LM-79-08 Test Report

for

P.Q.L., Inc.

2285 Ward Avenue / Simi Valley, CA 93065

LED TUBE

Model: 91301

Laboratory: Leading Testing Laboratories

NVLAP CODE: 200960-0

3rd Floor, Bld. 2, NO. 96 Longchuanwu Rd Qianjiang Economy Dev. Zone, Yuhang Dist,
Hangzhou, Zhejiang Province, China 311100
Tel: +86 571 86376106
www.ledtestlab.com

Report No.: HZ17050019e

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

Review by: April Zou

Engineer: April Zou
May 12, 2017

Approved by: Jim Zhang

Manager: Jim Zhang
May 12, 2017

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: **91301**

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)	Power Factor
138.7	2040.0	14.71	0.9716

CCT (K)	CRI	Stabilization Time (Light & Power)
5043	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	: May 08, 2017
Date of Test	: May 09, 2017
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

Sample Photos

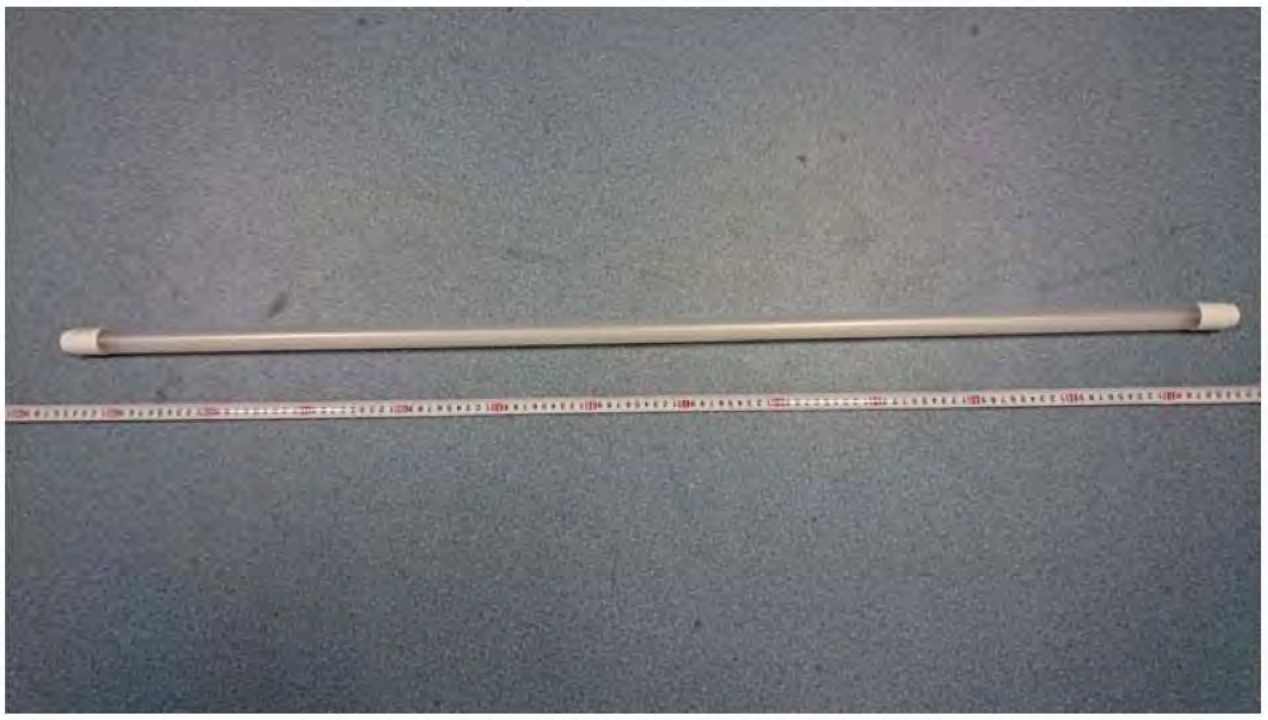


Figure 1- Overview of the sample

Equipment Under Test (EUT)	
Name	: LED TUBE
Model	: 91301
Electrical Ratings	: 120-277V, 50/60Hz, 14.5W
Product Description	: G13 base, 5000K
Manufacturer	: P.Q.L., Inc.
Address	: 2285 Ward Avenue / Simi Valley, CA 93065

TEST RESULTS

Test ambient temperature was 24.9℃.

