



LM-79-08 Test Report

for

Revolution Lighting Technologies, Inc.

2280 Ward Ave. Simi Valley, CA 93065

LED Tube

Model: 202101-113

Laboratory: Leading Testing Laboratories

NVLAP CODE: 200960-0

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Report No.: HZ18110016p

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: 202101-113

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)	Power Factor
133.4	1450.0	10.87	0.9792
CCT (K)	CRI	Stabilization Time (Light & Power)	
4007	82.4	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

TABLE OF CONTENT

LM-79-08 Test Report.....	1
Test Summary.....	2
Sample Photo.....	4
TEST RESULTS	5
Goniophotometer Method	6
Spectral Power Distribution - Sphere Spectroradiometer Method	7
Chromaticity Diagram - Sphere Spectroradiometer Method.....	8
Nominal CCT Quadrangles – Sphere Spectroradiometer Method	9
Note: The location on the diagram of the tristimulus coordinates are indicated by the blue diamond.Zonal	
Lumen Tabulation- Goniophotometer Method.....	9
Zonal Lumen Tabulation- Goniophotometer Method	10
Luminous Intensity Data- Goniophotometer Method.....	13
EQUIPMENT LIST	15
TEST METHODS	15
Seasoning of SSL Product.....	15
Sphere-Spectroradiometer Method- Photometric and Electrical Measurements.....	15
Goniophotometer Method	16
Photometric and Electrical Measurements.....	16
Color Characteristics Measurements.....	16
Color Spatial Uniformity	16

Sample Photo

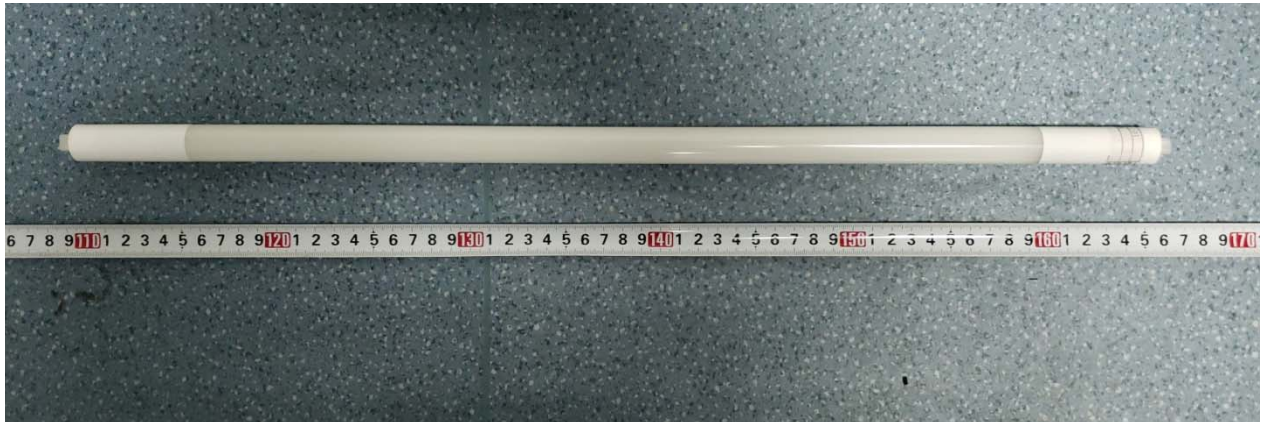


Figure 1- Overview of the sample

Equipment Under Test (EUT)

Name	: LED Tube
Model	: 202101-113
Electrical Ratings	: 120-277V, 60Hz
Product Description	: 4000K
Manufacturer	: Revolution Lighting Technologies, Inc.
Address	: 2280 Ward Ave. Simi Valley, CA 93065

TEST RESULTS

Test ambient temperature was 25.0°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)	0.093	0.043
Power Factor	0.9792	0.9363
Test Power (W)	10.87	11.26
THD A%	19.10	25.86
Luminous Efficacy (lm/W)	133.4	129.0
Total Luminous Flux (lm)	1450.0	1452.0
Color Rendering Index (CRI)	82.4	
R9	3.9	
Correlated Color Temperature (CCT)(K)	4007	
Chromaticity Chroma x	0.3812	
Chromaticity Chroma y	0.3810	
Chromaticity Chroma u	0.2239	
Chromaticity Chroma v	0.3357	
Duv	0.0010	
Chromaticity Chroma u'	0.2239	
Chromaticity Chroma v'	0.5036	

