



LM-79-08 Test Report

for

Revolution Lighting Technologies, Inc.

2280 Ward Ave. Simi Valley, CA 93065

LED Tube

Model: 204100-113

Laboratory: Leading Testing Laboratories

NVLAP CODE: 200960-0

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Report No.: HZ18110016b

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

Review by:

Engineer: April Zou
Nov. 19, 2018

Approved by:



Manager: Jim Zhang
Nov. 19, 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: 204100-113

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)	Power Factor
131.3	1996.0	15.20	0.9825
CCT (K)	CRI	Stabilization Time (Light & Power)	
3950	82.6	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. 12, 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	: 204100-113
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 24.9°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)	0.129	0.059
Power Factor	0.9825	0.9615
Test Power (W)	15.20	15.64
THD A%	17.27	19.77
Luminous Efficacy (lm/W)	131.3	127.9
Total Luminous Flux (lm)	1996.0	2001.0
Color Rendering Index (CRI)	82.6	
R9	4.2	
Correlated Color Temperature (CCT)(K)	3950	
Chromaticity Chroma x	0.3837	
Chromaticity Chroma y	0.3821	
Chromaticity Chroma u	0.2251	
Chromaticity Chroma v	0.3363	
Duv	0.0015	
Chromaticity Chroma u'	0.2251	
Chromaticity Chroma v'	0.5044	

Special Color Rendering Indices	
R1	80.5
R2	89.2
R3	95.6
R4	81
R5	80.7
R6	85.3
R7	85.5
R8	62.7
R9	4.2
R10	74.7
R11	80
R12	62.2
R13	82.7
R14	97.8

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 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)	0.130
Power Factor	0.9815
Power (W)	15.30
Luminous Efficacy (lm/W)	128.5
Total Luminous Flux (lm)	1966.3
Beam Angle (°)	113.7 (0°-180°) /146.8(90°-270°)
Center Beam Candle Power (cd)	477
Maximum Beam Candle Power (cd)	479.1 (At: C=0.0, Gamma=1.0)
Spacing Criteria	1.26 (0°-180°) /1.33 (90°-270°)
Zonal Lumens in the 0°-60°Zone	58.81%
Zonal Lumens in the 60°-90°Zone	27.84%
Zonal Lumens in the 90°-120°Zone	10.18%
Zonal Lumens in the 120°-180°Zone	3.17%