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	277.0
Voltage frequency (Hz)	60	60
Test Current (A)	0.126	0.060
Power Factor	0.9716	0.9017
Test Power (W)	14.71	15.01
THD A%	22.46	16.30
Luminous Efficacy (lm/W)	138.7	137.1
Total Luminous Flux (lm)	2040.0	2058.0
Color Rendering Index (CRI)	82.2	
R9	7.2	
Correlated Color Temperature (CCT)(K)	5043	
Chromaticity Chroma x	0.3445	
Chromaticity Chroma y	0.3588	
Chromaticity Chroma u	0.2083	
Chromaticity Chroma v	0.3254	
Duv	0.0031	
Chromaticity Chroma u ’	0.2083	
Chromaticity Chroma v’	0.4880	

Special Color Rendering Indices	
R1	80.3
R2	86.1
R3	90.6
R4	83
R5	81.3
R6	81.2
R7	86.9
R8	68
R9	7.2
R10	67.3
R11	82.5
R12	61.7
R13	81.5
R14	94.9

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℃.

The photometric distance is 30m.

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)	0.126
Power Factor	0.9723
Test Power (W)	14.71
Luminous Efficacy (lm/W)	141.0
Total Luminous Flux (lm)	2073.3
Beam Angle (°)	115.6
Center Beam Candle Power (cd)	557
Spacing Criteria	1.26 (0°-180°)/ 1.24(90°-270°)
Zonal Lumens in the 0°-60°Zone	61.72%
Zonal Lumens in the 60°-90°Zone	23.29%
Zonal Lumens in the 90°-120°Zone	9.16%
Zonal Lumens in the 120°-180°Zone	5.83%