Special Color Rendering Indices	
R1	80.3
R2	89
R3	95.4
R4	80.9
R5	80.5
R6	84.9
R7	85.6
R8	62.8
R9	3.9
R10	74.2
R11	79.8
R12	61.6
R13	82.5
R14	97.7

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 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)	0.093
Power Factor	0.9808
Power (W)	10.94
Luminous Efficacy (lm/W)	131.7
Total Luminous Flux (lm)	1441.1
Beam Angle (°)	110.0 (0°-180°) /146.2 (90°-270°)
Center Beam Candle Power (cd)	362
Maximum Beam Candle Power (cd)	363.2 (At: C=60.0, Gamma=3.5)
Spacing Criteria	1.24 (0°-180°) /1.33 (90°-270°)
Zonal Lumens in the 0°-60°Zone	59.83%
Zonal Lumens in the 60°-90°Zone	27.68%
Zonal Lumens in the 90°-120°Zone	9.80%
Zonal Lumens in the 120°-180°Zone	2.70%

Table 3: Test data per Goniophotometer Method

Spectral Power Distribution - Sphere Spectroradiometer Method

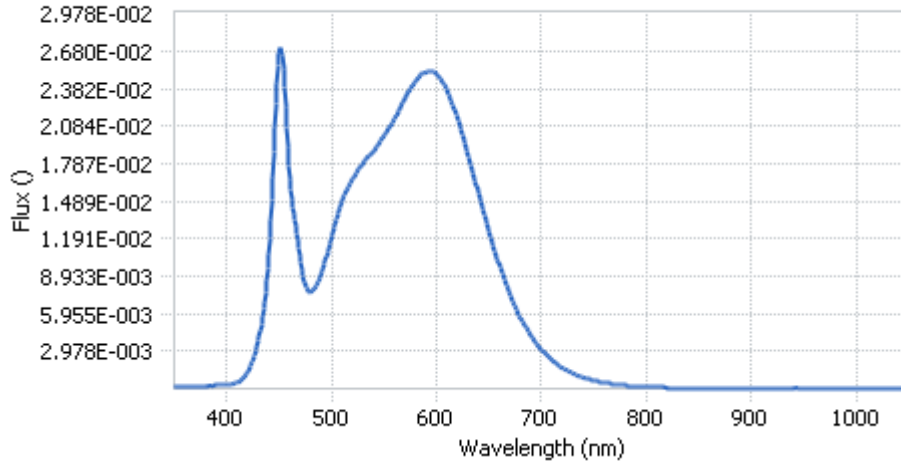
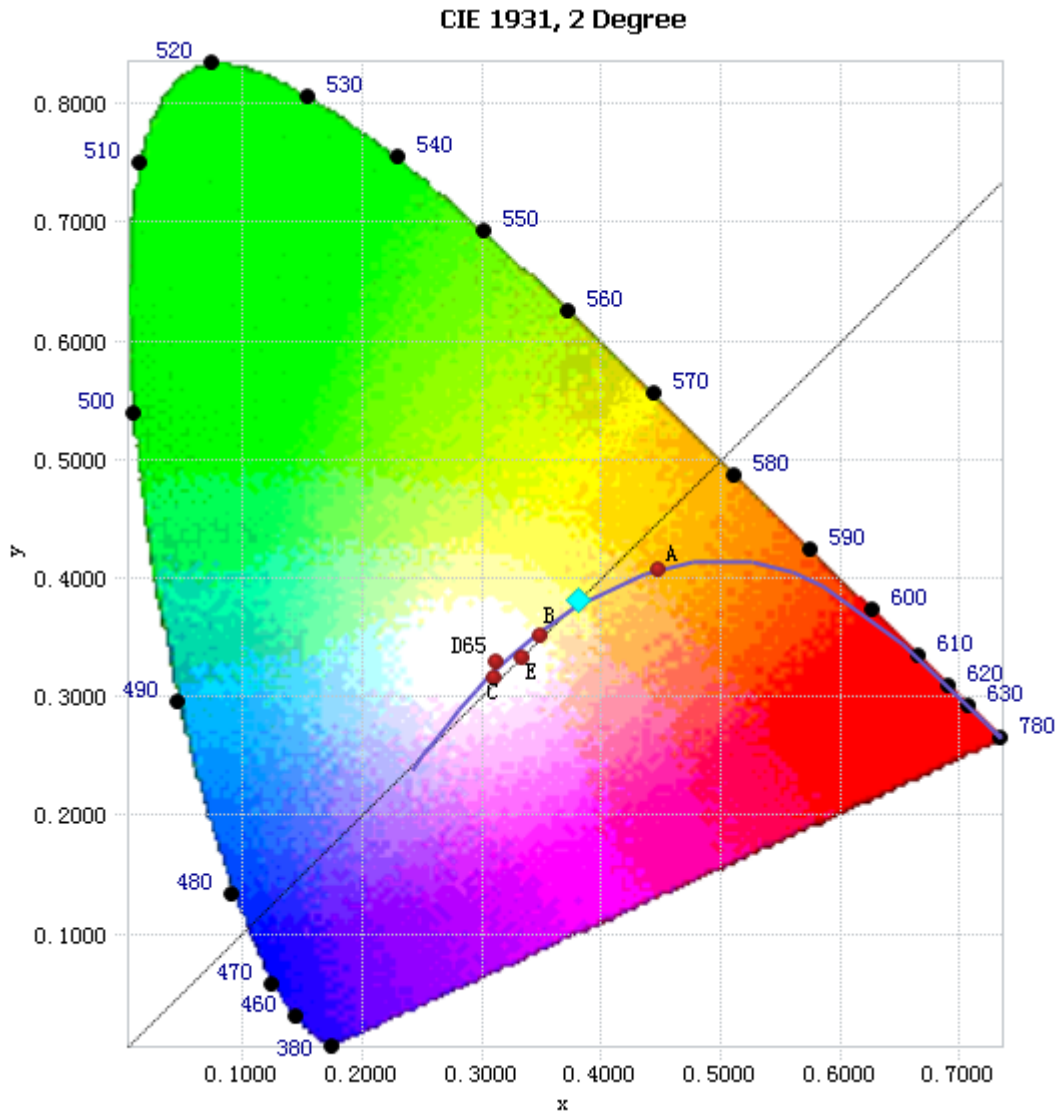


