LM-79-08 Test Report

for

Revolution Lighting Technologies, Inc.

2280 Ward Ave. Simi Valley, CA 93065

LED Tube

Model: 202101-112

Laboratory: Leading Testing Laboratories

NVLAP CODE: 200960-0

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Report No.: HZ18110016k

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: Jim Zhang

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: **202101-112**

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)	Power Factor
137.8	1485.0	10.78	0.9792

CCT (K)	CRI	Stabilization Time (Light & Power)
3426	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	: 202101-112
Electrical Ratings	: 120-277V, 60Hz
Product Description	: 3500K
Manufacturer	: Revolution Lighting Technologies, Inc.
Address	: 2280 Ward Ave. Simi Valley, CA 93065

TEST RESULTS

Test ambient temperature was 25.2℃.

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)	0.092	0.043
Power Factor	0.9792	0.9327
Test Power (W)	10.78	11.20
THD A%	18.80	27.09
Luminous Efficacy (lm/W)	137.8	132.6
Total Luminous Flux (lm)	1485.0	1485.0
Color Rendering Index (CRI)	81.8	
R9	1.2	
Correlated Color Temperature (CCT)(K)	3426	
Chromaticity Chroma x	0.4104	
Chromaticity Chroma y	0.3953	
Chromaticity Chroma u	0.2371	
Chromaticity Chroma v	0.3426	
Duv	0.0005	
Chromaticity Chroma u ’	0.2371	
Chromaticity Chroma v’	0.5139	

Special Color Rendering Indices	
R1	80
R2	90.8
R3	95.8
R4	78.8
R5	80.2
R6	88
R7	82.7
R8	58.4
R9	1.2
R10	78.5
R11	77.6
R12	65.7
R13	82.9
R14	98.3

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 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)	0.092
Power Factor	0.9807
Power (W)	10.86
Luminous Efficacy (lm/W)	135.5
Total Luminous Flux (lm)	1471.4
Beam Angle (°)	102.2（0^o-180^o）/128.3(90^o-270^o)
Center Beam Candle Power (cd)	422
Maximum Beam Candle Power (cd)	422.3 (At: C=30.0, Gamma=2.5)
Spacing Criteria	1.18（0^o-180^o）/1.29 (90^o-270^o)
Zonal Lumens in the 0°-60°Zone	64.67%
Zonal Lumens in the 60°-90°Zone	25.44%
Zonal Lumens in the 90°-120°Zone	7.58%
Zonal Lumens in the 120°-180°Zone	2.31%