Table 3: Test data per Goniophotometer Method

Spectral Power Distribution - Sphere Spectroradiometer Method

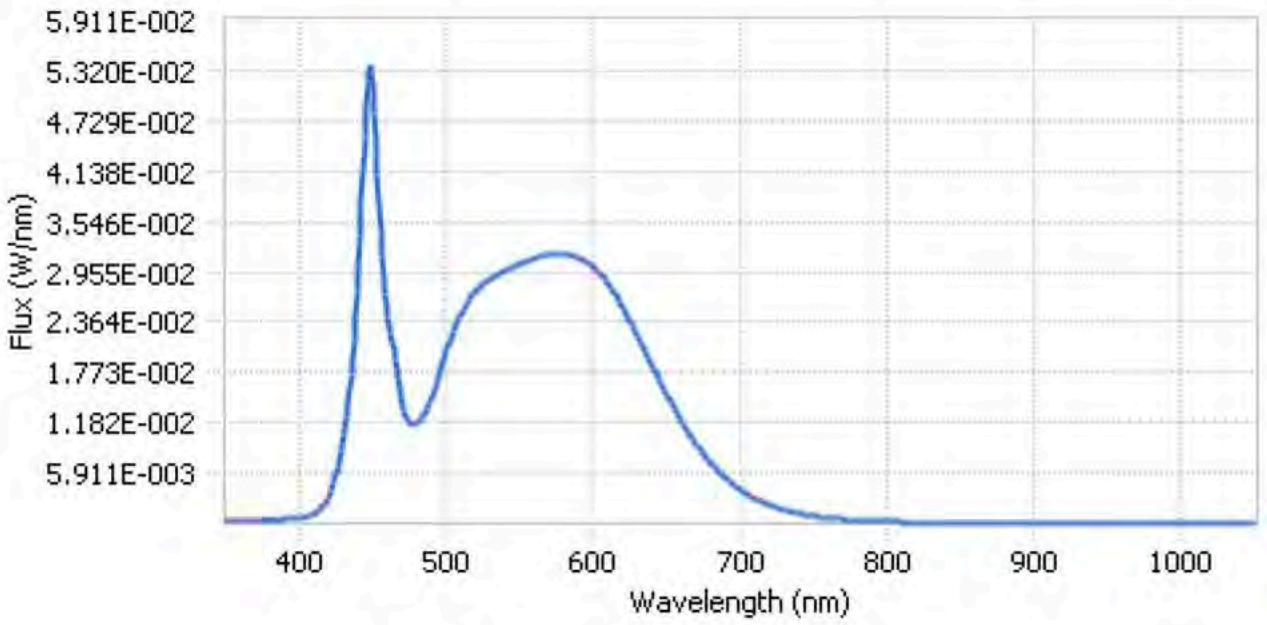
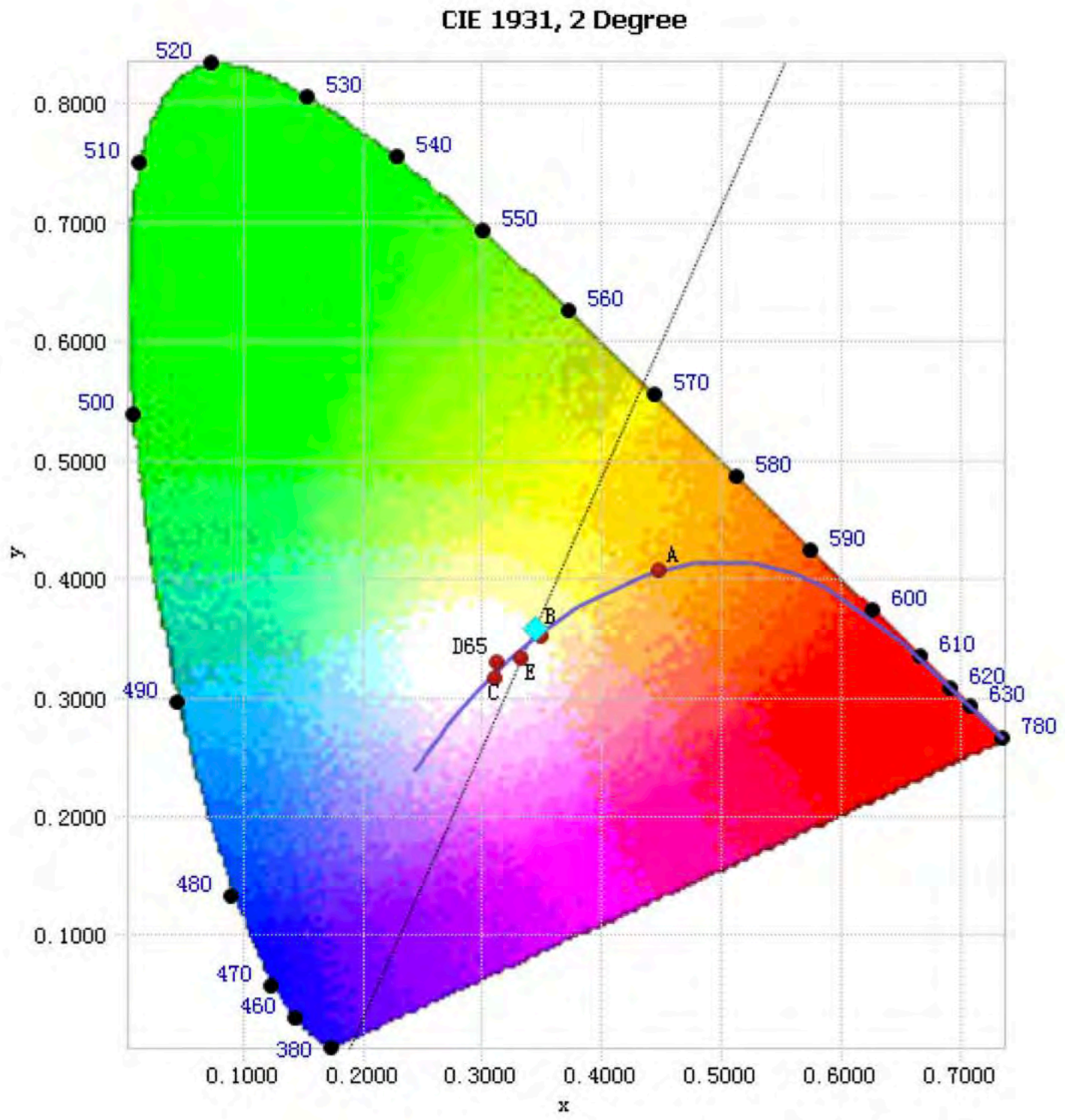


