



LM-79-08 Test Report

for

Revolution Lighting Technologies, Inc.

2280 Ward Ave. Simi Valley, CA 93065

LED Tube

Model: 202100-113

Laboratory: Leading Testing Laboratories

NVLAP CODE: 200960-0

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Report No.: HZ18110016j

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: 202100-113

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)	Power Factor
136.5	1252.0	9.17	0.9840
CCT (K)	CRI	Stabilization Time (Light & Power)	
3939	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

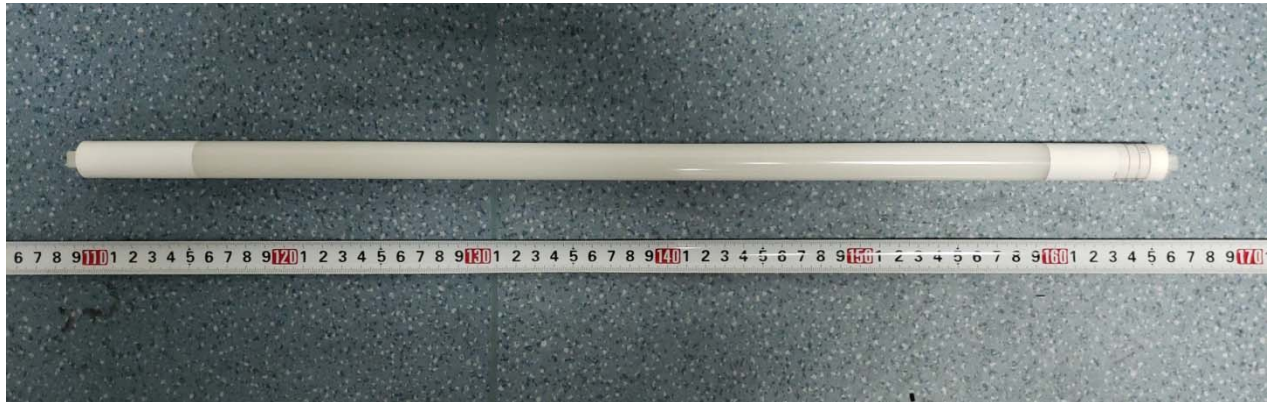


Figure 1- Overview of the sample

Equipment Under Test (EUT)

Name	: LED Tube
Model	: 202100-113
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 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)	0.078	0.038
Power Factor	0.9840	0.9185
Test Power (W)	9.17	9.55
THD A%	15.41	28.48
Luminous Efficacy (lm/W)	136.5	131.1
Total Luminous Flux (lm)	1252.0	1252.0
Color Rendering Index (CRI)	81.8	
R9	0.8	
Correlated Color Temperature (CCT)(K)	3939	
Chromaticity Chroma x	0.3852	
Chromaticity Chroma y	0.3861	
Chromaticity Chroma u	0.2245	
Chromaticity Chroma v	0.3376	
Duv	0.0029	
Chromaticity Chroma u'	0.2245	
Chromaticity Chroma v'	0.5064	

Special Color Rendering Indices	
R1	79.4
R2	88.3
R3	95.5
R4	80.4
R5	79.6
R6	84.3
R7	85.5
R8	61.6
R9	0.8
R10	72.8
R11	79.2
R12	60.8
R13	81.5
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 25.0 °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)	0.078
Power Factor	0.9846
Power (W)	9.20
Luminous Efficacy (lm/W)	135.2
Total Luminous Flux (lm)	1243.8
Beam Angle (°)	109.9 (0°-180°) /146.5(90°-270°)
Center Beam Candle Power (cd)	313
Maximum Beam Candle Power (cd)	312.8(At: C=250.0, Gamma=1.5)
Spacing Criteria	1.24 (0°-180°) /1.34 (90°-270°)
Zonal Lumens in the 0°-60°Zone	59.75%
Zonal Lumens in the 60°-90°Zone	27.69%
Zonal Lumens in the 90°-120°Zone	9.82%
Zonal Lumens in the 120°-180°Zone	2.74%