Table 3: Test data per Goniophotometer Method

Spectral Power Distribution - Sphere Spectroradiometer Method

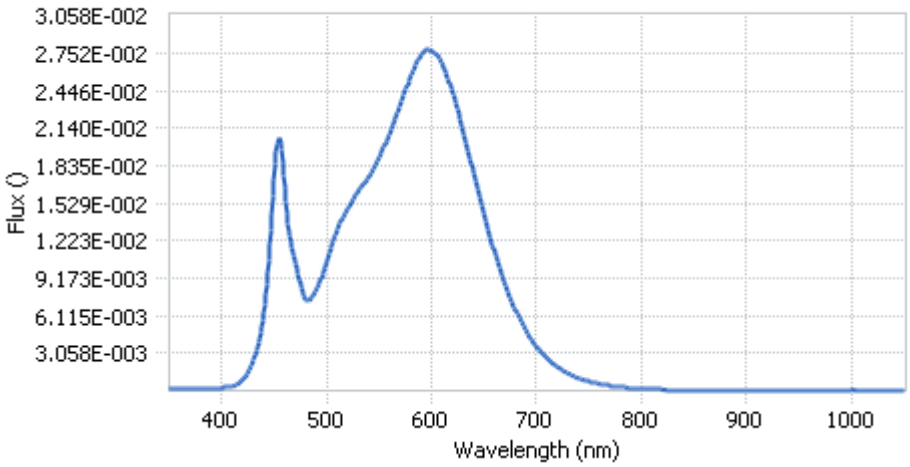
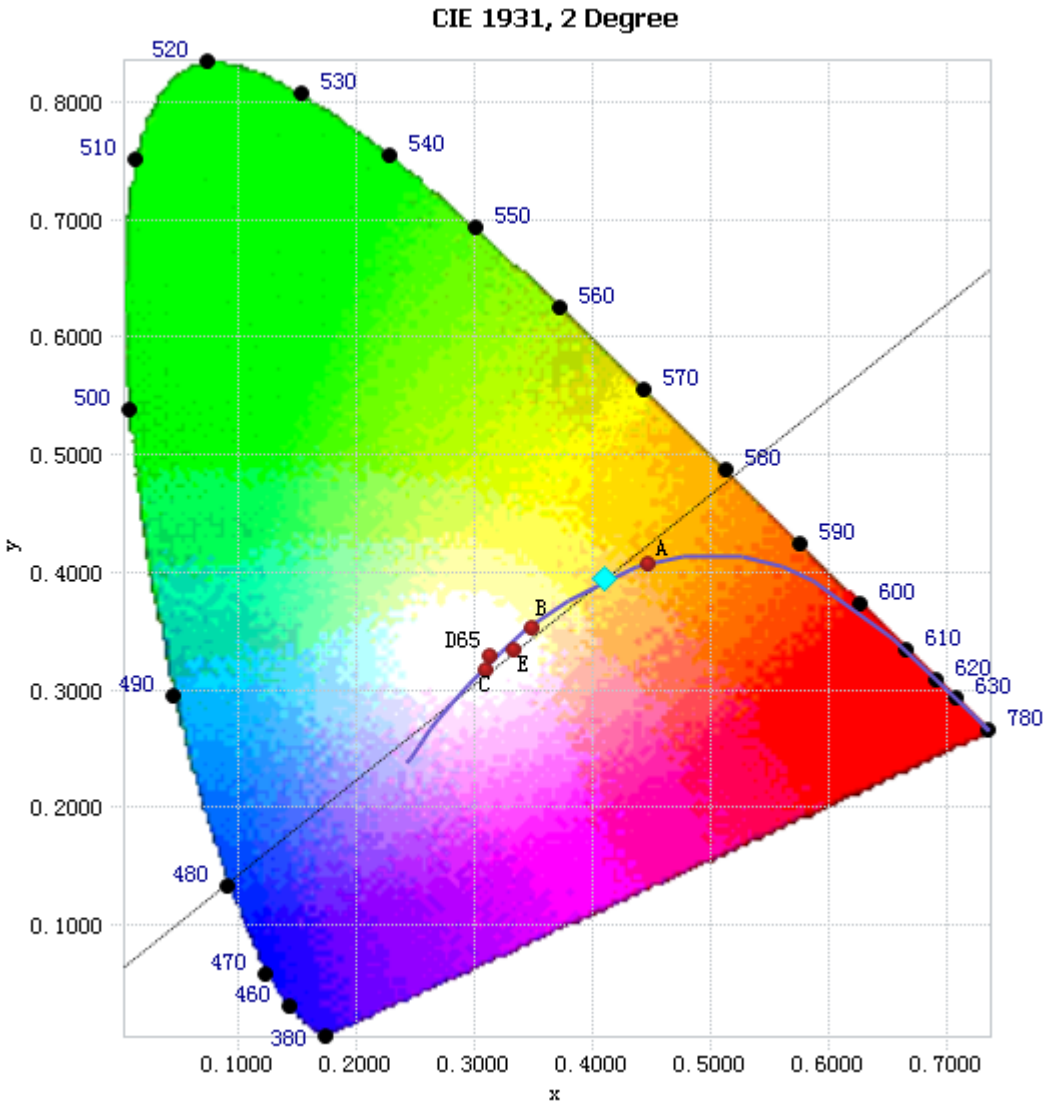