Table 3: Test data per Goniophotometer Method

Spectral Power Distribution - Sphere Spectroradiometer Method

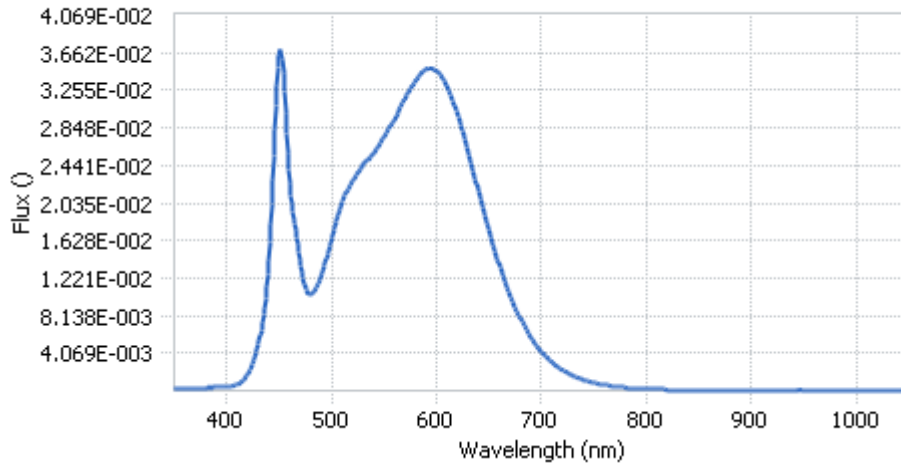
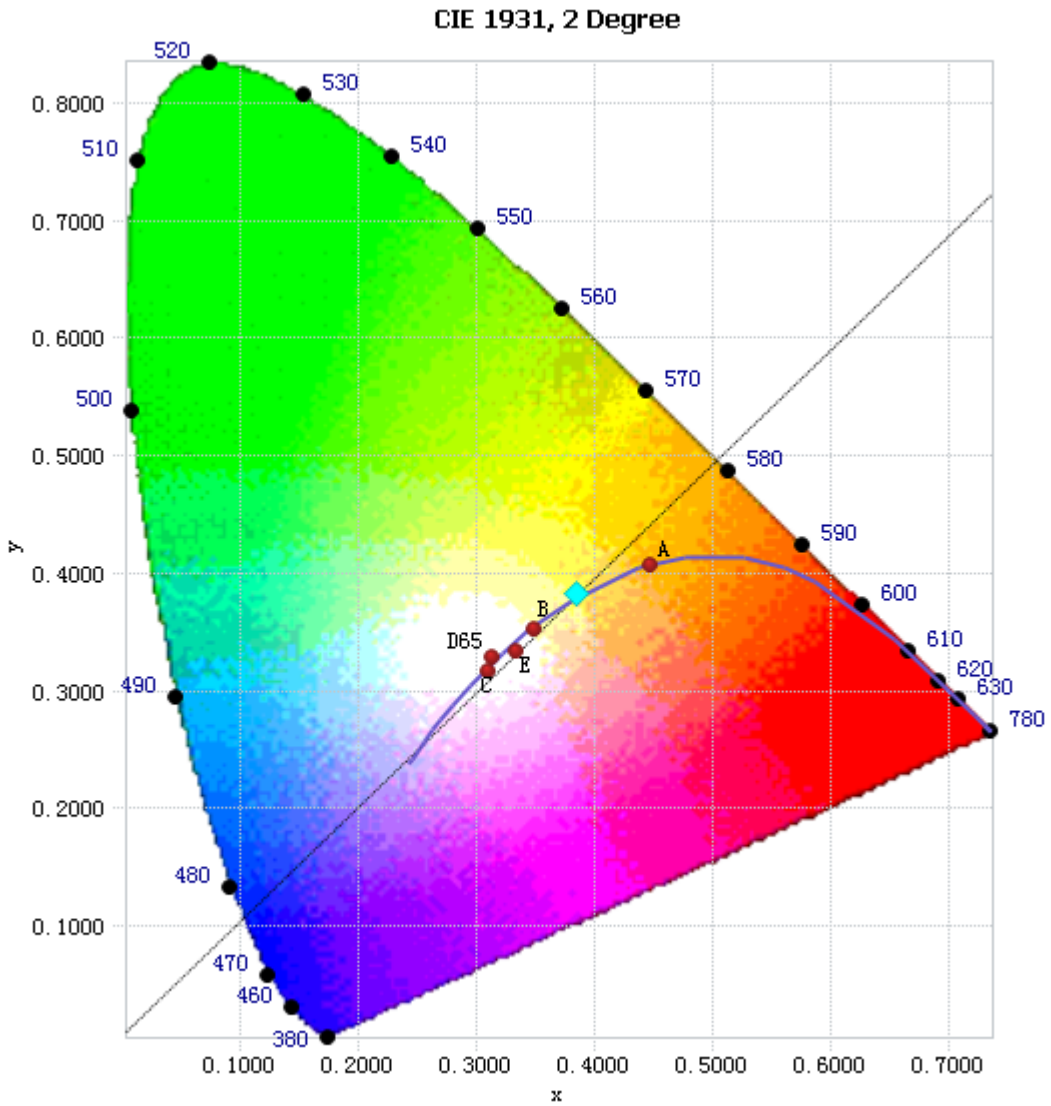