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	2.48E-04	485	8.13E-03	590	2.51E-02	695	3.61E-03
385	2.39E-04	490	9.05E-03	595	2.52E-02	700	3.11E-03
390	2.65E-04	495	1.05E-02	600	2.49E-02	705	2.66E-03
395	2.90E-04	500	1.21E-02	605	2.44E-02	710	2.28E-03
400	3.06E-04	505	1.36E-02	610	2.37E-02	715	1.95E-03
405	3.76E-04	510	1.49E-02	615	2.26E-02	720	1.68E-03
410	5.27E-04	515	1.59E-02	620	2.14E-02	725	1.43E-03
415	8.09E-04	520	1.67E-02	625	2.00E-02	730	1.23E-03
420	1.35E-03	525	1.73E-02	630	1.85E-02	735	1.04E-03
425	2.27E-03	530	1.79E-02	635	1.70E-02	740	8.97E-04
430	3.77E-03	535	1.84E-02	640	1.55E-02	745	7.63E-04
435	6.31E-03	540	1.89E-02	645	1.39E-02	750	6.53E-04
440	1.07E-02	545	1.95E-02	650	1.25E-02	755	5.67E-04
445	1.87E-02	550	2.01E-02	655	1.11E-02	760	4.87E-04
450	2.67E-02	555	2.07E-02	660	9.77E-03	765	4.22E-04
455	2.40E-02	560	2.15E-02	665	8.58E-03	770	3.64E-04
460	1.66E-02	565	2.22E-02	670	7.49E-03	775	3.12E-04
465	1.33E-02	570	2.30E-02	675	6.53E-03	780	2.71E-04
470	1.05E-02	575	2.38E-02	680	5.64E-03		
475	8.21E-03	580	2.45E-02	685	4.90E-03		
480	7.69E-03	585	2.50E-02	690	4.21E-03		

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

Chromaticity Diagram - Sphere Spectroradiometer Method



Tristimulus values(x, y): (0.3812, 0.3810)

