



LM-79-08 Test Report

for

Revolution Lighting Technologies, Inc.

2280 Ward Ave. Simi Valley, CA 93065

LED Tube

Model: 202101-115

Laboratory: Leading Testing Laboratories

NVLAP CODE: 200960-0

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Report No.: HZ18110016q

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: 202101-115

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)	Power Factor
138.3	1514.0	10.95	0.9792
CCT (K)	CRI	Stabilization Time (Light & Power)	
4980	82.2	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

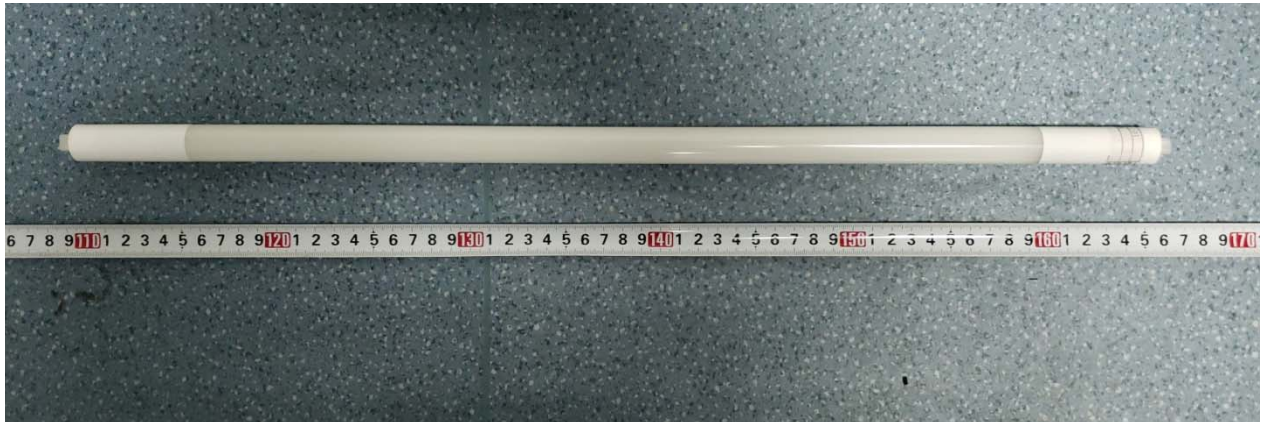


Figure 1- Overview of the sample

Equipment Under Test (EUT)

Name	: LED Tube
Model	: 202101-115
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 25.0°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	0.044
Power Factor	0.9792	0.9375
Test Power (W)	10.95	11.35
THD A%	19.15	25.67
Luminous Efficacy (lm/W)	138.3	133.4
Total Luminous Flux (lm)	1514.0	1514.0
Color Rendering Index (CRI)	82.2	
R9	2.7	
Correlated Color Temperature (CCT)(K)	4980	
Chromaticity Chroma x	0.3462	
Chromaticity Chroma y	0.3584	
Chromaticity Chroma u	0.2095	
Chromaticity Chroma v	0.3254	
Duv	0.0029	
Chromaticity Chroma u'	0.2095	
Chromaticity Chroma v'	0.4881	

Special Color Rendering Indices	
R1	79.8
R2	87.7
R3	93.2
R4	81.1
R5	80.2
R6	82.6
R7	87.2
R8	65.7
R9	2.7
R10	70.6
R11	79.7
R12	57.6
R13	81.9
R14	96.5

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)	0.094
Power Factor	0.9807
Power (W)	11.02
Luminous Efficacy (lm/W)	136.6
Total Luminous Flux (lm)	1505.2
Beam Angle (°)	109.7 (0°-180°) /145.4(90°-270°)
Center Beam Candle Power (cd)	381
Maximum Beam Candle Power (cd)	381.6 (At: C=280.0, Gamma=0.5)
Spacing Criteria	1.23 (0°-180°) /1.33 (90°-270°)
Zonal Lumens in the 0°-60°Zone	60.09%
Zonal Lumens in the 60°-90°Zone	27.61%
Zonal Lumens in the 90°-120°Zone	9.66%
Zonal Lumens in the 120°-180°Zone	2.63%