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	3.41E-04	485	1.11E-02	590	3.48E-02	695	4.92E-03
385	3.36E-04	490	1.23E-02	595	3.49E-02	700	4.22E-03
390	3.49E-04	495	1.43E-02	600	3.46E-02	705	3.62E-03
395	3.89E-04	500	1.66E-02	605	3.40E-02	710	3.07E-03
400	4.34E-04	505	1.87E-02	610	3.30E-02	715	2.62E-03
405	5.09E-04	510	2.04E-02	615	3.16E-02	720	2.25E-03
410	6.98E-04	515	2.18E-02	620	2.99E-02	725	1.92E-03
415	1.09E-03	520	2.28E-02	625	2.80E-02	730	1.64E-03
420	1.83E-03	525	2.36E-02	630	2.59E-02	735	1.39E-03
425	3.06E-03	530	2.45E-02	635	2.38E-02	740	1.19E-03
430	4.96E-03	535	2.51E-02	640	2.16E-02	745	1.02E-03
435	8.18E-03	540	2.58E-02	645	1.94E-02	750	8.60E-04
440	1.42E-02	545	2.66E-02	650	1.74E-02	755	7.45E-04
445	2.56E-02	550	2.75E-02	655	1.54E-02	760	6.37E-04
450	3.64E-02	555	2.84E-02	660	1.35E-02	765	5.43E-04
455	3.24E-02	560	2.94E-02	665	1.19E-02	770	4.74E-04
460	2.24E-02	565	3.06E-02	670	1.03E-02	775	4.04E-04
465	1.80E-02	570	3.17E-02	675	8.97E-03	780	3.58E-04
470	1.42E-02	575	3.27E-02	680	7.78E-03		
475	1.11E-02	580	3.37E-02	685	6.72E-03		
480	1.04E-02	585	3.45E-02	690	5.75E-03		

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

Chromaticity Diagram - Sphere Spectroradiometer Method



Tristimulus values(x, y): (0.3837, 0.3821)