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	4.25E-04	485	1.27E-02	590	3.13E-02	695	4.67E-03
385	4.44E-04	490	1.45E-02	595	3.08E-02	700	4.02E-03
390	4.91E-04	495	1.72E-02	600	3.02E-02	705	3.47E-03
395	5.33E-04	500	1.99E-02	605	2.93E-02	710	2.96E-03
400	5.96E-04	505	2.24E-02	610	2.83E-02	715	2.55E-03
405	7.60E-04	510	2.44E-02	615	2.70E-02	720	2.19E-03
410	1.05E-03	515	2.61E-02	620	2.55E-02	725	1.87E-03
415	1.69E-03	520	2.72E-02	625	2.39E-02	730	1.61E-03
420	2.90E-03	525	2.80E-02	630	2.23E-02	735	1.38E-03
425	5.24E-03	530	2.87E-02	635	2.05E-02	740	1.17E-03
430	9.26E-03	535	2.91E-02	640	1.87E-02	745	1.01E-03
435	1.58E-02	540	2.97E-02	645	1.70E-02	750	8.62E-04
440	2.73E-02	545	3.01E-02	650	1.53E-02	755	7.48E-04
445	4.54E-02	550	3.04E-02	655	1.37E-02	760	6.43E-04
450	5.30E-02	555	3.08E-02	660	1.21E-02	765	5.51E-04
455	3.73E-02	560	3.10E-02	665	1.08E-02	770	4.78E-04
460	2.57E-02	565	3.13E-02	670	9.42E-03	775	4.09E-04
465	2.03E-02	570	3.15E-02	675	8.26E-03	780	3.54E-04
470	1.48E-02	575	3.16E-02	680	7.18E-03		
475	1.18E-02	580	3.16E-02	685	6.25E-03		
480	1.18E-02	585	3.15E-02	690	5.42E-03		

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

Chromaticity Diagram - Sphere Spectroradiometer Method



Tristimulus values(x, y): (0.3445, 0.3588)