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	1.93E-04	485	7.51E-03	590	2.73E-02	695	4.20E-03
385	1.98E-04	490	8.18E-03	595	2.77E-02	700	3.61E-03
390	2.14E-04	495	9.24E-03	600	2.77E-02	705	3.10E-03
395	2.28E-04	500	1.05E-02	605	2.74E-02	710	2.64E-03
400	2.58E-04	505	1.19E-02	610	2.67E-02	715	2.27E-03
405	3.04E-04	510	1.31E-02	615	2.56E-02	720	1.95E-03
410	4.01E-04	515	1.41E-02	620	2.43E-02	725	1.67E-03
415	5.83E-04	520	1.49E-02	625	2.28E-02	730	1.43E-03
420	9.18E-04	525	1.55E-02	630	2.12E-02	735	1.22E-03
425	1.51E-03	530	1.62E-02	635	1.95E-02	740	1.03E-03
430	2.42E-03	535	1.68E-02	640	1.77E-02	745	8.86E-04
435	3.97E-03	540	1.74E-02	645	1.60E-02	750	7.57E-04
440	6.45E-03	545	1.82E-02	650	1.44E-02	755	6.55E-04
445	1.07E-02	550	1.90E-02	655	1.28E-02	760	5.66E-04
450	1.73E-02	555	1.99E-02	660	1.13E-02	765	4.87E-04
455	2.06E-02	560	2.10E-02	665	9.92E-03	770	4.15E-04
460	1.65E-02	565	2.21E-02	670	8.67E-03	775	3.60E-04
465	1.25E-02	570	2.33E-02	675	7.56E-03	780	3.06E-04
470	1.07E-02	575	2.45E-02	680	6.55E-03		
475	8.65E-03	580	2.56E-02	685	5.69E-03		
480	7.43E-03	585	2.67E-02	690	4.90E-03		

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

Chromaticity Diagram - Sphere Spectroradiometer Method



Tristimulus values(x, y): (0.4104, 0.3953)