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

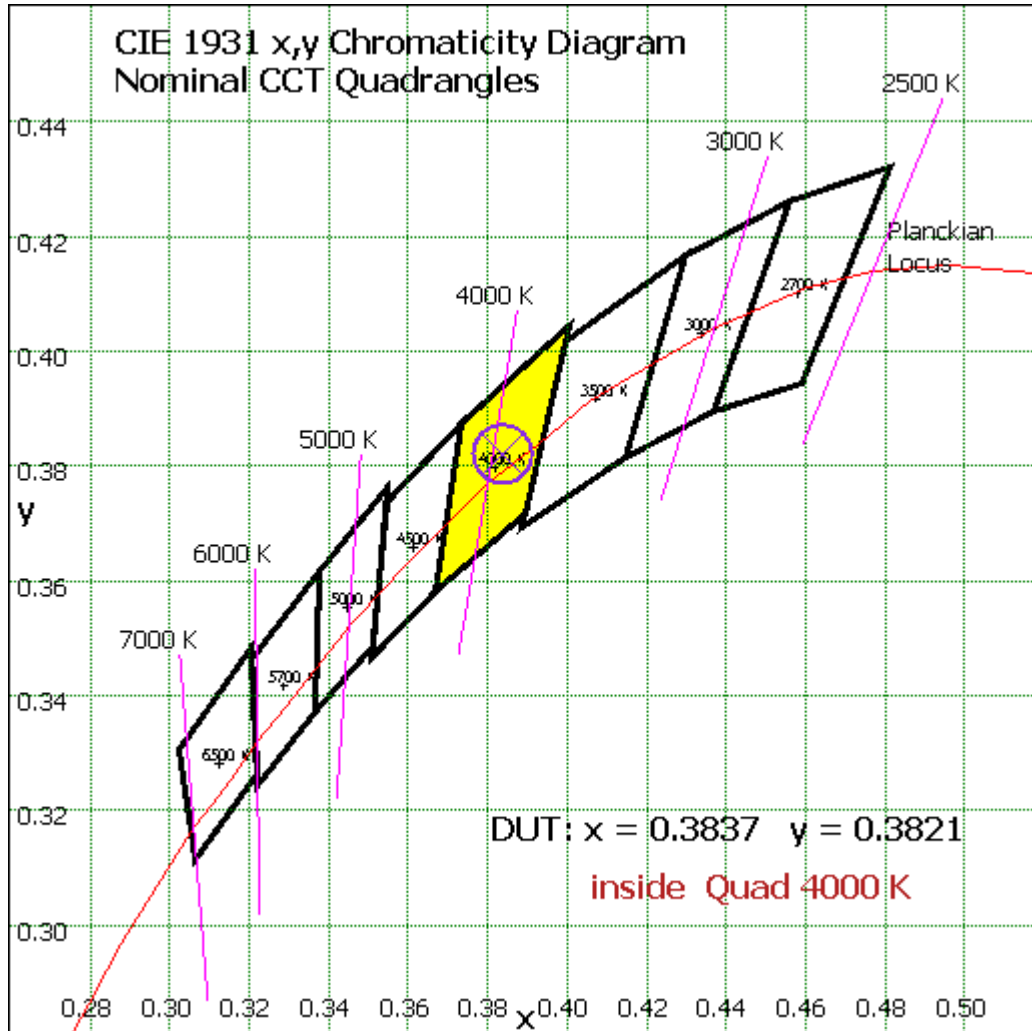


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

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	45.258	2.30%
10- 20	130.554	6.64%
20- 30	200.855	10.21%
30- 40	248.553	12.64%
40- 50	269.136	13.69%
50- 60	261.974	13.32%
60- 70	230.699	11.73%
70- 80	183.486	9.33%
80- 90	133.221	6.78%
90-100	93.646	4.76%
100-110	64.144	3.26%
110-120	42.434	2.16%
120-130	27.06	1.38%
130-140	16.725	0.85%
140-150	9.926	0.50%
150-160	5.465	0.28%
160-170	2.477	0.13%
170-180	0.715	0.04%
Total	1966.3	100%

$\gamma(^{\circ})$	Lumens	% Total
0- 60	1156.33	58.81%
60- 90	547.406	27.84%
0-90	1703.736	86.65%
90- 180	262.592	13.35%
0- 180	1966.3	100%