Table 3: Test data per Goniophotometer Method

Spectral Power Distribution - Sphere Spectroradiometer Method

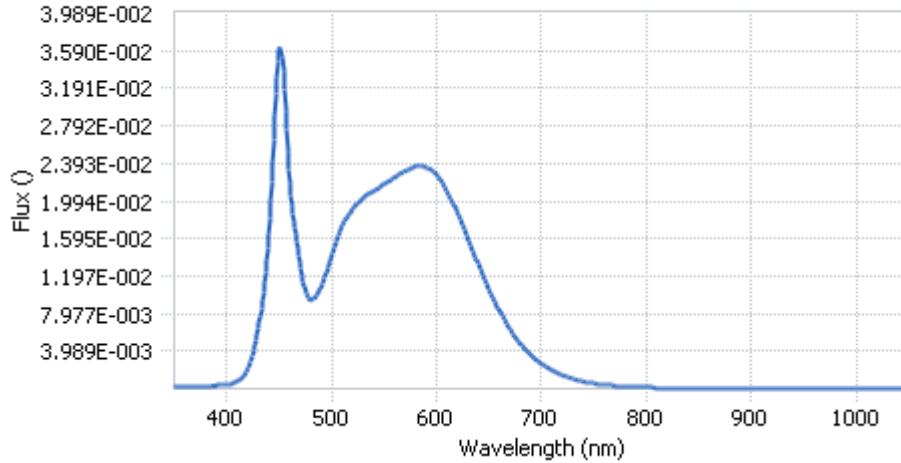
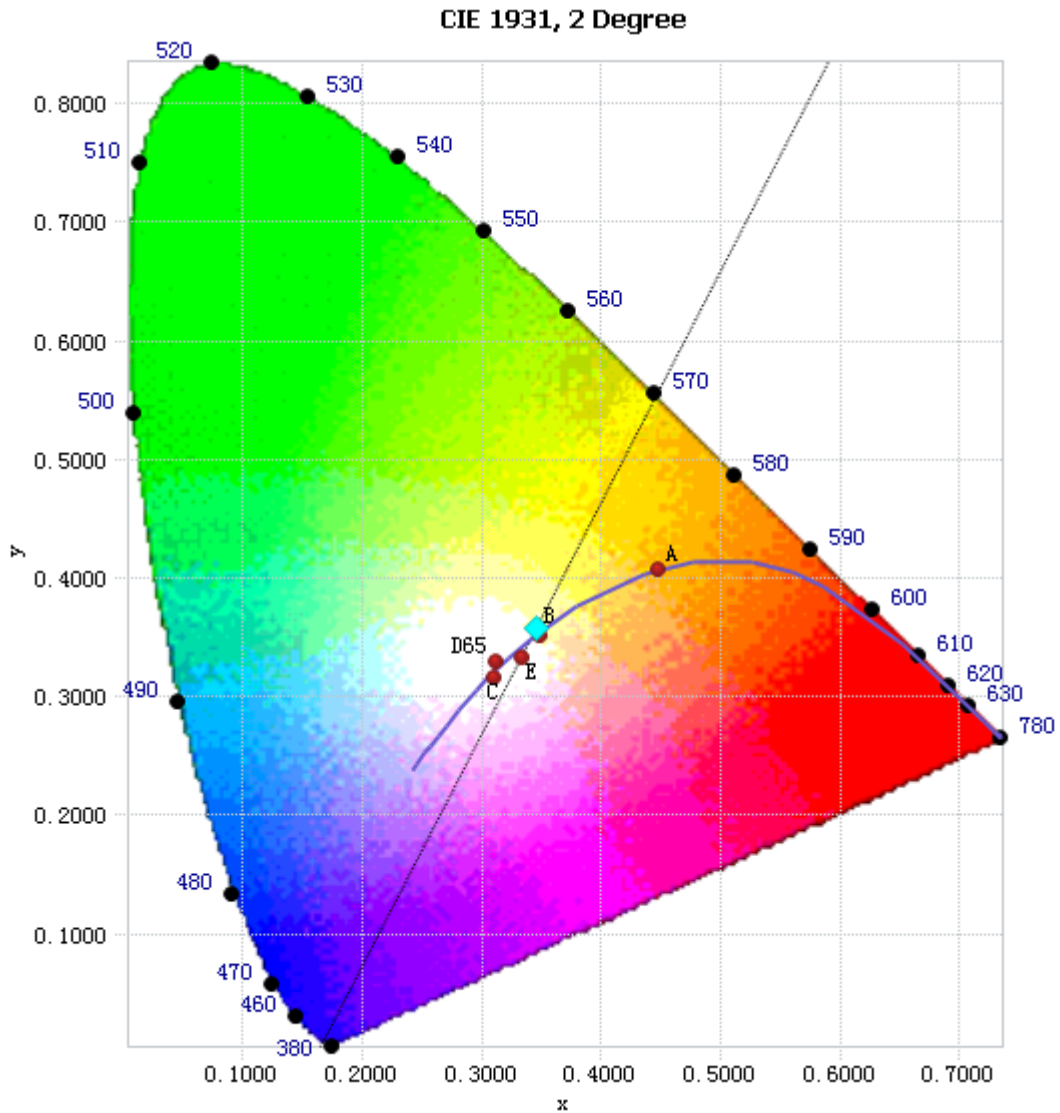