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

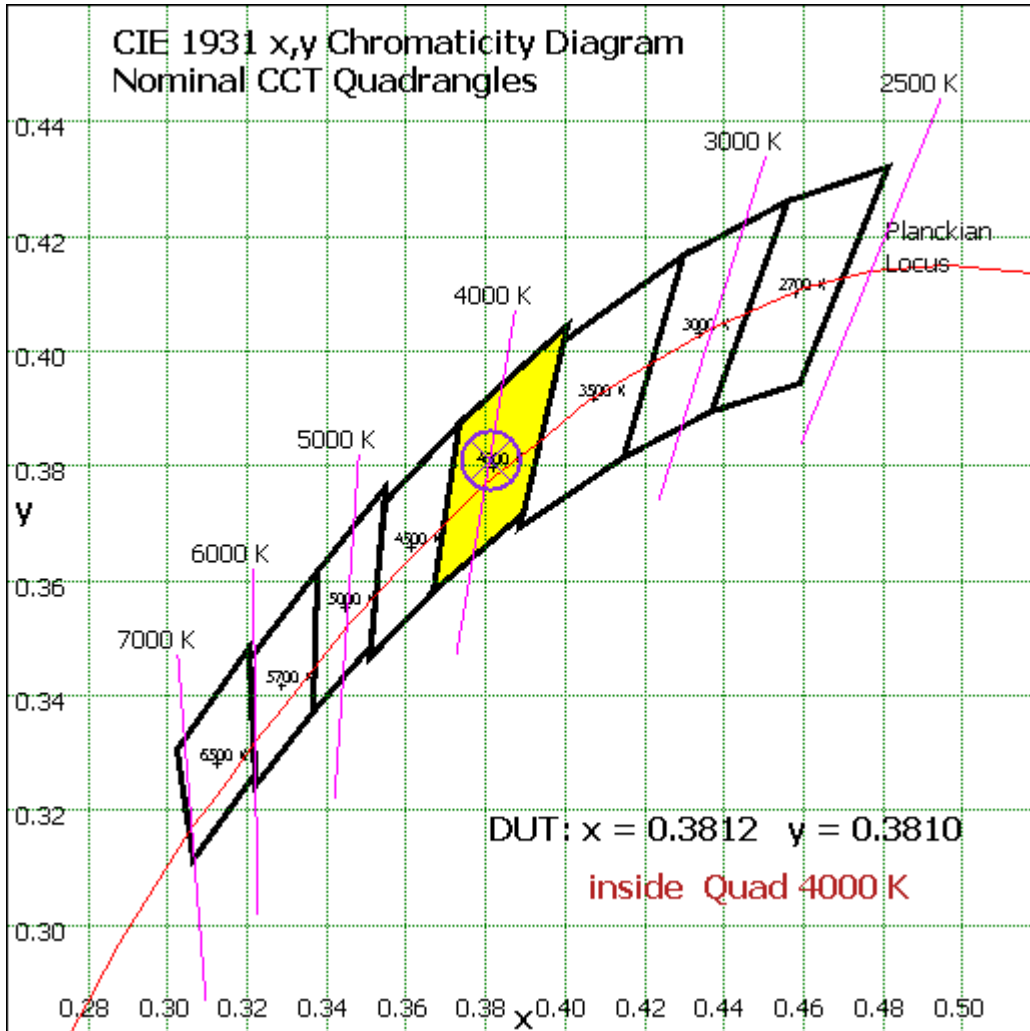


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

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	34.352	2.38%
10- 20	98.799	6.86%
20- 30	151.214	10.49%
30- 40	185.736	12.89%
40- 50	199.482	13.84%
50- 60	192.635	13.37%
60- 70	168.569	11.70%
70- 80	133.503	9.26%
80- 90	96.758	6.71%
90-100	67.519	4.69%
100-110	45.256	3.14%
110-120	28.416	1.97%
120-130	17.257	1.20%
130-140	10.383	0.72%
140-150	6.031	0.42%
150-160	3.302	0.23%
160-170	1.504	0.10%
170-180	0.379	0.03%
Total	1441.1	100%

$\gamma(^{\circ})$	Lumens	% Total
0- 60	862.218	59.83%
60- 90	398.83	27.68%
0-90	1261.048	87.51%
90- 180	180.047	12.49%
0- 180	1441.1	100%