Table 3: Test data per Goniophotometer Method

Spectral Power Distribution - Sphere Spectroradiometer Method

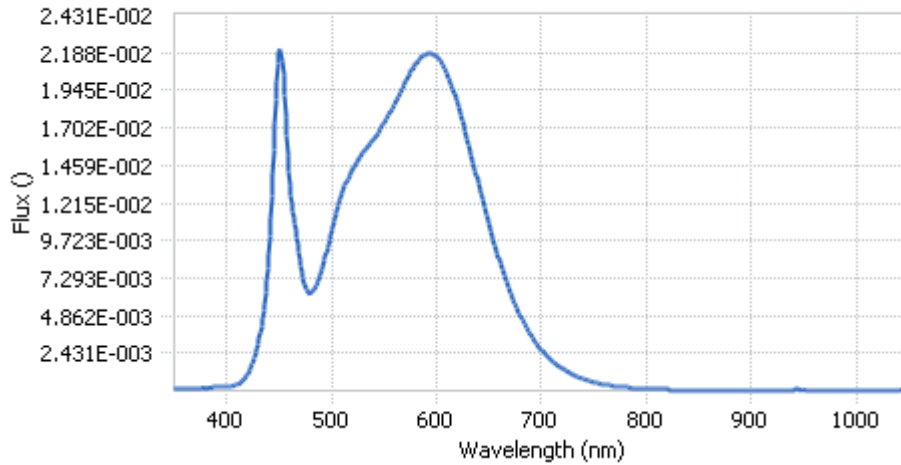
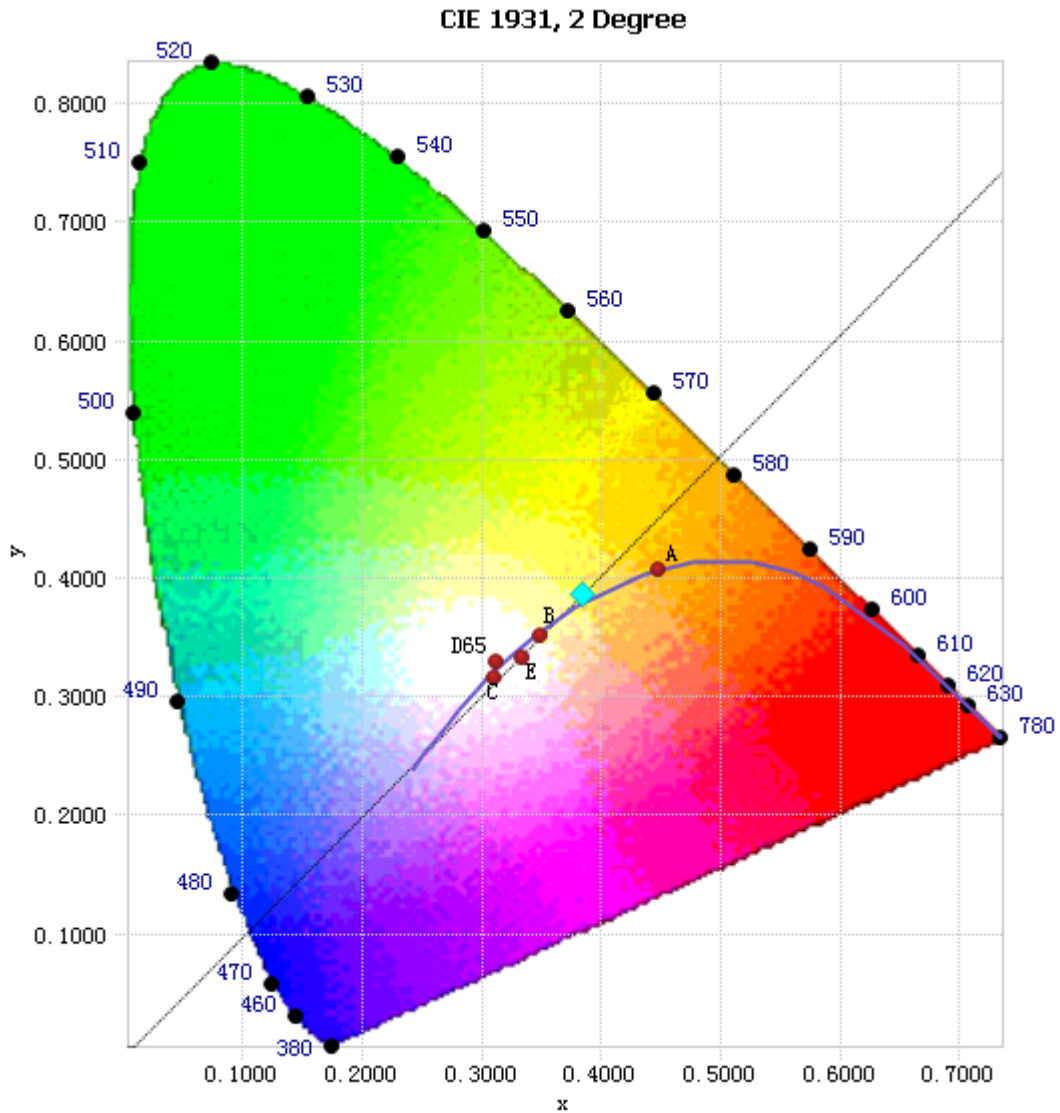


