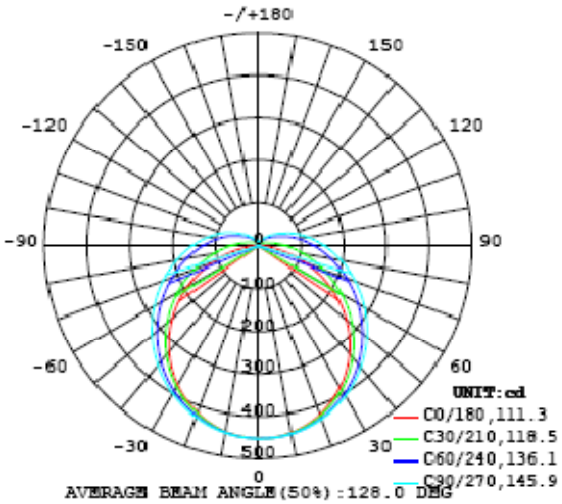


Chart 6: Polar Candela Distribution

Luminous Intensity Data- Goniophotometer Method

Table--1 UNIT: cd

γ (DEG) \ C (DEG)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
0	452	452	452	452	452	452	452	452	452	452	452	452	452	452	452	452	452	452	452
5	450	451	451	451	451	451	451	451	451	451	451	451	450	450	450	450	449	449	449
10	445	445	445	446	447	447	447	447	447	448	447	446	446	445	445	444	443	443	443
15	435	435	436	437	438	439	440	441	441	441	441	440	438	437	436	434	433	432	431
20	421	422	423	425	428	429	430	431	432	432	431	430	428	426	423	421	419	418	417
25	404	404	406	409	412	414	417	419	420	421	420	417	415	411	408	404	402	399	398
30	383	384	386	390	394	398	402	404	406	407	405	403	399	394	389	385	381	378	377
35	358	360	363	367	373	379	384	387	390	391	389	386	381	375	368	362	357	354	352
40	331	333	337	343	350	357	363	368	371	373	371	367	360	353	345	337	331	327	325
45	301	303	308	316	324	333	342	348	351	353	351	346	338	329	319	310	302	296	295
50	269	271	277	287	297	308	318	326	330	332	330	324	315	305	293	281	271	264	262
55	234	237	245	256	270	282	294	303	308	310	308	301	291	279	265	251	239	230	228
60	197	201	211	225	241	256	269	279	285	287	285	278	267	253	237	221	206	195	192
65	158	163	176	194	212	230	244	255	262	264	262	254	242	227	209	190	172	158	154
70	119	125	142	163	184	203	220	231	239	241	238	231	218	202	182	160	139	121	116
75	80.2	88.6	110	134	158	178	196	208	216	219	216	208	195	177	156	133	108	86.0	77.2
80	44.2	55.5	80.2	107	133	155	173	186	193	196	194	185	172	154	132	107	79.9	54.6	41.6
85	14.5	28.8	56.3	84.2	110	133	151	164	172	175	172	164	151	133	110	84.7	57.2	29.6	13.2
90	0.37	12.6	38.0	65.2	90.8	113	131	144	152	155	152	145	131	114	91.5	66.4	39.7	14.4	0.18