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

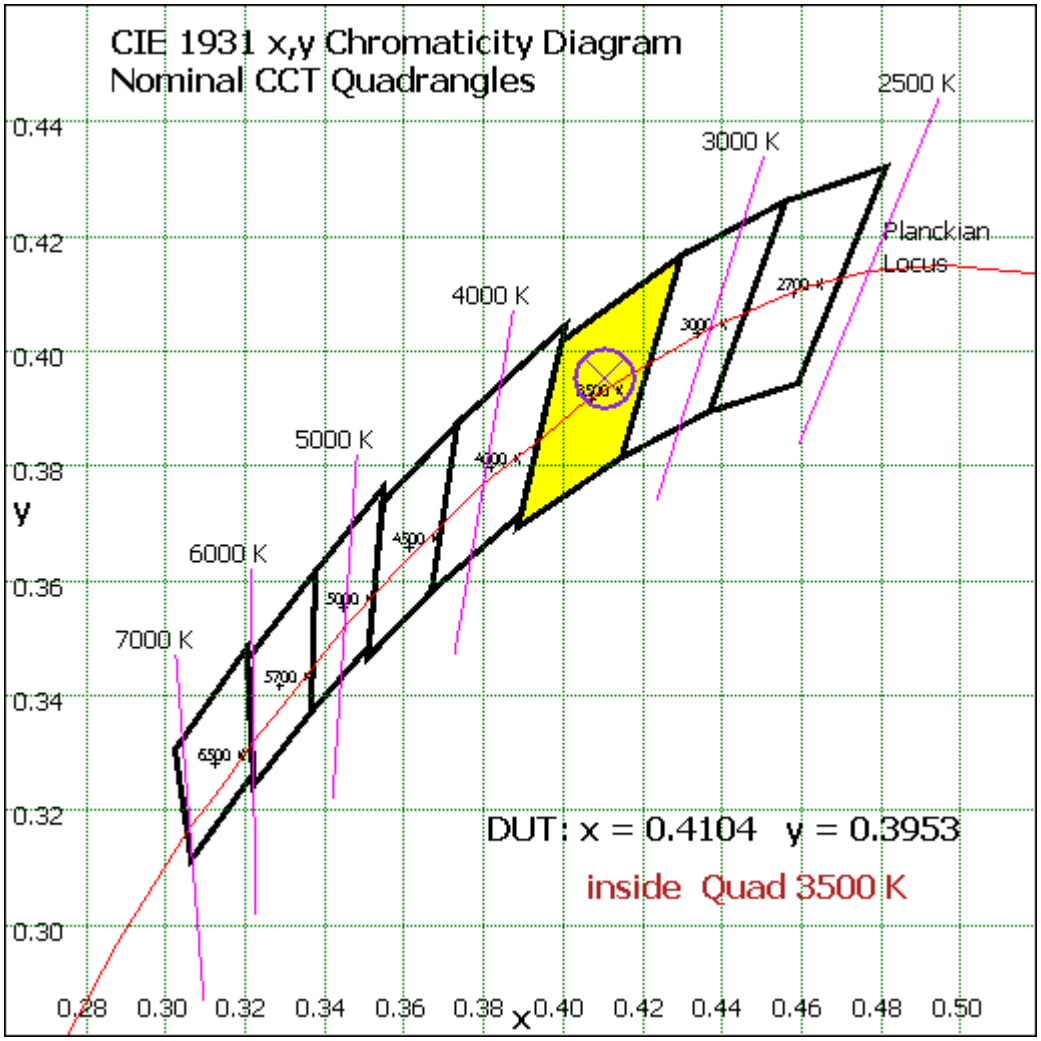


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

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	39.913	2.71%
10- 20	114.109	7.76%
20- 30	172.509	11.72%
30- 40	207.7	14.12%
40- 50	216.513	14.71%
50- 60	200.754	13.64%
60- 70	166.83	11.34%
70- 80	123.999	8.43%
80- 90	83.486	5.67%
90-100	54.41	3.70%
100-110	35.056	2.38%
110-120	22.12	1.50%
120-130	13.95	0.95%
130-140	8.959	0.61%
140-150	5.644	0.38%
150-160	3.353	0.23%
160-170	1.659	0.11%
170-180	0.415	0.03%
Total	1471.4	100%

γ(°)	Lumens	% Total
0- 60	951.498	64.67%
60- 90	374.315	25.44%
0-90	1325.813	90.11%
90- 180	145.566	9.89%
0- 180	1471.4	100%