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	1.95E-04	485	6.81E-03	590	2.18E-02	695	3.09E-03
385	1.90E-04	490	7.63E-03	595	2.18E-02	700	2.64E-03
390	2.14E-04	495	8.92E-03	600	2.16E-02	705	2.26E-03
395	2.37E-04	500	1.04E-02	605	2.12E-02	710	1.94E-03
400	2.60E-04	505	1.17E-02	610	2.05E-02	715	1.65E-03
405	3.12E-04	510	1.28E-02	615	1.96E-02	720	1.42E-03
410	4.28E-04	515	1.37E-02	620	1.85E-02	725	1.22E-03
415	6.68E-04	520	1.44E-02	625	1.74E-02	730	1.04E-03
420	1.10E-03	525	1.49E-02	630	1.61E-02	735	8.81E-04
425	1.86E-03	530	1.55E-02	635	1.47E-02	740	7.51E-04
430	3.06E-03	535	1.59E-02	640	1.34E-02	745	6.43E-04
435	5.18E-03	540	1.63E-02	645	1.20E-02	750	5.56E-04
440	8.91E-03	545	1.68E-02	650	1.08E-02	755	4.75E-04
445	1.57E-02	550	1.74E-02	655	9.56E-03	760	4.08E-04
450	2.20E-02	555	1.79E-02	660	8.40E-03	765	3.49E-04
455	1.92E-02	560	1.86E-02	665	7.37E-03	770	3.02E-04
460	1.33E-02	565	1.92E-02	670	6.43E-03	775	2.61E-04
465	1.08E-02	570	2.00E-02	675	5.59E-03	780	2.24E-04
470	8.49E-03	575	2.06E-02	680	4.83E-03		
475	6.66E-03	580	2.12E-02	685	4.18E-03		
480	6.35E-03	585	2.16E-02	690	3.59E-03		

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

Chromaticity Diagram - Sphere Spectroradiometer Method



Tristimulus values(x, y): (0.3852, 0.3861)