Table 5: Zonal Lumen Data

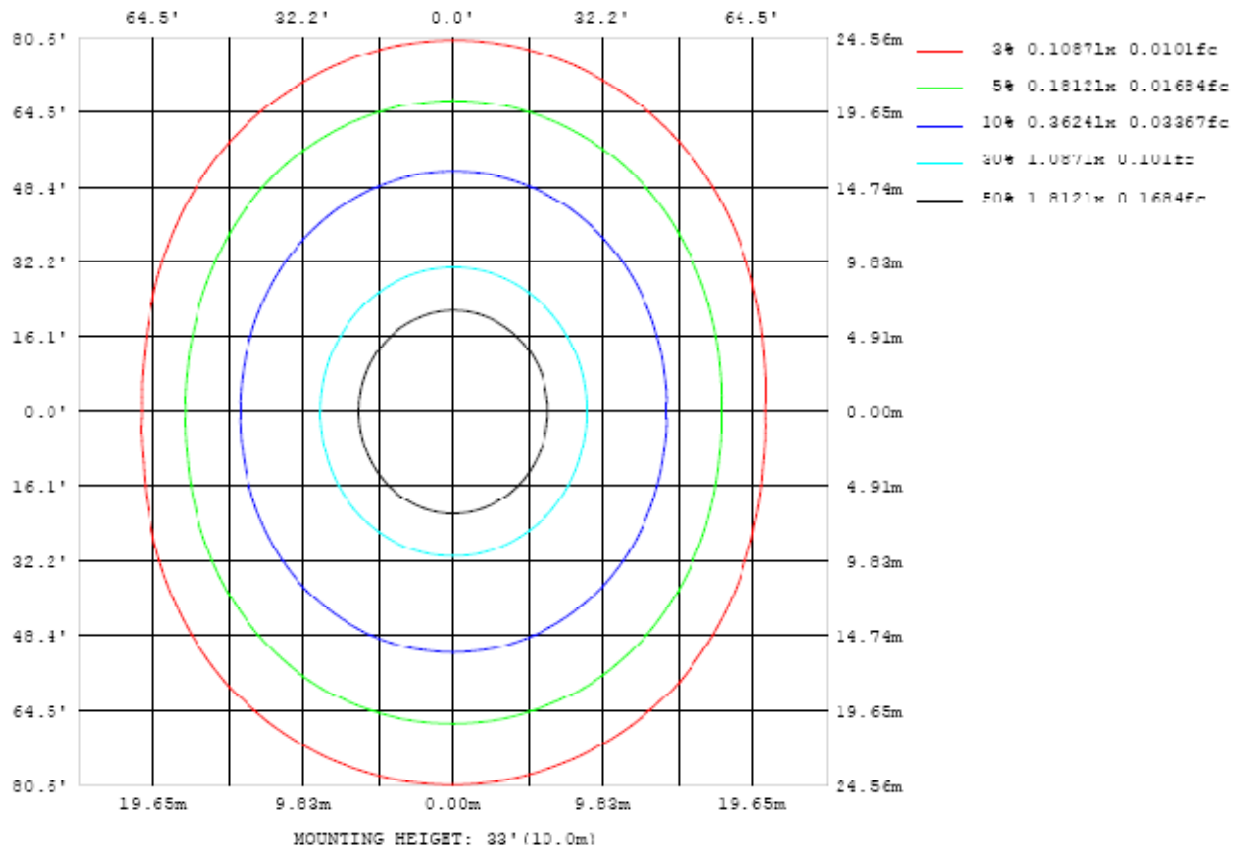


Chart 4: Beam Angle

Luminous Intensity Distribution Plots- Goniophotometer Method

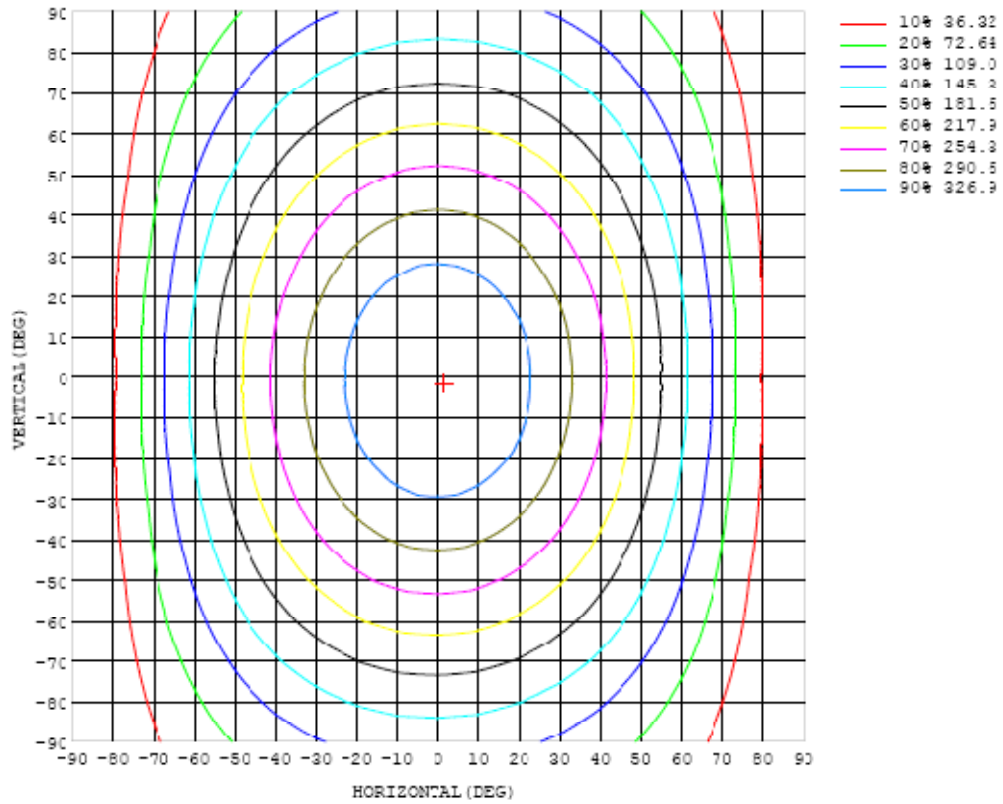


Chart 5: Illuminance Plot (Footcandles)