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	2.94E-04	485	9.82E-03	590	2.35E-02	695	3.06E-03
385	3.01E-04	490	1.08E-02	595	2.32E-02	700	2.65E-03
390	3.33E-04	495	1.24E-02	600	2.27E-02	705	2.27E-03
395	3.73E-04	500	1.42E-02	605	2.20E-02	710	1.94E-03
400	4.25E-04	505	1.59E-02	610	2.10E-02	715	1.67E-03
405	5.19E-04	510	1.73E-02	615	1.99E-02	720	1.44E-03
410	7.67E-04	515	1.84E-02	620	1.86E-02	725	1.23E-03
415	1.24E-03	520	1.92E-02	625	1.73E-02	730	1.07E-03
420	2.14E-03	525	1.97E-02	630	1.59E-02	735	9.14E-04
425	3.74E-03	530	2.03E-02	635	1.45E-02	740	7.75E-04
430	6.32E-03	535	2.07E-02	640	1.32E-02	745	6.67E-04
435	1.03E-02	540	2.10E-02	645	1.18E-02	750	5.73E-04
440	1.65E-02	545	2.14E-02	650	1.05E-02	755	4.98E-04
445	2.65E-02	550	2.17E-02	655	9.36E-03	760	4.30E-04
450	3.60E-02	555	2.20E-02	660	8.22E-03	765	3.75E-04
455	3.19E-02	560	2.24E-02	665	7.23E-03	770	3.20E-04
460	2.18E-02	565	2.28E-02	670	6.32E-03	775	2.78E-04
465	1.71E-02	570	2.31E-02	675	5.50E-03	780	2.44E-04
470	1.34E-02	575	2.34E-02	680	4.79E-03		
475	1.03E-02	580	2.37E-02	685	4.15E-03		
480	9.43E-03	585	2.37E-02	690	3.57E-03		

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

Chromaticity Diagram - Sphere Spectroradiometer Method



Tristimulus values(x, y): (0.3462, 0.3584)