Table 5: Zonal Lumen Data

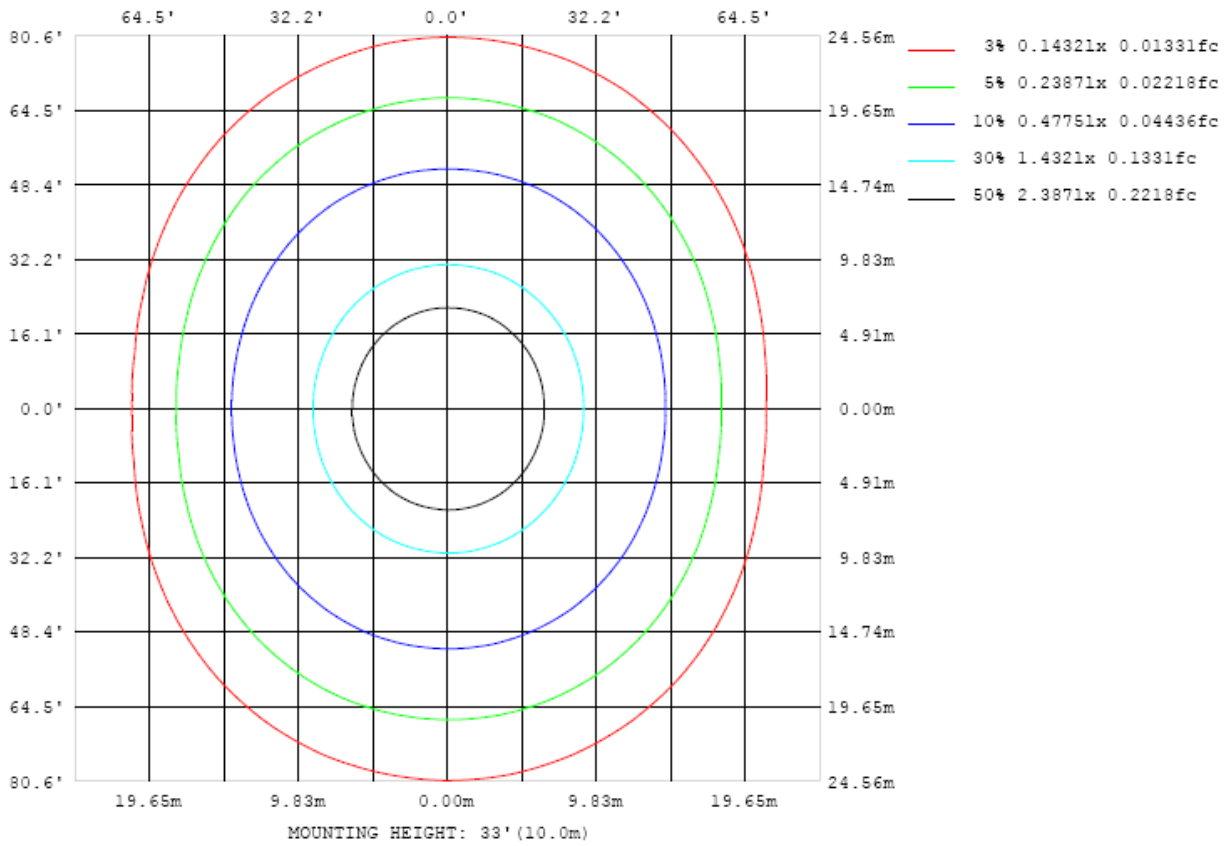


Chart 4: Beam Angle

Luminous Intensity Distribution Plots- Goniophotometer Method

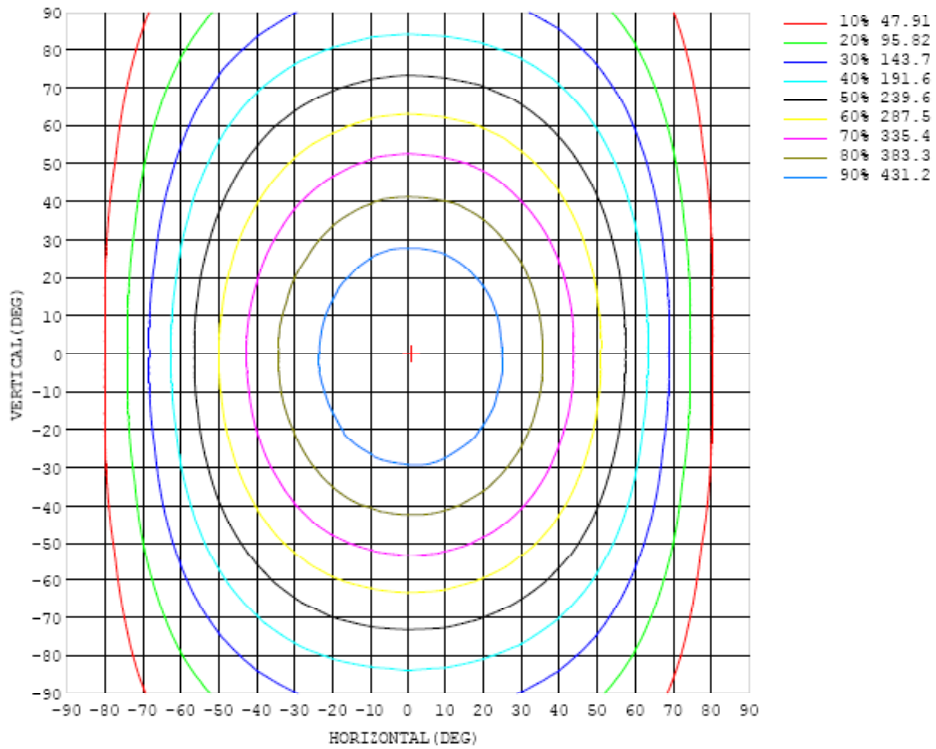


Chart 5: Illuminance Plot (Footcandles)