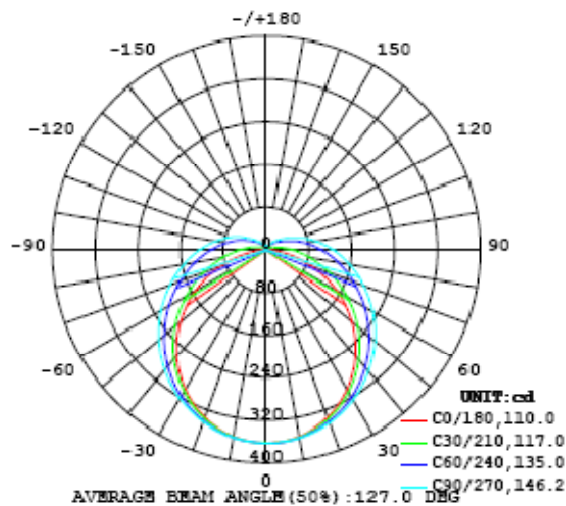


Chart 6: Polar Candela Distribution

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	352	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362
5	351	361	361	361	361	361	362	362	362	362	362	362	362	362	361	361	360	361	361
10	356	366	366	367	367	368	368	369	369	368	369	369	368	368	367	366	366	366	366
15	347	347	348	350	350	351	352	353	354	353	353	353	352	351	349	349	348	347	347
20	335	335	337	338	340	341	343	345	346	346	346	345	344	342	340	339	337	335	335
25	320	320	322	325	327	330	332	335	337	337	337	336	333	331	328	325	322	321	320
30	302	303	305	308	312	316	320	323	325	325	325	324	320	317	313	309	306	303	303
35	282	283	286	290	295	300	305	309	312	312	312	310	306	301	296	291	287	284	282
40	250	261	264	269	276	283	288	294	298	298	298	294	290	284	277	271	265	262	260
45	235	237	241	247	255	263	271	277	282	283	282	279	272	265	257	249	242	237	235
50	209	211	216	224	234	244	252	259	264	266	265	261	254	245	235	226	218	212	209
55	181	184	190	200	211	223	235	241	247	248	248	243	235	225	214	202	192	184	182
60	152	155	163	175	188	202	213	222	229	231	229	224	215	204	191	177	165	156	153
65	122	126	136	150	166	181	193	203	210	212	211	206	196	183	169	153	138	127	123
70	91.8	96.5	110	126	144	160	174	185	192	194	193	187	177	163	147	129	112	97.9	91.8
75	62.1	68.1	84.0	104	122	140	155	166	174	176	175	168	158	144	127	107	87.3	69.8	61.4
80	34.1	42.1	61.6	82.6	103	122	137	148	156	158	157	150	140	125	107	86.8	65.8	44.9	33.3
85	11.6	21.5	42.6	64.8	85.6	104	119	131	139	142	140	134	123	108	89.9	68.9	46.9	24.9	10.8
90	0.77	3.08	28.2	49.8	70.2	88.6	104	115	123	125	124	117	107	92.3	74.4	54.3	32.6	12.3	0.35
95	0.36	3.33	18.1	37.5	57.1	74.4	89.1	100.0	107	110	109	102	92.1	78.0	61.3	41.9	22.0	5.79	0.30