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

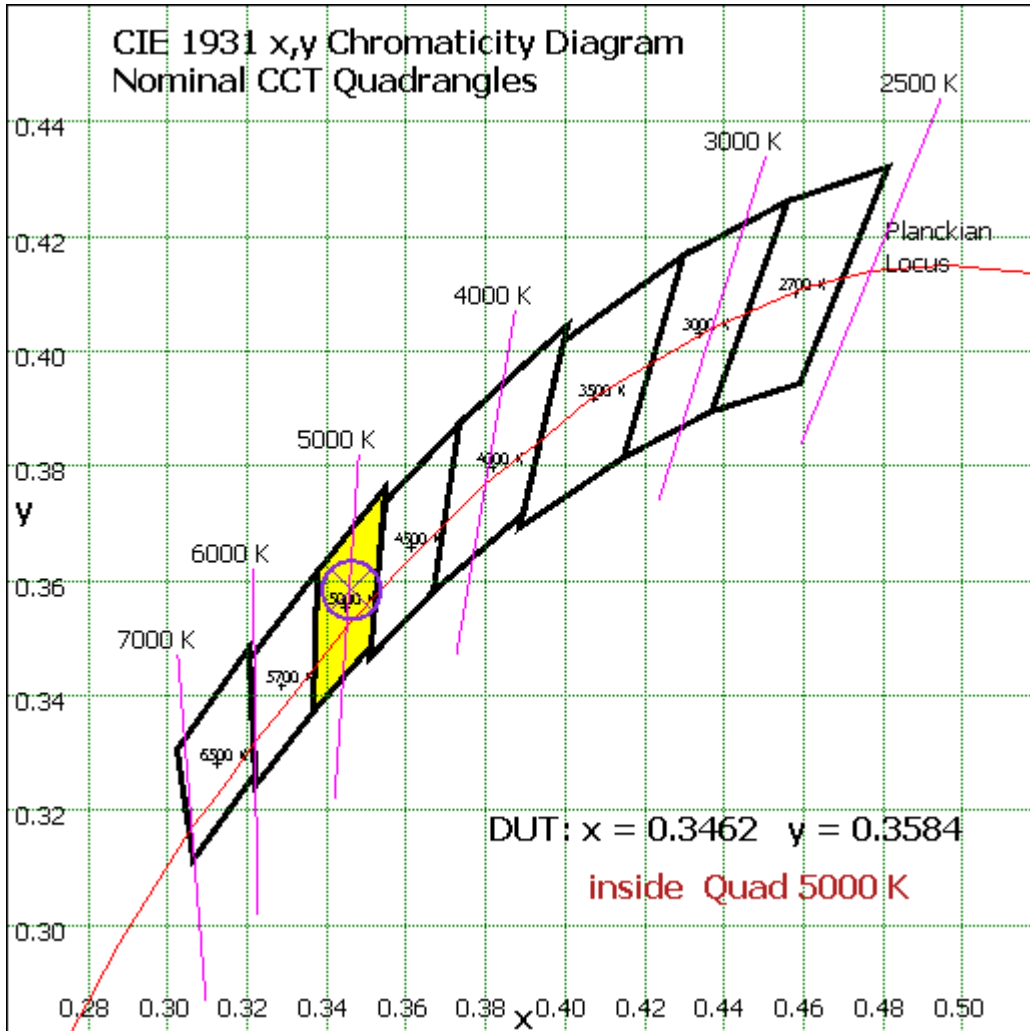


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

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	36.115	2.40%
10- 20	103.841	6.90%
20- 30	158.82	10.55%
30- 40	194.941	12.95%
40- 50	209.122	13.89%
50- 60	201.645	13.40%
60- 70	176.112	11.70%
70- 80	139.079	9.24%
80- 90	100.41	6.67%
90-100	69.824	4.64%
100-110	46.781	3.11%
110-120	28.829	1.92%
120-130	17.514	1.16%
130-140	10.582	0.70%
140-150	6.183	0.41%
150-160	3.403	0.23%
160-170	1.612	0.11%
170-180	0.361	0.02%
Total	1505.2	100%

$\gamma(^{\circ})$	Lumens	% Total
0- 60	904.484	60.09%
60- 90	415.601	27.61%
0-90	1320.085	87.70%
90- 180	185.089	12.30%
0- 180	1505.2	100%