Table 5: Zonal Lumen Data

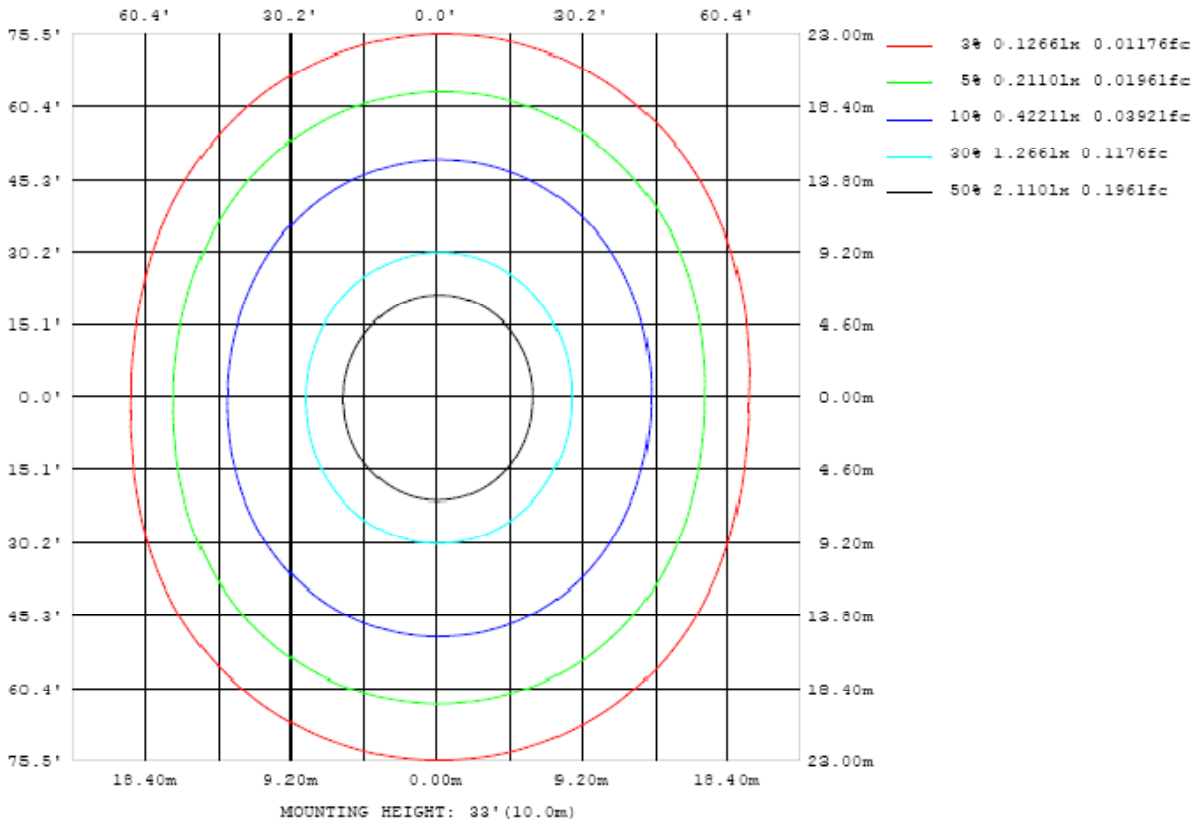


Chart 4: Beam Angle

Luminous Intensity Distribution Plots- Goniophotometer Method

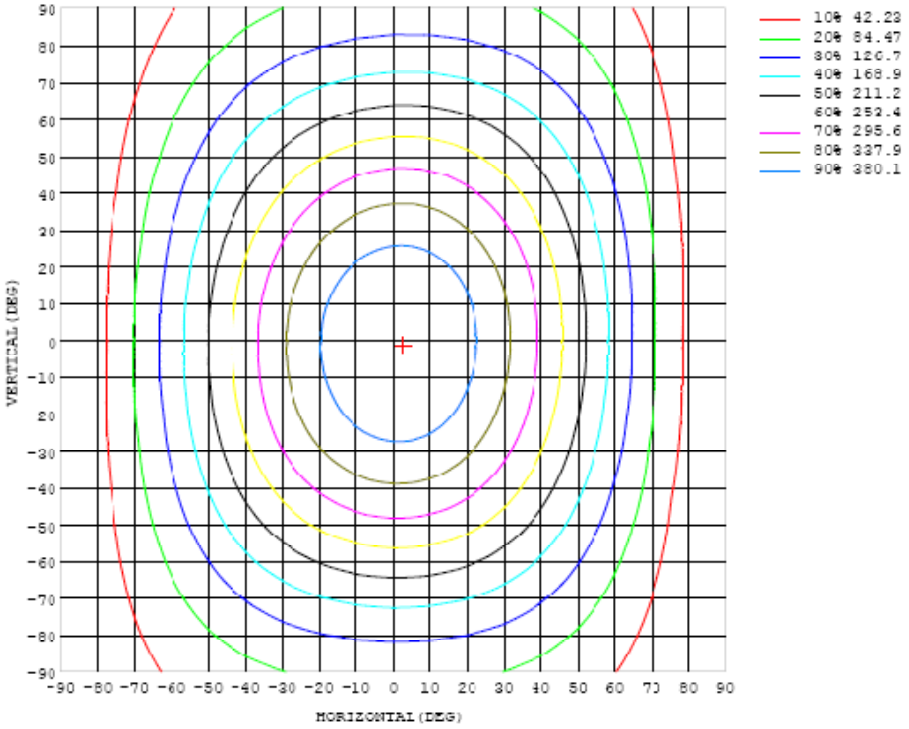


Chart 5: Illuminance Plot (Footcandles)