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

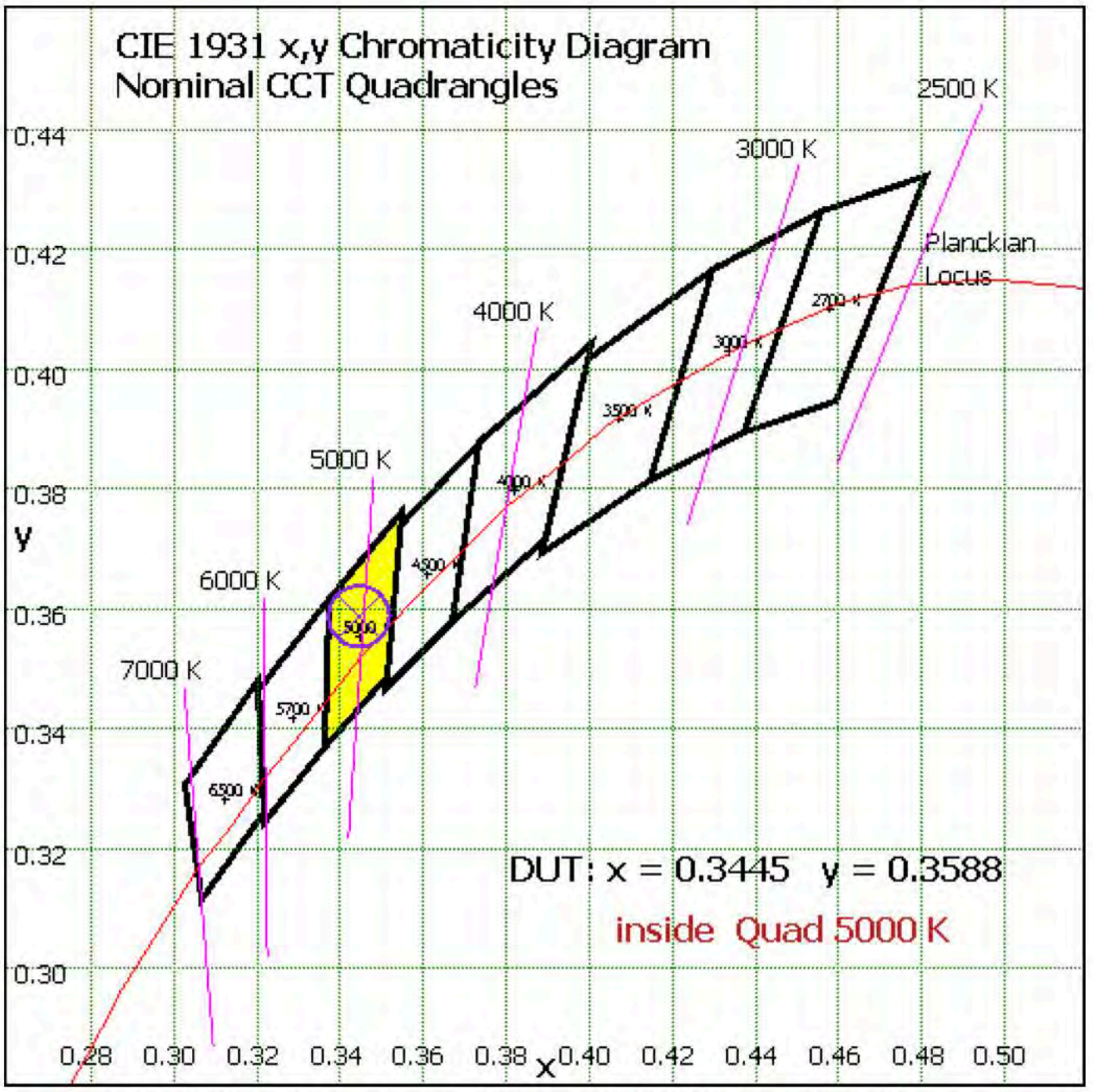


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

Zonal Lumen Tabulation- Goniophotometer Method

γ(°)	Lumens	% Total
0- 10	52.873	2.55%
10- 20	153.13	7.39%
20- 30	233.892	11.28%
30- 40	282.129	13.61%
40- 50	291.383	14.05%
50- 60	266.186	12.84%
60- 70	215.783	10.41%
70- 80	158.027	7.62%
80- 90	109.084	5.26%
90-100	78.051	3.76%
100-110	61.37	2.96%
110-120	50.511	2.44%
120-130	41.407	2.00%
130-140	32.407	1.56%
140-150	23.122	1.12%
150-160	14.251	0.69%
160-170	7.288	0.35%
170-180	2.431	0.12%
Total	2073.3	100%

γ(°)	Lumens	% Total
0- 60	1279.593	61.72%
60- 90	482.894	23.29%
0-90	1762.487	85.01%
90- 180	310.838	14.99%
0- 180	2073.3	100%