Table 5: Zonal Lumen Data

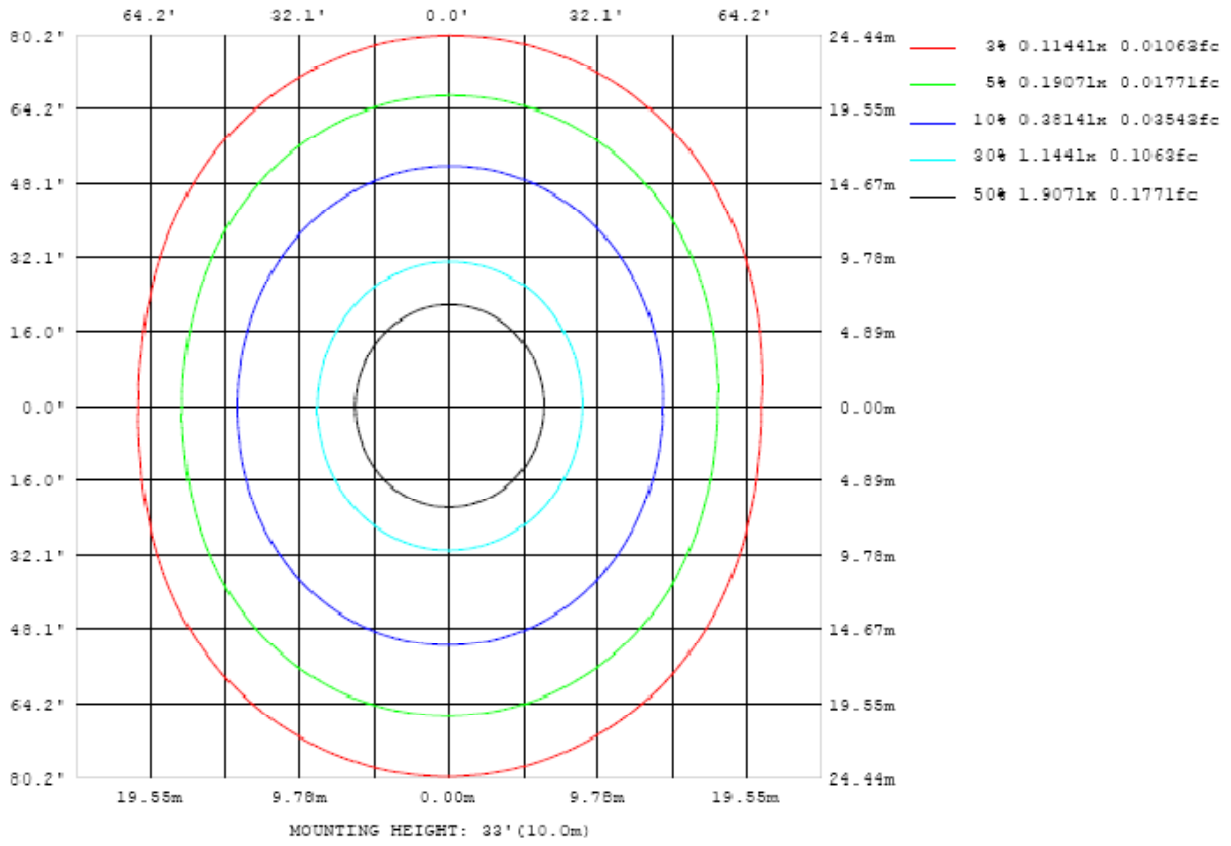


Chart 4: Beam Angle

Luminous Intensity Distribution Plots- Goniophotometer Method

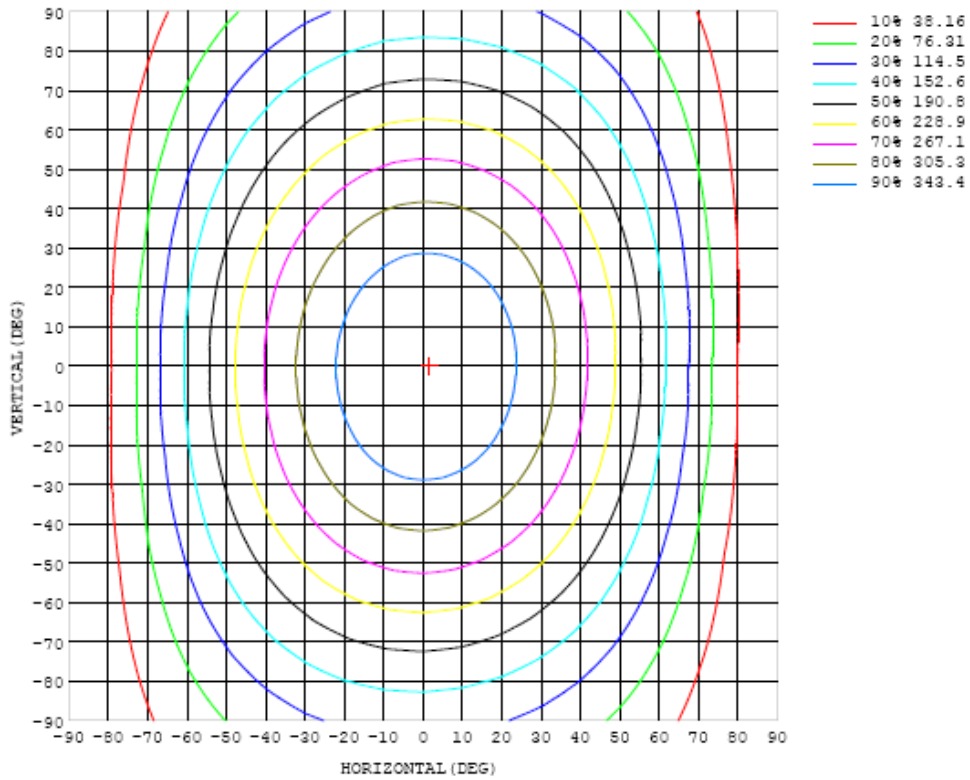


Chart 5: Illuminance Plot (Footcandles)