100	0.42	2.04	10.9	26.9	44.9	61.9	75.4	85.8	92.9	95.4	94.1	88.2	78.2	65.1	49.0	30.9	14.4	3.76	0.35
105	0.54	1.54	8.17	19.1	33.5	48.7	62.1	71.9	78.5	80.9	79.7	74.0	64.8	52.2	37.4	23.2	10.8	2.87	0.62
110	0.83	1.67	6.38	15.1	26.1	37.8	48.6	57.8	64.0	66.3	64.9	59.9	51.5	41.4	30.0	18.3	8.70	2.75	0.97
115	1.13	1.95	5.22	12.1	21.2	30.9	39.6	46.7	51.7	53.7	52.9	48.9	42.4	33.9	24.3	14.9	7.41	2.82	1.33
120	1.47	2.25	4.83	9.99	17.3	25.3	32.7	38.6	42.7	44.3	43.6	40.3	34.8	27.8	19.9	12.4	6.60	2.94	1.70
125	1.83	2.48	4.67	8.48	14.2	20.7	26.7	31.6	35.0	36.4	35.7	33.0	28.5	22.8	16.5	10.6	6.04	3.09	2.09
130	2.19	2.65	4.62	7.55	11.9	17.0	21.9	25.8	28.6	29.7	29.1	26.9	23.3	18.8	13.8	9.18	5.70	3.22	2.41
135	2.62	2.80	4.60	6.91	10.2	14.1	17.9	21.0	23.2	24.1	23.6	21.9	19.0	15.4	11.5	8.03	5.38	3.29	2.61
140	2.91	2.84	4.60	6.43	8.88	11.8	14.7	17.0	18.7	19.4	19.1	17.7	15.5	12.7	9.84	7.24	5.22	3.42	2.94
145	3.14	2.78	4.49	6.02	7.87	9.91	12.0	13.7	15.0	15.5	15.2	14.2	12.6	10.6	8.58	6.65	5.12	3.52	3.27
150	3.48	2.89	4.19	5.66	6.94	8.44	9.88	11.1	12.0	12.3	12.2	11.5	10.3	9.02	7.60	6.21	4.88	3.52	3.59
155	3.86	3.29	3.37	5.01	6.33	7.29	8.28	9.08	9.68	9.93	9.82	9.37	8.66	7.77	6.77	5.81	4.33	3.52	3.94
160	3.69	3.70	2.79	4.59	5.72	6.41	7.01	7.57	7.92	8.11	8.05	7.77	7.34	6.75	6.11	5.22	3.59	3.62	4.15
165	4.22	3.80	3.29	2.86	3.74	4.14	5.51	6.42	6.56	6.66	6.65	6.13	5.48	5.06	4.66	3.71	3.53	3.82	4.32
170	4.38	3.99	3.27	2.76	2.60	2.59	2.72	2.75	2.97	2.27	3.34	3.39	3.38	3.30	3.23	3.23	3.25	3.72	4.30
175	4.47	4.42	3.99	3.34	2.69	2.44	2.37	2.21	1.40	1.49	2.56	2.95	2.98	2.97	2.96	3.02	3.25	3.52	3.71
180	4.37	4.37	4.37	4.37	4.37	4.37	4.37	4.37	4.37	4.37	4.37	4.37	4.37	4.37	4.37	4.37	4.37	4.37	4.37