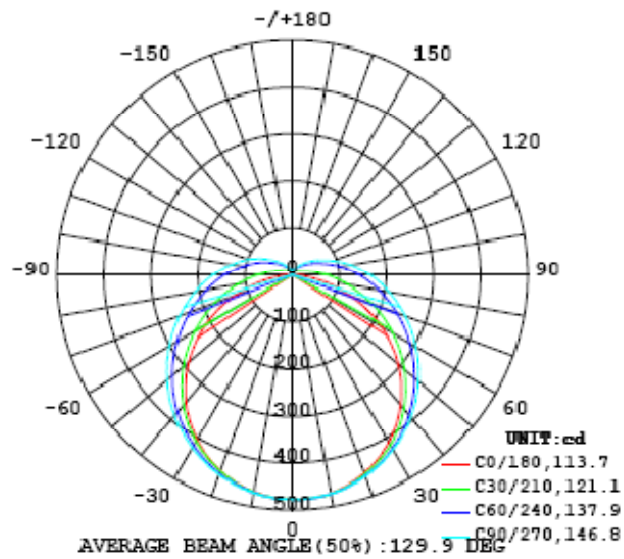


Chart 6: Polar Candela Distribution

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	477	477	477	477	477	477	477	477	477	477	477	477	477	477	477	477	477	477	477
5	477	477	476	477	476	476	477	477	476	476	476	475	476	476	475	476	476	477	475
10	472	471	472	473	473	472	473	473	473	471	470	471	472	472	470	470	469	468	467
15	462	462	463	463	465	465	465	465	466	465	465	465	465	463	461	460	458	458	459
20	449	449	451	451	453	454	455	455	457	455	453	453	454	451	449	447	445	444	444
25	431	433	434	436	438	442	442	444	445	444	442	441	440	437	432	431	428	427	426
30	410	412	413	417	421	424	426	423	429	428	427	426	424	420	415	410	408	405	404
35	387	389	390	395	399	405	407	411	412	412	410	409	405	399	393	388	385	381	379
40	359	361	364	370	375	381	387	391	394	393	392	389	384	377	369	363	358	355	351
45	328	330	335	342	351	356	364	369	373	373	371	367	361	353	344	336	328	323	320
50	294	297	303	312	322	332	340	345	350	351	349	345	338	327	316	306	297	290	288
55	258	261	269	280	293	305	315	322	327	328	325	321	312	301	288	274	263	254	251
60	210	222	232	247	263	277	293	297	304	304	301	296	287	274	259	243	229	216	212
65	177	181	196	214	232	245	262	273	279	281	277	272	261	246	229	210	192	177	171
70	133	140	158	181	202	221	237	243	255	256	253	247	235	220	200	178	156	136	130
75	90.2	98.9	123	149	174	195	212	223	230	232	229	223	210	193	173	148	122	97.5	87.3
80	49.7	62.1	90.5	120	147	165	187	193	207	209	206	199	187	169	146	120	90.9	62.4	47.4
85	16.0	32.2	63.3	94.5	123	146	164	175	185	186	184	177	164	146	123	95.7	65.1	34.6	15.4
90	0.31	14.2	43.1	73.4	101	124	142	155	163	166	162	156	143	125	102	75.3	45.9	17.1	0.16