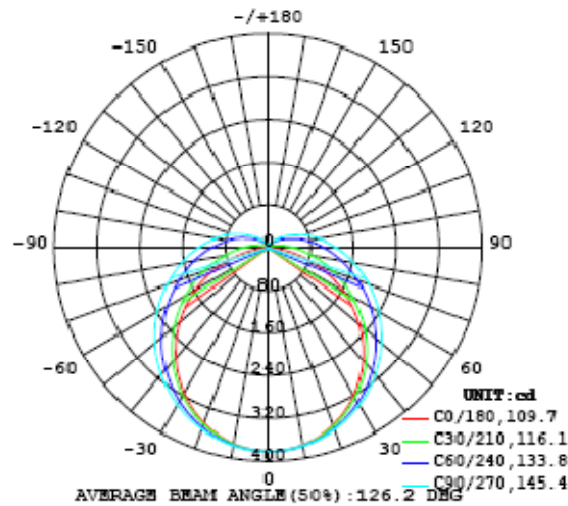


Chart 6: Polar Candela Distribution

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	381	381	381	381	381	381	381	381	381	381	381	381	381	381	381	381	381	381	381
5	380	380	380	380	380	380	381	380	380	380	380	380	380	380	379	379	379	379	379
10	375	375	375	376	376	376	377	377	377	377	377	377	376	376	375	374	373	373	373
15	366	366	367	367	368	369	370	371	371	371	371	370	369	367	366	365	364	363	363
20	354	354	355	356	358	360	361	362	363	363	363	361	360	358	355	353	352	350	350
25	338	339	340	342	344	347	349	351	352	353	352	351	348	345	342	339	336	335	334
30	320	321	322	325	328	332	336	339	340	341	340	338	335	330	326	322	318	316	315
35	299	300	302	305	310	315	319	323	326	327	326	323	319	313	307	302	297	294	293
40	275	276	279	283	289	296	302	307	310	311	310	307	302	295	288	281	275	271	270
45	250	251	254	260	267	275	283	289	293	294	293	289	283	275	266	258	250	245	244
50	222	223	228	235	244	254	263	270	275	277	275	271	264	254	243	233	224	218	215
55	193	194	200	209	220	231	242	250	256	258	257	251	243	232	220	208	197	190	187
60	162	164	171	182	196	209	221	230	236	239	237	232	223	210	197	183	170	160	157
65	131	133	142	156	171	186	199	210	217	219	218	212	202	189	174	158	142	130	125
70	98.5	101	113	130	148	164	179	190	197	200	199	192	182	168	151	133	115	101	94.0
75	66.7	70.6	85.9	105	125	143	158	170	178	181	179	173	162	148	130	111	90.2	72.1	62.7
80	37.4	43.0	61.9	83.3	105	123	139	151	159	163	161	155	143	129	110	89.8	67.8	47.2	33.8
85	13.4	20.9	41.7	64.5	85.9	105	121	133	141	145	143	137	126	111	92.7	71.7	49.3	27.2	11.0
90	1.46	7.37	26.8	48.8	69.9	88.8	105	117	125	128	126	120	109	94.3	76.9	56.9	34.8	14.4	0.96