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

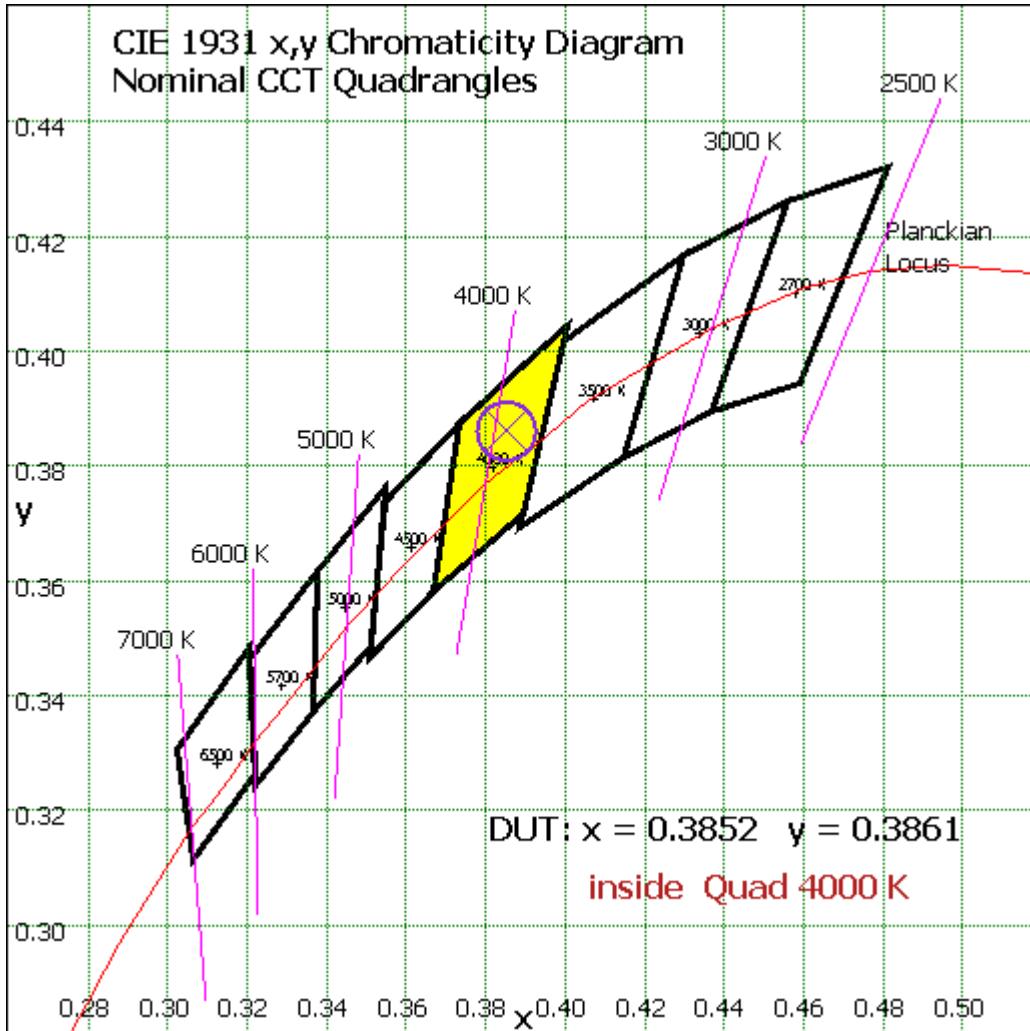


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

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	29.612	2.38%
10- 20	85.166	6.85%
20- 30	130.326	10.48%
30- 40	160.086	12.87%
40- 50	171.931	13.82%
50- 60	166.097	13.35%
60- 70	145.437	11.69%
70- 80	115.303	9.27%
80- 90	83.612	6.72%
90-100	58.42	4.70%
100-110	39.151	3.15%
110-120	24.567	1.98%
120-130	15.031	1.21%
130-140	9.12	0.73%
140-150	5.333	0.43%
150-160	2.932	0.24%
160-170	1.374	0.11%
170-180	0.308	0.02%
Total	1243.8	100%

$\gamma(^{\circ})$	Lumens	% Total
0- 60	743.218	59.75%
60- 90	344.352	27.69%
0-90	1087.57	87.44%
90- 180	156.236	12.56%
0- 180	1243.8	100%