95	0.34	6.41	28.4	56.2	82.4	105	123	135	143	145	143	136	123	106	84.1	59.0	31.3	8.65	0.26
100	0.53	4.02	19.6	41.8	65.2	86.5	104	115	124	126	124	117	105	88.4	67.5	44.5	22.3	5.82	0.49
105	0.96	3.35	14.6	32.4	52.3	70.4	85.1	98.0	106	108	106	99.2	87.7	72.1	54.4	35.1	16.9	4.67	0.96
110	1.53	3.42	11.7	25.7	42.3	58.2	71.6	81.3	87.7	90.3	88.1	82.7	72.8	59.7	44.5	28.2	13.8	4.47	1.57
115	2.20	3.73	9.96	20.9	34.5	48.0	59.8	68.3	73.9	75.9	74.4	69.4	61.2	49.9	36.5	23.1	11.8	4.53	2.23
120	2.86	4.01	9.01	17.4	28.3	39.5	49.7	57.6	62.1	63.7	62.3	58.6	51.1	41.2	30.3	19.5	10.6	4.69	2.90
125	3.51	4.34	8.47	14.9	23.5	32.7	41.1	47.5	51.8	53.3	52.1	48.5	42.3	34.3	25.4	15.7	9.76	4.86	3.55
130	4.13	4.54	8.13	13.3	19.7	27.0	33.9	39.4	42.9	44.2	43.1	40.1	35.0	28.4	21.3	14.6	9.17	4.95	4.18
135	4.80	4.59	7.81	11.9	16.9	22.5	27.9	32.2	35.2	36.2	35.4	32.9	28.9	23.7	18.2	13.0	8.77	5.00	4.81
140	5.48	4.70	7.67	10.8	14.7	18.9	23.1	26.3	28.6	29.5	28.8	27.0	23.8	19.9	15.7	11.7	8.36	4.98	5.37
145	6.09	4.84	7.41	9.99	12.8	16.0	19.0	21.5	23.2	23.9	23.4	22.1	19.7	16.8	13.7	10.7	7.99	5.06	6.29
150	6.76	5.46	6.75	9.19	11.4	13.5	15.8	17.6	18.8	19.3	19.0	18.1	16.3	14.3	11.9	9.86	7.32	5.45	6.84
155	7.14	6.02	5.49	7.80	10.4	11.3	13.2	14.5	15.3	15.6	15.5	14.8	13.6	11.3	9.72	8.30	6.03	5.95	7.16
160	7.32	6.31	5.15	5.75	8.46	10.9	11.2	12.1	12.6	12.8	12.8	11.8	9.21	8.33	7.53	6.69	5.18	5.49	6.83
165	8.16	7.38	5.43	4.98	5.33	6.17	8.38	9.83	10.5	10.7	8.70	7.07	7.24	6.76	5.83	5.22	5.12	5.73	6.33
170	8.19	7.96	6.89	5.73	5.60	6.15	6.42	6.65	7.36	5.96	7.03	7.31	6.79	6.27	5.85	5.34	5.27	5.65	5.88
175	8.38	8.14	7.94	7.63	7.11	6.71	6.59	6.48	5.52	3.92	6.30	6.42	6.41	6.16	6.06	6.12	6.13	5.93	5.72
180	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32