95	0.46	2.91	16.9	36.5	56.6	74.2	89.6	101	109	112	111	105	94.4	80.3	63.7	44.4	24.3	7.22	0.49
100	0.52	1.74	10.1	26.1	44.7	61.9	75.8	86.8	94.2	97.2	95.9	90.3	80.6	67.4	51.7	33.8	16.0	4.67	0.54
105	0.60	1.63	7.36	18.5	33.1	49.4	63.2	73.4	80.3	83.3	82.1	76.8	67.6	55.4	40.2	24.7	11.9	3.53	0.78
110	0.84	1.82	5.50	14.3	25.4	37.3	49.5	60.0	66.9	69.3	67.8	63.4	54.6	42.7	31.3	19.5	9.63	3.40	1.08
115	1.14	2.03	4.88	11.5	20.4	30.3	39.4	47.0	52.3	54.8	54.1	50.0	43.4	34.9	25.2	15.8	8.27	3.48	1.42
120	1.39	2.29	4.70	9.44	16.6	24.6	32.2	38.5	42.8	44.7	44.1	40.9	35.5	28.5	20.7	13.3	7.41	3.59	1.77
125	1.69	2.58	4.67	8.25	13.7	20.2	26.3	31.4	35.0	36.5	36.0	33.5	29.1	23.5	17.3	11.4	6.77	3.76	2.13
130	2.08	2.89	4.70	7.52	11.6	16.7	21.6	25.7	28.6	29.8	29.3	27.3	23.7	19.4	14.5	10.00	6.33	3.90	2.46
135	2.38	3.19	4.72	6.96	10.1	14.0	17.8	21.0	23.3	24.3	23.9	22.3	19.5	16.0	12.3	8.77	5.94	3.97	2.71
140	2.66	3.44	4.76	6.57	8.92	11.8	14.7	17.2	18.9	19.7	19.4	18.2	16.0	13.4	10.6	7.91	5.75	4.18	3.02
145	2.93	3.52	4.80	6.21	7.97	10.1	12.2	14.1	15.3	15.9	15.7	14.8	13.2	11.3	9.22	7.23	5.63	4.37	3.32
150	3.13	3.46	4.83	5.94	7.16	8.71	10.2	11.5	12.4	12.8	12.7	12.1	10.9	9.58	8.11	6.65	5.55	4.50	3.45
155	3.24	3.57	4.87	5.72	6.52	7.63	8.66	9.54	10.1	10.4	10.3	9.90	9.15	8.24	7.24	6.25	5.49	4.49	3.48
160	3.45	3.72	4.76	5.54	6.06	6.73	7.43	8.00	8.36	8.53	8.45	8.21	7.75	7.13	6.52	5.94	5.40	4.38	3.41
165	3.49	3.30	4.23	5.21	5.72	6.11	6.49	6.81	7.00	7.11	7.06	6.91	6.67	6.38	6.01	5.55	5.09	4.13	3.32
170	3.09	2.95	3.03	3.37	4.13	5.28	5.82	5.97	6.06	6.11	6.08	6.03	5.78	5.13	4.53	4.06	3.63	3.26	3.22
175	2.67	2.56	2.68	2.69	2.71	2.72	2.87	3.32	3.93	4.23	3.11	3.10	3.11	3.12	3.11	3.15	3.14	3.08	3.11
180	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17