Table 5: Zonal Lumen Data

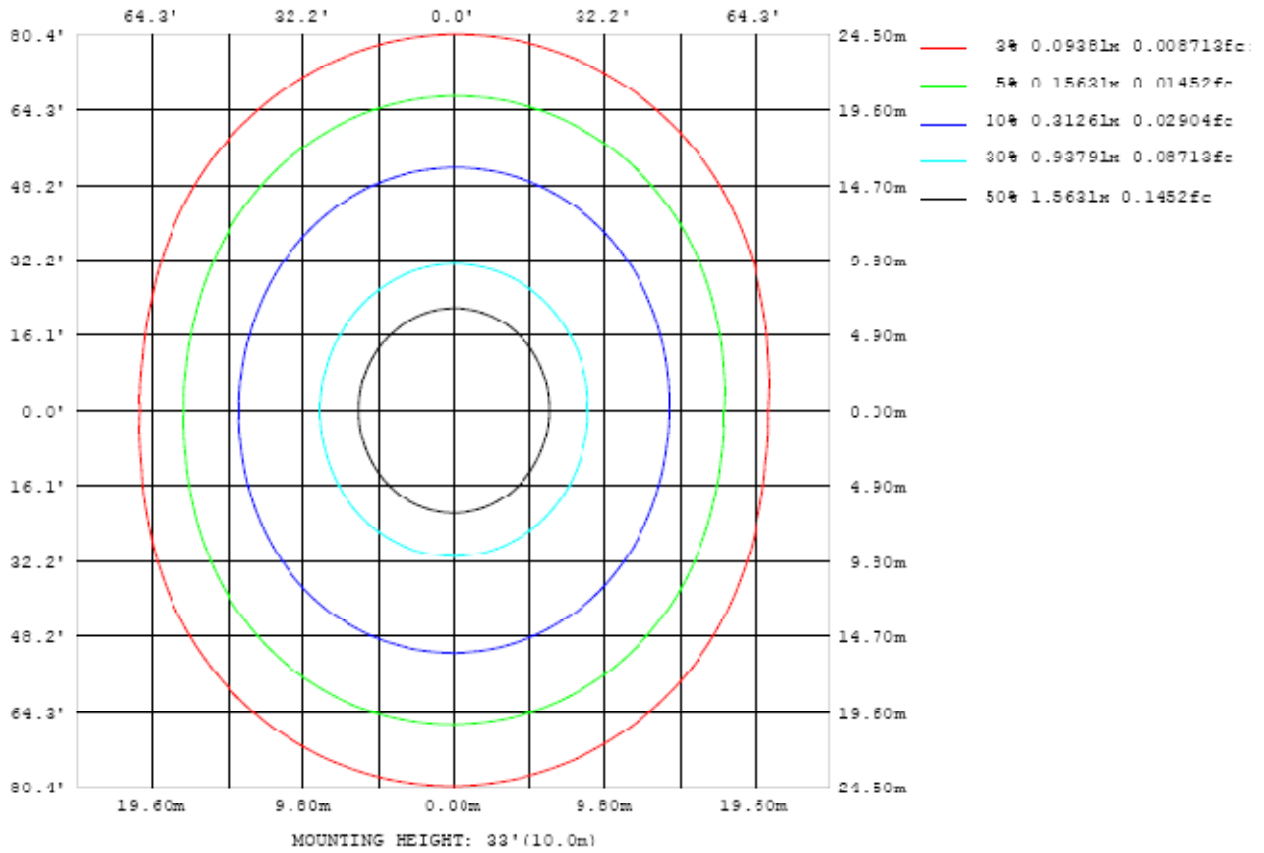


Chart 4: Beam Angle

Luminous Intensity Distribution Plots- Goniophotometer Method

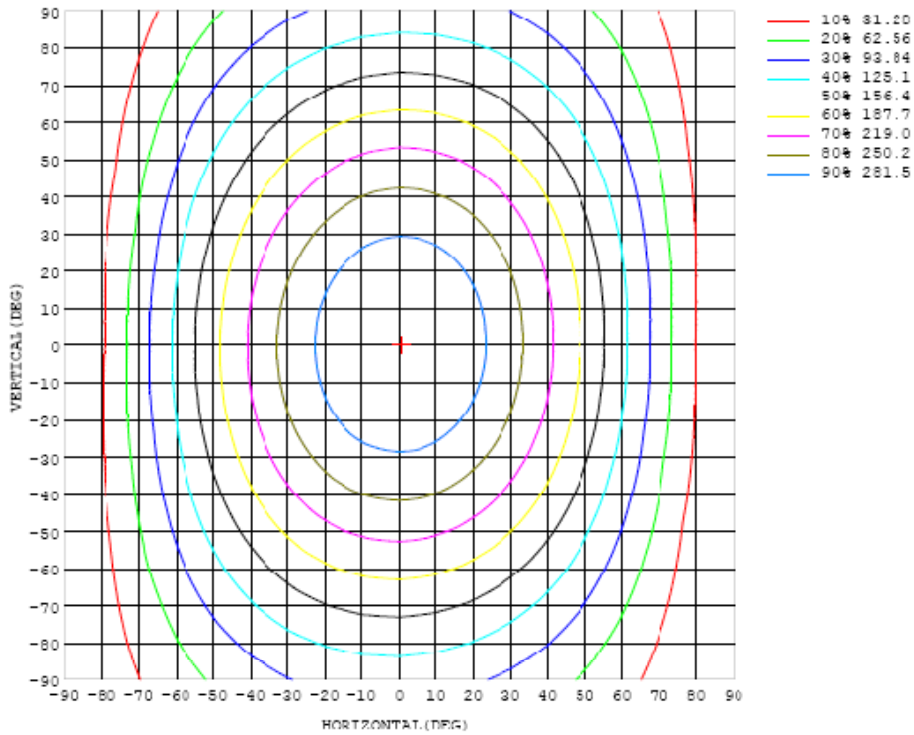


Chart 5: Illuminance Plot (Footcandles)