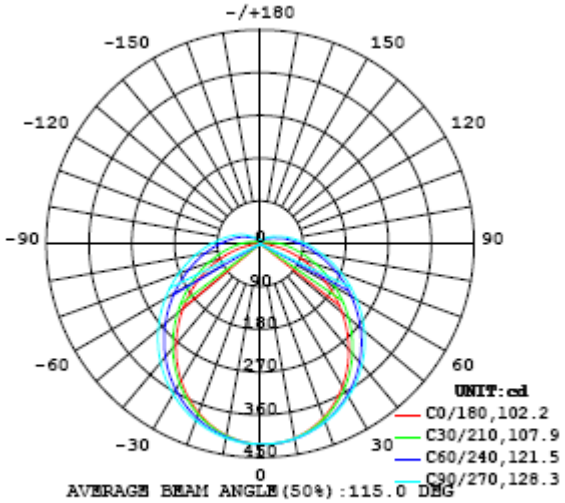


Chart 6: Polar Candela Distribution

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	422	422	422	422	422	422	422	422	422	422	422	422	422	422	422	422	422	422	422
5	421	421	421	421	421	421	421	421	421	421	420	420	420	419	419	419	419	418	418
10	415	415	416	416	417	417	417	417	417	416	416	415	414	413	412	411	411	410	410
15	405	405	406	406	408	408	409	410	410	409	408	407	405	404	402	400	398	397	396
20	389	390	391	392	394	396	398	399	400	399	398	396	393	390	387	384	382	380	379
25	370	370	372	374	378	381	384	387	387	387	385	382	379	375	370	365	362	359	357
30	346	347	350	353	358	363	368	371	372	371	370	366	362	356	350	344	338	335	333
35	320	320	324	329	335	342	348	352	354	353	351	347	342	334	327	319	313	308	305
40	290	291	295	302	310	318	326	331	333	333	331	326	319	311	302	293	284	278	276
45	258	260	265	273	283	293	301	307	310	310	308	303	296	286	275	264	255	247	244
50	225	227	233	243	255	266	276	282	286	286	284	278	270	259	248	235	224	216	212
55	191	193	201	212	226	238	249	256	260	261	258	252	244	232	220	206	193	184	180
60	157	160	169	182	197	210	222	229	234	234	232	226	217	205	192	177	163	152	148
65	124	127	137	152	168	183	195	203	207	208	205	199	191	179	165	149	134	122	117
70	91.0	94.7	108	124	142	157	168	176	181	181	179	173	165	154	139	123	107	92.6	85.9
75	60.2	65.1	80.3	98.8	117	132	144	152	156	157	155	150	141	130	116	99.5	82.0	66.0	56.9
80	32.8	38.8	56.9	76.4	94.7	110	121	129	133	134	132	127	120	109	95.3	78.7	61.0	42.8	30.9
85	11.3	18.5	37.8	58.0	75.7	90.4	101	109	112	113	112	107	101	90.4	77.3	61.7	43.4	24.6	10.5
90	1.17	7.01	24.0	42.9	60.2	73.8	84.2	91.1	94.6	95.7	94.4	90.4	84.0	74.5	62.5	47.4	30.1	12.8	1.01