95	0.32	5.51	25.2	50.1	73.9	95.4	113	125	133	136	134	126	113	96.2	75.1	51.8	27.3	6.83	0.30
100	0.48	3.44	16.6	37.6	59.6	79.4	96.0	108	116	118	116	109	96.8	80.6	61.3	39.6	18.6	4.70	0.45
105	0.74	2.69	12.3	27.8	46.8	64.7	80.3	91.8	99.0	102	99.4	92.6	81.3	66.3	48.6	30.0	14.1	3.78	0.80
110	1.15	2.75	9.76	21.9	36.7	51.9	65.4	76.2	82.9	85.5	83.4	77.1	66.7	53.5	38.9	24.0	11.4	3.65	1.24
115	1.58	3.02	8.13	17.8	29.9	42.3	53.5	62.0	67.6	69.9	68.2	63.2	54.9	44.1	31.8	19.6	9.77	3.74	1.71
120	2.06	3.34	7.31	14.8	24.5	34.8	44.2	51.7	56.5	58.4	57.1	52.7	45.5	36.4	26.2	16.5	8.75	3.92	2.21
125	2.54	3.46	6.85	12.5	20.2	28.6	36.3	42.6	46.6	48.3	47.1	43.5	37.5	30.0	21.8	14.1	8.05	4.08	2.73
130	3.02	3.82	6.67	11.0	16.9	23.6	29.8	34.9	38.3	39.6	38.6	35.7	30.9	24.9	18.4	12.4	7.40	3.91	3.21
135	3.38	4.29	6.64	9.92	14.4	19.5	24.5	28.5	31.2	32.2	31.5	29.1	25.3	20.6	15.6	11.0	7.11	4.12	3.58
140	3.67	4.46	6.58	9.10	12.5	16.3	20.1	23.2	25.2	26.1	25.5	23.7	20.7	17.2	13.4	9.84	7.06	4.59	3.98
145	4.33	4.47	6.51	8.39	11.0	13.8	16.5	18.8	20.3	21.0	20.5	19.2	17.1	14.4	11.7	8.77	6.83	4.67	4.40
150	4.98	4.29	6.49	7.98	9.71	11.7	13.7	15.3	16.4	16.9	16.6	15.6	14.1	12.3	10.2	7.65	6.55	4.60	4.83
155	5.59	3.94	6.01	7.60	8.56	10.0	11.4	12.5	13.3	13.6	13.4	12.8	11.8	10.5	8.33	7.65	6.70	4.36	5.46
160	5.93	4.18	5.17	6.93	8.06	8.65	9.61	10.4	10.9	11.1	11.0	10.6	9.82	8.24	7.87	6.95	5.84	4.24	5.16
165	5.82	4.39	4.19	4.74	6.18	7.86	8.46	8.81	9.11	9.23	9.21	8.66	7.49	6.41	5.84	5.34	4.48	4.09	4.85
170	5.65	4.33	3.92	3.99	4.08	4.39	4.60	6.47	7.76	7.87	6.08	4.68	4.79	4.51	4.35	4.17	4.06	4.11	4.37
175	5.44	4.66	4.58	4.43	4.56	5.00	5.45	5.57	5.12	2.60	5.23	5.67	5.37	5.10	4.85	4.52	4.16	4.12	4.12
180	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90