Table 5: Zonal Lumen Data

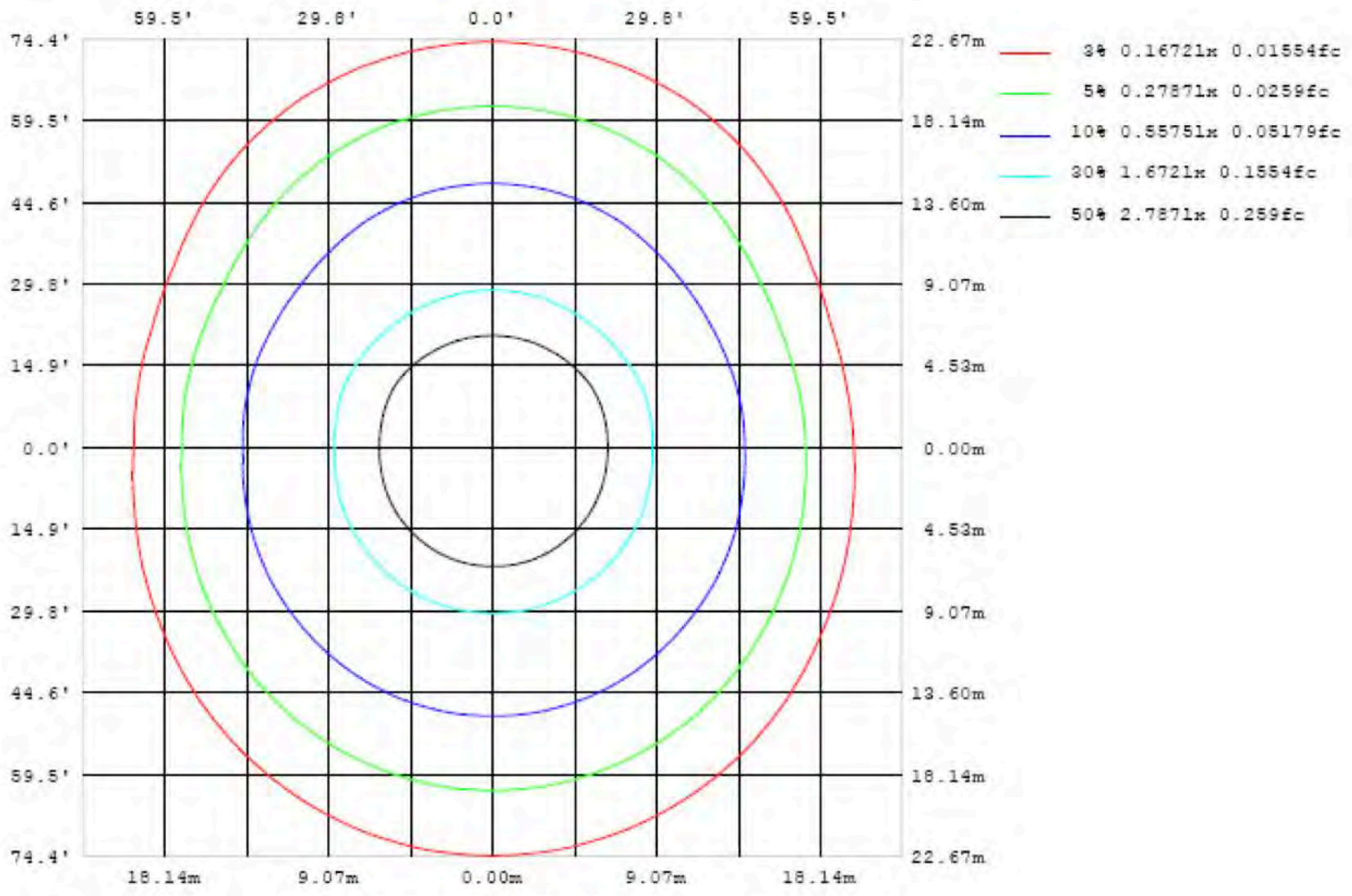


Chart 4: Illuminance Plot (Footcandles)