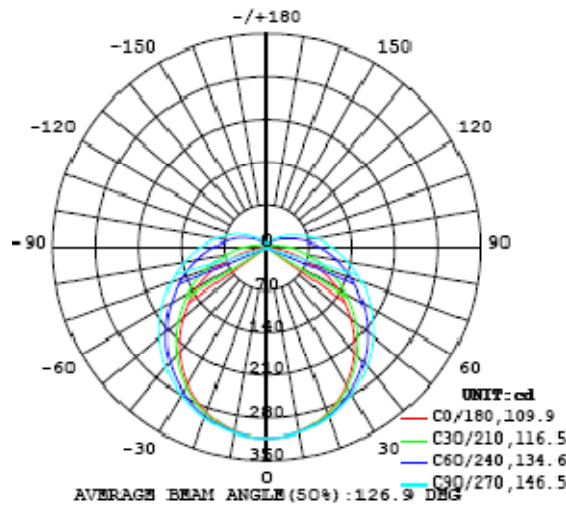


Chart 6: Polar Candela Distribution

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	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313
5	311	311	311	311	311	311	311	312	312	311	311	311	311	311	311	311	311	311	311
10	307	307	307	307	307	308	308	308	309	308	308	308	308	308	307	307	307	305	306
15	300	300	300	300	301	302	302	303	304	304	303	303	303	302	301	300	299	299	299
20	290	290	290	291	292	294	295	296	297	297	296	296	295	293	292	290	289	288	288
25	277	277	278	279	281	283	285	287	288	288	288	287	286	283	281	279	277	275	275
30	261	262	263	265	268	271	274	276	278	278	278	277	275	271	268	265	262	260	260
35	244	245	246	249	253	257	261	264	266	267	267	265	262	258	255	249	245	245	242
40	225	225	228	231	236	241	246	251	254	255	254	252	248	243	237	232	227	224	223
45	203	204	207	212	218	225	231	236	240	241	240	238	233	227	220	213	207	203	202
50	181	182	186	192	199	207	215	221	225	227	226	223	217	210	202	193	186	181	179
55	157	158	163	171	180	189	198	205	210	212	211	207	201	193	183	173	164	158	156
60	132	133	139	149	160	171	181	189	194	197	195	191	184	175	164	152	142	134	131
65	106	108	116	127	140	153	164	173	179	181	180	176	168	157	145	132	119	109	105
70	79.6	82.1	92.4	106	121	135	147	157	163	165	164	160	152	140	127	112	97.4	84.7	78.6
75	54.1	57.6	70.1	86.6	103	118	131	141	147	150	149	144	136	124	110	93.5	76.7	61.7	52.8
80	29.9	34.6	50.6	68.7	86.4	102	116	126	132	135	134	129	121	108	93.5	76.3	58.6	40.7	28.8
85	10.7	16.6	34.2	53.4	71.3	87.6	101	111	118	121	120	115	106	93.9	78.8	61.7	42.9	24.0	9.71
90	1.21	6.30	22.1	40.6	58.6	74.2	87.5	97.7	104	107	106	101	92.8	80.6	66.0	49.0	30.7	13.1	1.00