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	452	452	452	452	452	452	452	452	452	452	452	452	452	452	452	452	452
5	449	449	449	449	449	449	450	450	450	450	450	450	450	450	450	450	450
10	442	442	443	443	443	444	445	445	445	445	445	445	445	445	445	445	445
15	431	432	432	433	435	436	437	437	438	438	437	437	437	436	436	435	435
20	417	418	419	421	422	424	426	427	428	428	427	426	425	424	424	422	421
25	399	400	402	404	407	410	413	414	415	415	414	413	411	409	407	405	404
30	378	379	382	386	390	394	397	399	400	400	399	397	394	390	388	385	383
35	353	356	360	364	370	375	380	383	384	384	382	378	374	370	365	362	359
40	326	329	334	341	348	355	360	364	366	365	363	359	353	346	341	336	332
45	297	301	307	316	324	333	340	344	346	345	342	337	329	321	314	308	303
50	264	270	278	289	300	310	318	323	325	324	320	314	305	295	285	277	271
55	231	238	249	261	274	286	295	302	304	303	298	290	280	267	255	245	238
60	195	204	218	233	248	262	272	279	282	280	275	266	254	239	225	211	202
65	156	171	188	206	223	237	249	257	260	258	252	241	228	211	194	178	165
70	122	138	158	179	198	214	227	234	237	235	229	218	202	184	164	145	128
75	86.2	107	131	154	174	191	204	213	215	213	207	194	178	158	136	113	91.7
80	53.6	78.5	105	130	152	169	183	191	194	192	185	172	156	135	110	83.7	58.6
85	20.2	50.3	83.4	109	131	149	162	171	174	172	164	152	135	113	87.7	59.6	32.1
90	13.0	37.9	64.9	90.3	112	130	144	152	154	152	146	133	115	93.8	68.5	41.2	15.6
95	5.96	26.1	50.4	74.2	95.3	113	126	134	137	134	127	115	98.0	77.0	53.3	28.4	7.26
100	4.08	17.6	38.9	60.7	80.5	96.9	109	117	119	117	110	98.6	82.7	63.0	41.2	19.4	4.53
105	3.48	13.2	29.5	48.9	67.2	82.3	94.0	101	104	101	94.8	83.9	69.0	50.9	31.2	14.1	3.73
110	3.57	10.8	23.4	38.7	54.6	68.8	79.7	86.4	88.6	86.7	80.5	70.2	56.3	39.9	24.2	11.0	3.58
115	3.74	9.35	19.2	31.5	44.2	55.6	65.5	71.8	74.1	72.2	66.3	56.5	44.9	32.1	19.7	9.31	3.62
120	4.04	8.52	16.2	26.0	36.4	45.8	53.4	58.2	59.9	58.3	53.7	46.2	36.8	26.4	16.2	8.33	3.89
125	4.37	7.96	14.0	21.8	30.2	37.9	44.0	48.0	49.3	48.0	44.2	38.1	30.4	22.0	13.8	7.80	4.21
130	4.68	7.61	12.4	18.5	25.1	31.3	36.2	39.5	40.6	39.6	36.4	31.4	25.2	18.4	12.2	7.44	4.50
135	4.96	7.35	11.0	15.8	21.0	25.8	29.7	32.3	33.3	32.4	29.9	25.9	21.0	15.7	10.9	7.29	4.79
140	5.34	7.24	10.1	13.7	17.7	21.3	24.3	26.4	27.1	26.4	24.5	21.4	17.7	13.6	9.97	7.18	5.03
145	5.60	7.13	9.33	12.0	14.9	17.7	19.9	21.4	22.0	21.5	20.0	17.7	14.9	11.9	9.21	7.10	5.50
150	5.88	6.95	8.63	10.6	12.7	14.6	16.3	17.4	17.8	17.4	16.4	14.6	12.6	10.5	8.65	6.93	5.62
155	6.18	6.90	7.64	9.31	10.9	12.2	13.2	14.0	14.3	14.1	13.3	12.2	10.9	9.52	8.12	6.69	6.05
160	6.38	6.83	7.38	8.38	9.41	10.3	10.9	11.4	11.6	11.5	11.1	10.4	9.58	8.66	7.61	6.91	6.41
165	5.79	6.41	7.00	7.29	8.02	8.70	9.15	9.44	9.60	9.56	9.35	8.99	8.46	7.71	7.29	7.06	6.74
170	4.89	5.24	5.75	6.44	6.88	7.08	7.55	7.81	7.88	7.86	7.74	7.59	7.49	7.42	7.24	7.00	6.79
175	4.17	4.28	4.48	4.83	5.43	6.09	6.48	6.72	6.95	7.11	7.19	7.13	7.05	7.00	6.95	6.84	6.39
180	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90

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 expended 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 expended uncertainty is 2.3% with a coverage factor k=2.

Color Characteristics Measurements

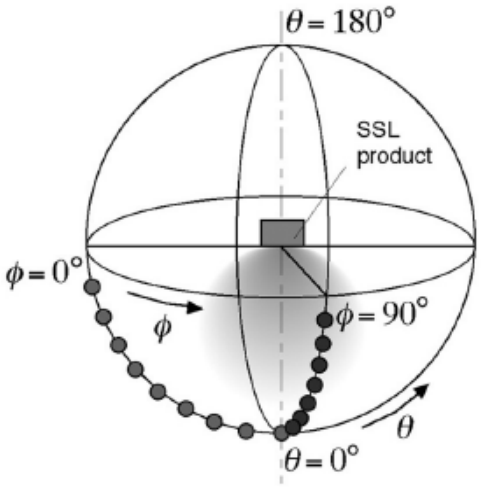
The color characteristics of SSL products include chromaticity coordinates, correlated color temperature, and color rendering index. These characteristics of SSL products may be spatially non-uniform, and thus, in order that they can be specified accurately, the color quantities shall be measured as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