Luminous Intensity Distribution Plots- Goniophotometer Method

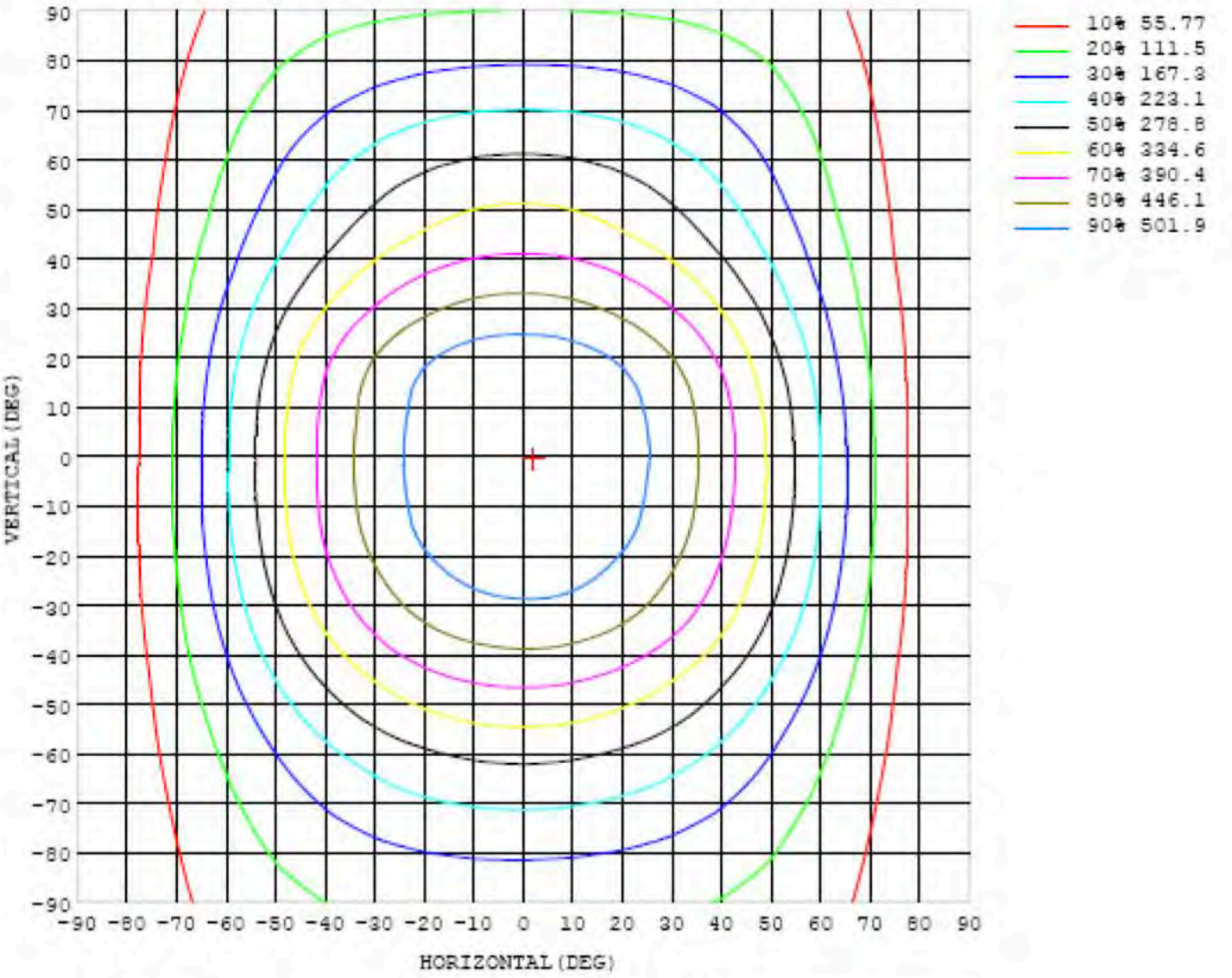


Chart 5: Isocandela Plot

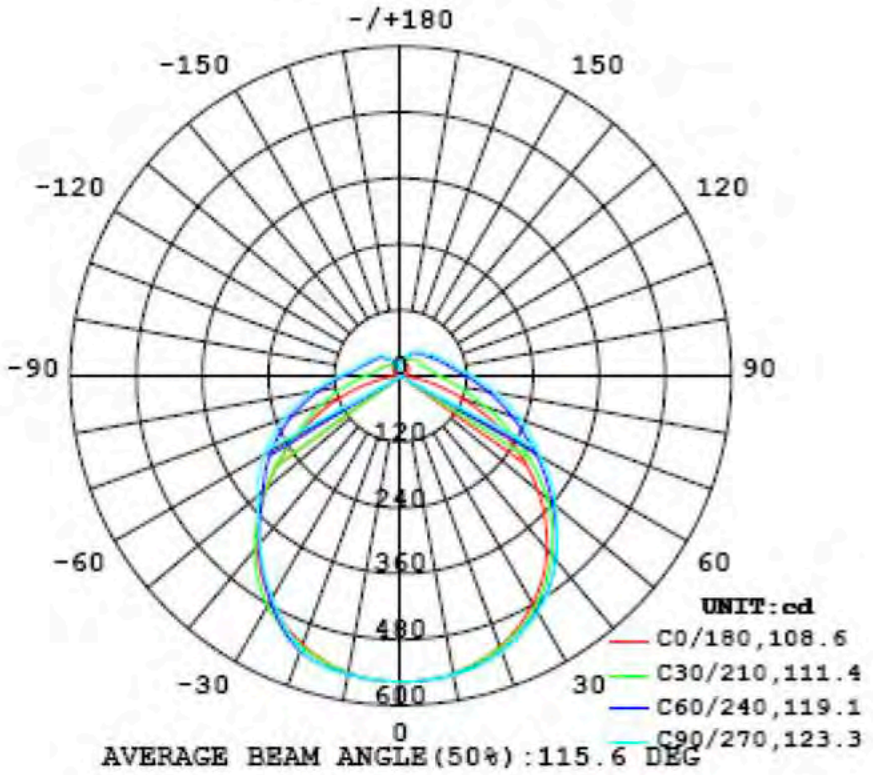


Chart 6: Polar Candela Distribution

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	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557
5	556	556	556	555	555	555	555	555	555	555	555	555	555	555	555	556	556	556	556
10	550	550	549	550	550	551	552	552	552	552	552	552	552	551	550	549	549	549	549
15	539	539	539	541	542	544	545	546	547	547	546	546	544	543	541	539	537	537	537
20	524	524	525	527	529	532	533	534	534	534	534	534	533	531	528	525	522	520	520
25	504	503	505	509	512	513	515	517	517	517	517	516	515	513	511	507	502	499	498
30	478	479	482	486	489	491	494	496	498	497	496	495	493	490	487	484	478	473	471
35	449	450	454	458	462	466	469	471	471	471	470	470	467	464	459	455	450	443	441
40	412	414	421	426	431	436	437	437	438	438	438	437	436	433	427	422	416	408	404
45	370	374	381	389	395	397	399	400	402	401	402	400	399	396	391	385	378	368	363
50	325	330	338	347	353	356	359	363	366	367	366	364	360	356	350	344	334	324	317
55	275	281	291	300	307	314	321	327	330	331	331	327	322	314	306	298	287	276	269
60	223	230	241	251	262	274	282	287	291	292	291	288	282	274	262	251	239	226	218
65	170	178	190	204	220	235	246	254	259	261	260	254	245	234	221	205	190	176	167
70	120	129	144	163	184	202	215	223	228	230	229	224	215	201	184	163	145	128	119
75	74.4	85.2	105	131	154	173	186	194	199	201	200	196	187	174	155	131	107	86.1	75.7
80	38.3	51.7	76.9	105	130	148	160	168	173	175	174	170	162	149	131	106	78.4	53.5	39.8
85	12.7	29.5	57.9	86.5	110	127	138	145	149	151	150	147	141	129	112	87.9	59.3	31.4	13.7