95	0.43	2.28	13.2	30.2	47.3	62.7	75.1	85.1	91.5	94.3	93.1	88.5	80.3	68.6	54.7	38.3	21.1	6.38	0.42
100	0.50	1.48	8.43	20.9	36.4	51.3	63.9	73.0	79.2	81.9	81.0	76.5	68.6	57.7	43.9	28.5	14.2	4.25	0.44
105	0.57	1.37	5.98	15.6	27.4	40.1	51.8	61.0	66.4	69.3	68.7	64.5	57.0	46.2	33.4	21.6	10.6	3.15	0.65
110	0.73	1.50	4.65	12.0	21.6	31.6	40.0	48.5	54.2	56.9	56.1	51.9	44.9	36.6	26.9	17.0	8.61	3.03	0.91
115	1.00	1.67	4.22	9.61	17.4	25.7	33.4	39.5	43.9	45.8	45.2	42.2	37.0	29.9	21.9	13.9	7.34	3.04	1.20
120	1.26	1.87	4.08	8.03	14.2	21.0	27.4	32.6	36.1	37.8	37.3	34.8	30.5	24.7	18.1	11.7	6.45	3.08	1.51
125	1.51	2.09	4.03	7.13	11.7	17.3	22.5	26.8	29.8	31.1	30.8	28.6	25.1	20.4	15.1	10.0	5.87	3.16	1.82
130	1.85	2.35	3.96	6.44	10.0	14.3	18.6	22.0	24.5	25.6	25.3	23.5	20.6	16.8	12.6	8.67	5.42	3.21	2.08
135	2.17	2.66	3.96	6.99	8.76	12.0	16.3	18.0	20.0	20.9	20.6	19.3	16.9	14.0	10.7	7.61	6.08	3.28	2.31
140	2.48	2.67	3.93	5.58	7.74	10.2	12.7	14.7	16.3	17.0	16.8	15.7	13.9	11.7	9.22	6.85	4.90	3.43	2.61
145	2.73	2.80	3.93	5.26	6.84	8.67	10.5	12.0	13.2	13.7	13.6	12.8	11.5	9.82	7.98	6.19	4.78	3.53	2.85
150	2.93	2.79	3.88	5.02	6.13	7.44	8.75	9.85	10.7	11.1	11.0	10.4	9.49	8.30	6.99	5.71	4.68	3.51	2.95
155	3.09	2.84	3.78	4.81	5.61	6.45	7.36	8.12	8.69	8.96	8.90	8.52	7.91	7.08	6.17	5.36	4.54	3.29	3.06
160	3.32	2.81	3.66	4.67	5.21	5.73	6.27	6.72	7.11	7.30	7.28	6.99	6.62	6.13	5.69	5.07	4.34	3.08	3.11
165	3.43	2.65	2.93	3.79	4.69	5.22	5.50	5.75	5.96	6.05	6.03	5.91	5.72	5.45	5.02	4.49	3.92	2.81	3.16
170	2.93	2.62	2.34	2.46	2.72	3.07	4.18	4.99	5.12	5.16	5.18	4.57	3.92	3.51	3.27	2.97	2.77	2.60	2.85
175	2.21	2.22	2.23	2.24	2.27	2.29	2.30	2.32	1.99	1.14	1.93	2.53	2.66	2.66	2.64	2.59	2.61	2.60	2.58
180	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80