Table 6: Luminous Intensity Data

Table--2 UNIT: cd

C (DEG) γ (DEG)	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350		
0	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362		
5	361	361	360	361	361	361	361	361	361	360	362	362	362	361	361	362	362		
10	355	356	356	356	357	357	358	357	358	358	357	357	357	356	356	356	356		
15	347	347	348	349	350	351	352	351	351	352	351	351	350	349	348	348	347		
20	335	336	337	338	340	342	343	344	344	344	343	341	340	339	338	336	335		
25	320	322	324	326	328	331	332	334	334	334	332	330	328	325	324	322	321		
30	303	305	307	310	314	318	319	322	323	322	320	317	314	310	308	305	303		
35	283	285	289	293	298	302	305	309	309	309	306	303	298	293	289	286	282		
40	261	264	268	273	280	286	290	294	295	294	290	286	280	274	269	264	260		
45	237	240	246	253	261	268	273	278	279	278	274	268	261	254	247	241	237		
50	211	215	222	231	240	249	256	260	262	261	257	250	242	232	224	216	211		
55	183	189	198	208	219	229	237	243	245	243	238	230	221	210	199	191	184		
60	155	162	173	186	199	209	219	225	226	225	219	211	200	188	175	164	156		
65	126	135	149	163	178	190	200	207	209	207	201	192	180	166	151	138	127		
70	96.3	108	125	142	157	171	181	188	191	189	183	173	159	144	128	112	98.6		
75	67.4	83.1	102	121	139	153	164	171	173	171	165	155	141	124	106	86.9	70.6		
80	41.5	60.7	81.8	102	120	135	147	154	156	155	148	137	123	105	85.6	64.7	45.4		
85	21.5	42.2	64.2	85.1	104	119	130	138	140	138	132	121	106	88.3	67.9	46.2	25.4		
90	9.46	28.5	49.8	70.2	88.3	103	115	122	124	123	116	105	90.7	73.1	53.4	32.3	12.4		
95	4.15	19.3	38.3	57.4	74.7	88.9	99.9	107	110	107	101	90.9	77.1	60.2	41.5	22.4	6.12		
100	2.65	12.4	29.4	46.8	62.7	76.2	86.5	93.3	95.6	93.8	87.9	78.2	64.9	49.3	32.3	15.3	3.57		
105	2.23	9.08	21.5	37.6	52.3	64.7	74.4	80.6	82.8	81.1	75.5	66.5	54.4	40.0	24.4	10.6	2.81		
110	2.39	7.30	16.5	28.6	42.5	54.2	63.0	68.9	71.0	69.4	64.2	55.9	44.5	31.0	18.2	8.14	2.59		
115	2.54	6.33	13.4	22.8	32.8	43.4	52.0	57.5	59.4	57.9	53.1	45.1	34.6	23.9	14.3	6.71	2.62		
120	2.79	5.86	11.3	18.6	26.6	34.2	40.4	45.3	47.2	45.7	41.3	34.9	27.5	19.4	11.9	5.98	2.72		
125	3.04	5.53	9.74	15.4	21.9	27.8	32.7	36.2	37.3	36.3	33.2	28.4	22.4	16.0	9.96	5.52	2.96		
130	3.26	5.33	8.67	13.1	18.1	22.8	26.7	29.2	30.1	29.4	27.0	23.2	18.5	13.4	8.71	5.33	3.26		
135	3.38	5.14	7.79	11.2	15.0	18.7	21.7	23.8	24.5	23.9	22.0	19.0	15.3	11.4	7.84	5.16	3.38		
140	3.51	5.01	7.10	9.67	12.5	15.3	17.7	19.3	19.8	19.4	17.9	15.6	12.8	9.86	7.22	5.14	3.61		
145	3.80	4.97	6.60	8.53	10.6	12.7	14.4	15.6	16.1	15.7	14.5	12.8	10.8	8.68	6.72	4.86	3.84		
150	4.05	4.70	6.17	7.60	9.11	10.5	11.7	12.6	12.8	12.6	11.8	10.7	9.23	7.71	6.24	4.83	4.10		
155	4.43	4.86	5.66	6.81	7.86	8.84	9.67	10.2	10.4	10.2	9.74	8.94	7.98	6.91	5.66	4.82	4.28		
160	4.58	4.97	5.29	5.89	6.76	7.46	8.00	8.35	8.47	8.38	8.07	7.58	6.96	6.11	5.33	4.86	4.40		
165	4.60	4.80	5.14	5.45	5.72	6.06	6.48	6.80	6.90	6.84	6.58	6.32	6.03	5.56	5.21	4.93	4.67		
170	4.58	4.73	4.65	4.83	5.31	5.55	5.63	5.66	5.68	5.70	5.67	5.55	5.40	5.22	5.03	4.88	4.66		
175	4.05	4.47	4.63	4.56	4.47	4.59	4.81	4.94	5.00	5.02	5.01	4.99	4.94	4.88	4.78	4.66	4.52		
180	4.37	4.37	4.37	4.37	4.37	4.37	4.37	4.37	4.37	4.37	4.37	4.37	4.37	4.37	4.37	4.37	4.37		

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

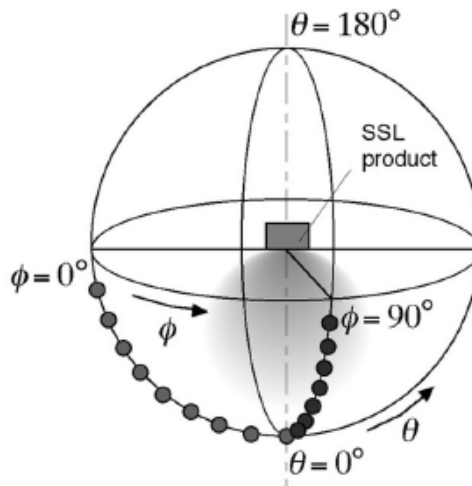
The color characteristics of SSL products include chromaticity coordinates, correlated color temperature, and color rendering index. These characteristics of SSL products may be spatially non-uniform, and thus, in order that they can be specified accurately, the color quantities shall be measured as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