95	0.48	2.52	14.0	30.4	46.4	59.9	69.3	76.0	79.4	80.5	79.4	75.9	69.9	61.5	49.9	35.6	19.9	6.19	0.43
100	0.55	1.61	8.98	21.3	35.1	47.3	56.7	63.0	65.9	67.3	66.7	63.7	58.1	49.7	38.8	25.8	13.5	4.01	0.46
105	0.69	1.44	6.37	15.5	26.3	36.4	45.0	51.2	54.7	56.0	55.3	52.1	46.6	38.8	29.4	19.6	9.90	3.00	0.74
110	0.97	1.68	4.89	12.0	20.4	28.7	35.5	40.4	43.5	44.7	44.1	41.4	37.0	31.0	23.6	15.4	8.04	2.93	1.10
115	1.38	1.91	4.44	9.62	16.4	23.2	28.9	33.2	35.8	36.7	36.3	34.2	30.5	25.4	19.2	12.7	6.93	2.99	1.49
120	1.79	2.18	4.33	8.09	13.5	19.0	23.9	27.5	29.7	30.6	30.2	28.4	25.4	21.0	16.0	10.8	6.26	3.10	1.91
125	2.19	2.48	4.34	7.28	11.3	15.8	19.9	22.9	24.8	25.6	25.3	23.7	21.1	17.6	13.6	9.38	5.80	3.26	2.34
130	2.68	2.80	4.37	6.75	9.84	13.4	16.7	19.2	20.8	21.5	21.2	19.9	17.8	14.8	11.6	8.27	5.47	3.37	2.68
135	3.13	3.05	4.42	6.36	8.79	11.5	14.1	16.2	17.5	18.1	17.9	16.8	15.0	12.7	10.1	7.44	5.28	3.50	2.98
140	3.59	3.21	4.47	6.04	7.91	10.0	12.0	13.6	14.7	15.1	15.0	14.2	12.8	10.9	8.93	6.87	5.26	3.71	3.38
145	3.99	3.28	4.40	5.84	7.18	8.76	10.3	11.5	12.3	12.7	12.6	12.0	10.9	9.51	7.96	6.44	5.27	3.83	3.76
150	4.26	3.33	4.12	5.71	6.66	7.77	8.83	9.76	10.4	10.7	10.6	10.1	9.35	8.33	7.16	6.15	5.24	3.75	4.10
155	4.51	3.56	4.11	5.44	6.28	7.00	7.74	8.34	8.77	8.99	8.93	8.61	8.09	7.44	6.66	5.95	4.90	3.70	4.47
160	4.78	4.10	3.86	4.90	5.95	6.46	6.90	7.32	7.58	7.70	7.68	7.49	7.15	6.74	6.27	5.62	4.29	3.77	4.62
165	4.69	4.43	3.46	3.64	4.34	5.39	6.22	6.50	6.65	6.73	6.74	6.64	6.28	5.63	5.14	4.58	3.50	3.99	4.68
170	4.87	4.04	3.61	3.11	3.01	3.06	3.09	3.21	4.27	5.62	3.54	3.45	3.46	3.41	3.36	3.36	3.46	3.57	4.25
175	4.96	4.22	3.29	2.82	2.75	2.74	2.70	2.73	2.75	1.20	3.49	3.51	3.23	3.20	3.20	3.21	3.24	3.42	3.71
180	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36