Table 6: Luminous Intensity Data

Table--2 UNIT: cd

L (UMS)	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350		
γ (DEG)																			
0	381	381	381	381	381	381	381	381	381	381	381	381	381	381	381	381	381		
5	379	379	379	379	379	380	380	380	380	380	380	380	380	380	380	380	380		
10	373	373	374	374	375	375	376	376	377	376	377	376	376	376	376	376	376		
15	363	364	365	365	367	368	369	370	371	371	370	370	369	369	368	367	367		
20	350	351	353	354	357	359	360	362	362	362	362	361	360	358	357	356	355		
25	334	336	338	340	343	347	349	352	352	352	351	350	348	345	343	341	340		
30	315	317	320	324	328	332	336	339	340	340	339	336	334	330	327	324	322		
35	294	297	300	305	311	316	321	325	326	326	324	321	317	312	308	304	301		
40	270	274	279	285	292	299	305	309	311	311	308	304	299	293	287	281	278		
45	245	249	255	263	272	280	287	292	294	294	291	286	279	271	264	257	253		
50	210	223	230	240	250	260	269	275	276	276	273	267	260	249	240	232	226		
55	189	195	205	216	228	239	249	256	258	258	254	246	237	226	215	205	197		
60	160	167	179	192	205	219	229	237	239	239	234	226	215	203	189	177	168		
65	129	139	153	168	184	198	209	217	220	220	214	206	194	179	164	150	138		
70	97.8	111	128	146	163	178	190	198	201	200	195	185	172	157	140	122	107		
75	67.8	84.1	104	124	143	158	171	180	183	182	176	166	153	136	116	96.0	77.9		
80	40.7	60.3	82.5	104	123	140	153	162	165	163	158	148	133	115	94.5	72.4	51.1		
85	19.7	10.9	61.0	86.1	105	123	136	145	148	147	140	130	115	96.9	76.6	62.6	29.8		
90	7.68	26.8	48.9	70.4	89.7	106	119	128	131	130	124	113	98.7	80.4	59.5	37.0	15.7		
95	3.15	17.5	37.1	57.1	75.6	91.4	104	112	115	114	108	97.9	83.8	66.3	46.5	25.9	7.79		
100	2.03	10.6	27.7	46.0	63.1	78.0	89.6	97.5	100	99.2	93.4	83.9	70.6	54.2	35.9	17.6	4.46		
105	1.81	8.03	19.7	35.8	51.8	65.7	75.5	83.9	86.6	85.3	80.1	71.0	58.6	43.3	26.6	12.0	3.20		
110	2.03	6.58	15.5	27.0	40.6	53.7	63.9	70.8	73.3	72.2	67.2	58.7	46.8	33.0	19.7	9.15	2.31		
115	2.32	5.77	12.5	21.9	32.0	41.7	50.8	57.4	59.8	58.3	54.0	45.6	36.1	25.7	15.7	7.48	2.36		
120	2.60	5.36	10.6	17.9	26.2	34.0	40.8	45.1	47.0	46.1	42.1	36.6	29.2	20.9	12.9	6.34	3.00		
125	2.91	5.13	9.18	14.9	21.5	27.8	33.1	36.7	38.2	37.4	34.5	29.7	23.8	17.1	10.7	5.82	3.18		
130	3.12	5.01	8.22	12.8	17.9	22.8	27.0	29.8	31.0	30.4	28.0	24.2	19.5	14.2	9.17	5.56	3.39		
135	3.33	4.93	7.50	10.9	14.8	18.6	21.9	24.2	25.1	24.5	22.8	19.8	16.1	11.9	8.17	5.29	3.52		
140	3.51	4.89	6.85	9.39	12.3	15.3	17.8	19.5	20.3	19.9	18.5	16.2	13.3	10.2	7.46	5.17	3.90		
145	3.76	4.72	6.32	8.31	10.5	12.5	14.4	15.7	16.3	16.0	14.9	13.2	11.1	8.94	6.42	5.00	4.08		
150	4.02	4.75	5.63	7.35	8.96	10.4	11.7	12.5	13.0	12.3	12.0	10.9	9.45	7.84	6.14	4.94	4.13		
155	4.22	5.00	5.63	6.20	7.48	8.70	9.57	10.1	10.5	10.3	9.85	9.09	8.14	6.88	5.76	4.99	4.23		
160	4.12	4.85	5.43	5.81	6.26	6.98	7.58	8.03	8.35	8.25	7.98	7.60	6.86	6.21	5.55	4.88	4.38		
165	3.93	4.59	5.09	5.35	5.77	6.08	6.54	6.82	6.75	6.79	6.72	6.41	6.06	5.75	5.42	4.88	4.26		
170	3.32	3.55	4.10	4.48	4.95	5.35	5.14	5.06	5.59	5.73	5.73	5.62	5.49	5.28	4.90	4.13	3.47		
175	3.08	3.05	3.00	2.98	3.02	3.07	3.20	3.68	4.62	4.73	4.66	4.59	4.27	3.54	2.78	2.62	2.55		
180	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17		

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

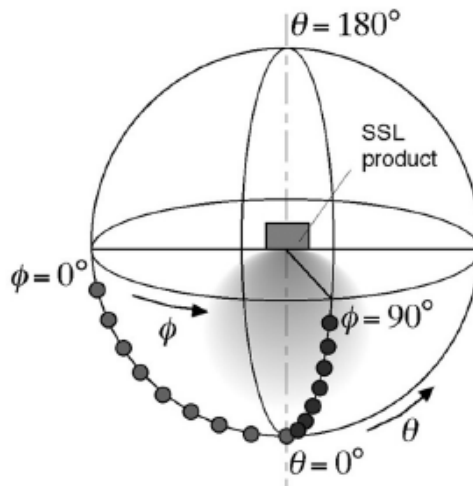
The color characteristics of SSL products include chromaticity coordinates, correlated color temperature, and color rendering index. These characteristics of SSL products may be spatially non-uniform, and thus, in order that they can be specified accurately, the color quantities shall be measured as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