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	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313		
5	311	311	311	312	312	312	312	312	312	312	312	312	312	312	311	312	311		
10	306	307	307	307	308	308	309	309	309	309	309	309	309	308	308	307	307		
15	299	299	300	301	302	303	304	304	305	304	304	304	303	302	301	301	300		
20	288	289	291	292	294	295	296	298	298	298	297	297	295	294	292	291	290		
25	275	277	279	281	283	286	288	289	290	290	289	288	285	283	281	279	277		
30	260	262	264	267	271	274	277	279	280	280	279	277	274	270	267	265	263		
35	243	245	248	252	257	261	265	268	269	269	267	264	260	256	252	248	245		
40	224	226	230	236	241	247	252	255	257	256	254	250	245	240	234	230	226		
45	203	206	211	218	224	231	237	241	243	242	240	235	229	222	216	210	206		
50	180	184	191	199	207	215	222	227	229	228	225	219	212	204	196	189	184		
55	157	162	170	179	189	198	206	211	214	213	209	203	194	185	175	167	160		
60	133	139	149	159	171	181	190	196	198	197	193	186	177	166	155	145	137		
65	107	115	127	140	153	164	173	180	183	181	177	169	159	147	134	122	112		
70	81.4	91.7	106	121	135	148	158	164	167	166	161	153	142	129	114	99.2	86.7		
75	56.4	69.5	86.1	103	118	132	142	149	152	151	146	137	125	111	94.8	78.0	62.9		
80	33.8	49.8	68.3	86.3	102	116	127	134	137	136	131	122	110	94.6	77.3	59.0	41.4		
85	16.4	33.7	53.0	71.3	87.8	102	112	119	122	121	116	107	94.8	79.6	62.0	43.0	24.2		
90	6.17	22.0	40.4	58.4	74.6	88.2	98.8	106	109	108	102	93.7	81.3	66.3	49.0	30.6	12.8		
95	2.37	14.4	30.7	47.5	62.8	75.9	86.1	92.6	95.5	94.4	89.5	81.0	69.2	54.9	38.5	21.7	6.82		
100	1.69	9.01	23.3	38.4	52.6	64.8	74.4	80.6	83.3	82.3	77.6	69.7	58.5	45.0	30.1	15.2	3.99		
105	1.49	6.74	17.0	30.7	43.6	54.9	63.7	69.5	72.0	71.0	66.7	59.2	48.9	36.7	23.1	10.6	2.99		
110	1.70	5.55	13.1	23.2	35.2	45.7	53.8	59.2	61.5	60.6	56.7	49.7	40.1	28.8	17.3	8.04	2.52		
115	1.95	4.91	10.7	18.8	27.3	36.6	44.3	49.2	51.4	50.5	46.8	40.3	31.4	22.2	13.5	6.68	2.55		
120	2.20	4.59	9.03	15.3	22.4	28.9	34.8	39.0	41.0	40.2	36.8	31.6	25.0	18.0	11.2	5.70	2.63		
125	2.46	4.40	7.90	12.8	18.4	23.8	28.3	31.3	32.7	32.0	29.6	25.6	20.5	14.7	9.45	5.17	2.75		
130	2.68	4.33	7.09	10.8	15.1	19.5	23.1	25.5	26.5	26.0	24.1	20.9	16.8	12.3	8.09	4.88	2.97		
135	2.88	4.30	6.50	9.40	12.7	16.0	18.8	20.7	21.5	21.1	19.6	17.2	13.8	10.4	7.17	4.66	3.18		
140	3.03	4.11	5.97	8.17	10.6	13.1	15.3	16.8	17.4	17.1	16.0	14.0	11.5	8.91	6.52	4.51	3.39		
145	3.27	4.14	5.54	7.22	9.04	10.9	12.4	13.5	13.9	13.7	12.9	11.5	9.74	7.80	5.90	4.32	3.52		
150	3.48	4.04	5.02	6.47	7.77	9.05	10.2	10.9	11.2	11.1	10.5	9.52	8.26	6.88	5.45	4.33	3.65		
155	3.75	4.30	4.85	5.56	6.61	7.60	8.35	8.85	9.04	8.94	8.57	7.95	7.12	6.05	4.98	4.29	3.77		
160	3.80	4.29	4.66	5.10	5.59	6.19	6.80	7.20	7.33	7.26	7.06	6.71	6.09	5.36	4.75	4.34	3.85		
165	3.69	4.18	4.38	4.62	4.92	5.31	5.57	5.71	5.78	5.81	5.79	5.61	5.32	4.98	4.65	4.30	3.67		
170	3.03	3.60	3.95	4.32	4.58	4.31	4.47	4.98	5.01	5.00	4.97	4.88	4.75	4.62	4.42	4.08	3.41		
175	2.59	2.67	2.77	2.88	3.06	3.36	3.75	3.96	4.01	4.07	4.09	4.06	4.01	3.97	3.79	3.26	2.54		
180	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80		

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

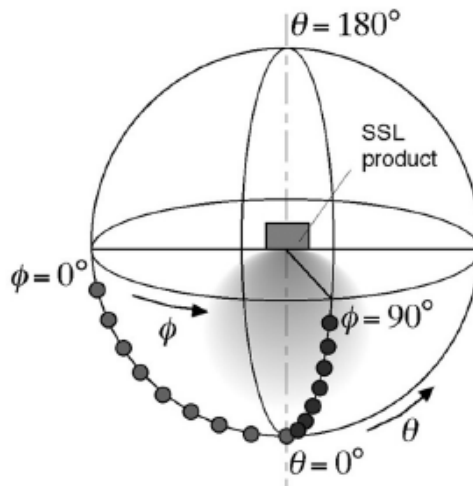
The color characteristics of SSL products include chromaticity coordinates, correlated color temperature, and color rendering index. These characteristics of SSL products may be spatially non-uniform, and thus, in order that they can be specified accurately, the color quantities shall be measured as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