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	422	422	422	422	422	422	422	422	422	422	422	422	422	422	422	422	422		
5	418	418	418	419	419	419	420	420	420	421	421	421	421	421	421	421	421		
10	409	409	410	411	412	413	414	414	415	416	416	416	416	416	416	415	415		
15	396	397	398	400	401	403	405	406	407	408	408	408	408	407	406	405	405		
20	379	380	382	384	387	390	392	394	396	397	397	396	396	394	392	391	390		
25	358	360	362	366	370	374	377	380	382	383	383	382	380	377	375	372	371		
30	334	336	339	344	350	355	360	363	366	367	366	364	361	357	354	350	347		
35	307	309	314	320	327	334	339	344	347	348	347	344	340	335	329	325	321		
40	277	280	286	294	302	311	317	323	326	327	326	322	316	310	303	297	292		
45	246	250	257	267	277	286	294	300	304	305	303	298	291	283	274	267	261		
50	214	219	227	238	250	260	269	276	280	281	279	273	265	255	245	235	228		
55	182	188	197	210	223	235	244	251	255	256	254	247	238	227	214	204	195		
60	150	157	168	182	196	209	219	226	231	231	229	221	211	199	185	172	162		
65	119	128	141	156	171	184	194	202	206	207	203	196	186	172	157	142	130		
70	88.7	99.6	115	132	147	160	171	178	182	183	179	172	161	147	130	113	99.1		
75	60.7	74.2	91.5	109	125	139	149	155	159	160	156	149	138	124	106	87.2	70.3		
80	36.1	52.3	71.1	89.2	105	119	128	135	138	139	136	128	117	102	84.2	64.4	45.4		
85	17.5	35.0	54.1	72.0	87.7	100	110	116	119	119	116	109	98.4	83.9	66.1	46.1	25.9		
90	6.78	22.8	40.8	57.9	72.8	84.7	93.6	99.4	102	102	99.1	92.6	82.2	68.4	51.3	32.2	13.5		
95	2.85	15.1	30.9	46.5	60.2	71.3	79.6	84.9	87.6	87.5	84.3	78.1	68.4	55.5	39.7	22.6	7.10		
100	2.02	9.72	23.5	37.4	49.8	60.0	67.5	72.5	74.9	74.7	71.7	65.8	56.8	45.0	30.8	16.0	4.31		
105	1.88	7.29	17.5	30.0	41.2	50.5	57.4	61.8	64.0	63.7	60.9	55.4	47.2	36.4	23.7	11.2	3.34		
110	2.19	6.11	13.4	23.2	33.7	42.2	48.6	52.7	54.6	54.2	51.6	46.5	38.8	28.8	17.9	8.71	3.03		
115	2.56	5.59	11.2	18.6	26.4	34.4	40.5	44.3	46.1	45.7	43.1	38.1	30.7	22.3	14.1	7.33	3.16		
120	2.93	5.41	9.72	15.5	21.7	27.4	32.3	35.9	37.6	37.1	34.5	29.9	24.4	18.2	11.9	6.48	3.36		
125	3.31	5.34	8.76	13.3	18.3	22.8	26.5	29.0	30.1	29.7	27.8	24.6	20.3	15.2	10.3	6.10	3.60		
130	3.65	5.38	8.11	11.6	15.5	19.2	22.2	24.1	25.0	24.7	23.1	20.5	17.1	13.1	9.09	5.90	3.91		
135	3.90	5.44	7.64	10.4	13.4	16.3	18.6	20.2	20.9	20.6	19.4	17.3	14.5	11.4	8.32	5.85	4.21		
140	4.06	5.37	7.18	9.29	11.6	13.8	15.8	17.0	17.5	17.3	16.3	14.6	12.5	10.1	7.77	5.85	4.48		
145	4.39	5.47	6.89	8.50	10.3	11.9	13.3	14.2	14.7	14.5	13.7	12.5	10.9	9.12	7.38	5.76	4.65		
150	4.70	5.27	6.50	7.07	9.14	10.4	11.4	12.1	12.4	12.2	11.7	10.0	9.60	8.31	6.97	5.71	4.83		
155	5.12	5.64	6.17	7.24	8.22	9.07	9.78	10.3	10.5	10.4	9.99	9.35	8.55	7.62	6.56	5.51	5.10		
160	5.29	5.70	6.09	6.48	7.26	7.94	8.44	8.76	8.91	8.86	8.61	8.22	7.72	6.98	6.18	5.63	5.28		
165	5.30	5.58	5.70	6.10	6.45	6.80	7.13	7.35	7.46	7.41	7.39	7.22	6.86	6.34	6.02	5.75	5.36		
170	4.92	5.41	5.61	5.49	5.47	6.25	6.46	6.50	6.54	6.52	6.44	6.33	6.18	5.99	5.82	5.73	5.35		
175	3.98	4.27	4.73	5.23	5.41	5.24	5.06	5.21	5.46	5.56	5.63	5.66	5.63	5.59	5.48	5.41	5.28		
180	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36		

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

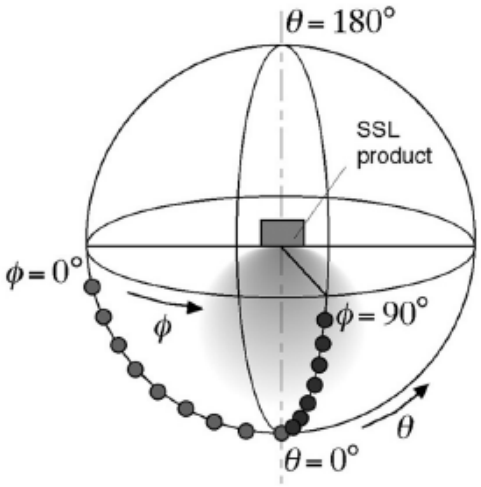
The color characteristics of SSL products include chromaticity coordinates, correlated color temperature, and color rendering index. These characteristics of SSL products may be spatially non-uniform, and thus, in order that they can be specified accurately, the color quantities shall be measured as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