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	477	477	477	477	477	477	477	477	477	477	477	477	477	477	477	477	477		
5	474	475	475	474	474	475	476	475	475	475	477	476	476	476	476	477	477		
10	469	469	469	468	469	469	469	471	470	471	471	471	472	470	470	471	470		
15	459	458	460	458	460	461	462	462	463	464	464	463	463	463	462	461	461		
20	444	445	444	447	448	450	451	452	452	453	454	452	452	452	450	450	448		
25	426	428	428	431	433	436	437	439	439	440	440	439	437	437	435	433	431		
30	405	406	408	412	415	419	421	423	424	424	425	422	420	418	416	413	410		
35	381	381	386	389	394	399	403	406	407	407	405	400	397	394	389	387			
40	353	354	360	365	372	379	383	387	388	388	386	384	378	373	369	364	361		
45	322	325	333	339	348	356	362	367	369	367	367	362	354	349	342	335	331		
50	289	294	303	312	323	332	339	345	346	346	344	338	329	321	312	304	298		
55	253	261	271	283	296	307	315	321	325	323	320	313	302	292	281	270	262		
60	215	225	239	254	269	282	290	299	301	299	297	288	276	262	248	235	224		
65	176	189	206	225	242	257	266	275	278	276	272	262	250	233	215	198	184		
70	136	153	174	196	215	231	243	251	254	253	248	238	223	204	184	161	143		
75	96.3	119	145	169	190	207	220	228	232	230	224	213	197	176	153	127	103		
80	60.4	88.1	117	144	166	184	198	206	210	207	202	190	173	151	125	95.2	66.6		
85	31.3	62.3	92.9	121	144	163	176	185	188	186	180	167	150	127	100	68.5	37.0		
90	15.0	43.1	73.1	101	124	143	155	164	168	165	159	147	130	106	79.1	48.2	18.1		
95	7.23	30.0	57.0	83.2	106	124	137	146	149	147	141	128	110	88.2	62.2	33.9	9.22		
100	5.03	21.4	44.8	68.5	89.6	107	119	128	131	129	122	111	93.9	72.6	48.9	24.4	6.06		
105	4.40	16.2	35.1	56.4	75.6	91.4	103	111	114	112	106	94.8	79.2	59.8	38.5	18.3	5.10		
110	4.49	13.3	28.1	45.7	63.1	77.7	88.5	95.9	98.3	96.5	90.3	80.5	66.3	48.8	30.5	14.6	4.38		
115	4.77	11.6	23.1	37.3	51.9	65.2	75.1	81.7	83.9	82.3	77.0	67.5	54.5	39.3	24.8	12.5	5.00		
120	5.14	10.6	19.7	31.1	42.7	53.3	62.4	68.2	70.5	68.8	63.3	55.4	44.6	32.6	20.9	11.2	5.25		
125	5.55	9.95	17.1	26.2	35.7	44.4	51.3	56.0	57.7	56.3	52.4	45.7	37.0	27.3	17.9	10.3	5.52		
130	6.01	9.56	15.2	22.4	29.9	36.3	42.6	46.4	47.7	46.5	43.3	37.9	30.9	23.1	15.6	9.74	6.02		
135	6.44	9.29	13.8	19.4	25.2	30.7	35.2	38.2	39.4	38.5	35.3	31.5	25.9	19.8	14.0	9.43	6.46		
140	6.82	9.12	12.5	16.8	21.3	25.5	29.1	31.5	32.3	31.6	29.5	26.2	21.9	17.2	12.7	9.25	6.38		
145	7.13	9.04	11.6	14.0	18.2	21.4	24.0	25.9	26.4	25.0	24.3	21.7	18.6	15.1	11.7	9.11	7.22		
150	7.37	8.38	10.9	13.1	15.6	18.0	19.9	21.1	21.6	21.1	20.1	18.2	15.9	13.3	10.9	8.99	7.56		
155	7.65	8.71	10.3	11.8	13.5	15.1	16.5	17.4	17.6	17.4	16.5	15.3	13.7	11.9	10.3	8.90	7.39		
160	7.60	8.23	9.18	10.7	11.8	12.3	13.6	14.2	14.4	14.2	13.7	13.0	12.0	10.9	9.80	8.85	8.13		
165	6.90	7.79	8.32	9.65	10.4	11.0	11.5	11.8	12.0	11.9	11.5	11.2	10.6	10.0	9.40	8.82	8.38		
170	6.22	6.91	7.67	8.35	9.15	9.63	9.93	10.1	10.2	10.1	10.0	9.95	9.61	9.33	9.03	8.76	8.49		
175	5.75	6.18	6.77	7.43	7.99	8.25	8.47	8.69	8.82	8.87	8.85	8.82	8.80	8.74	8.70	8.63	8.54		
180	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32		

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

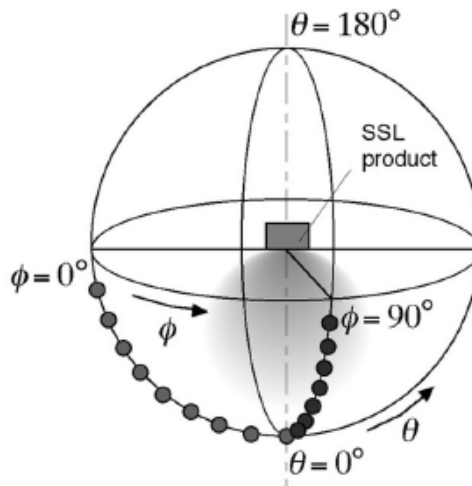
The color characteristics of SSL products include chromaticity coordinates, correlated color temperature, and color rendering index. These characteristics of SSL products may be spatially non-uniform, and thus, in order that they can be specified accurately, the color quantities shall be measured as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