90	0.29	18.5	46.0	72.9	94.4	110	120	126	129	131	130	127	122	112	96.1	74.3	47.1	19.4	0.19
95	1.87	14.7	39.1	63.3	82.5	96.0	105	110	113	114	114	111	106	97.6	84.0	64.4	39.7	14.9	1.67
100	4.33	14.2	35.2	56.8	73.9	85.8	93.4	98.1	101	101	101	99.1	94.8	87.1	75.0	57.5	35.5	14.0	4.13
105	7.26	15.5	32.8	51.8	67.2	78.2	85.0	89.1	91.3	92.2	91.8	89.9	86.1	79.2	68.0	52.2	32.9	15.1	6.97
110	10.3	17.9	32.0	48.1	61.8	71.6	78.1	82.2	84.4	85.2	84.8	82.8	79.0	72.4	62.4	48.4	31.9	17.3	9.82
115	13.2	20.4	32.2	45.3	57.4	66.5	72.3	76.0	78.1	78.8	78.3	76.5	73.0	67.1	57.9	45.5	31.8	19.4	12.3
120	15.7	22.4	32.9	43.6	53.6	61.8	67.6	71.3	73.3	73.9	73.5	71.7	68.2	62.4	54.0	43.7	32.2	21.3	14.5
125	18.0	23.5	33.7	42.9	50.9	57.7	62.9	66.5	68.6	69.3	68.8	66.9	63.5	58.2	51.1	42.6	32.8	22.7	16.3
130	19.9	24.6	33.9	42.4	49.1	54.6	58.9	62.0	64.0	64.6	64.2	62.4	59.2	54.8	49.1	42.0	33.0	23.9	18.7
135	21.5	25.3	33.1	41.9	47.8	52.4	55.8	58.3	59.9	60.4	60.0	58.5	56.0	52.5	47.7	41.3	32.3	24.6	20.6
140	22.7	25.8	32.1	40.6	46.6	50.6	53.6	55.6	56.9	57.3	57.0	55.8	53.7	50.6	46.3	39.9	31.5	25.2	21.8
145	23.1	26.1	30.6	37.8	44.7	48.8	51.5	53.3	54.4	54.8	54.5	53.4	51.6	48.7	44.3	37.3	30.2	25.7	22.7
150	24.3	26.5	29.6	34.6	41.0	46.0	49.1	51.0	52.0	52.3	52.1	51.0	49.0	45.9	40.6	34.2	29.4	26.1	23.9
155	24.2	26.5	28.9	32.0	36.1	41.0	45.0	47.3	48.5	48.9	48.5	47.2	44.8	40.8	35.9	31.8	28.7	26.3	24.5
160	24.8	26.7	28.2	30.1	32.5	35.2	38.0	40.6	42.1	42.5	42.0	40.4	37.9	35.1	32.5	30.1	28.2	26.5	25.2
165	24.0	26.5	27.6	28.7	30.0	31.5	32.8	33.9	34.6	34.9	34.6	33.9	32.8	31.5	30.2	28.9	27.7	26.6	25.6
170	25.0	26.3	27.0	27.7	28.4	29.0	29.6	30.1	30.4	30.5	30.4	30.2	29.7	29.1	28.5	27.9	27.3	26.6	25.9
175	25.9	26.1	26.4	26.8	27.1	27.4	27.6	27.7	27.8	27.9	27.9	27.8	27.7	27.5	27.2	26.9	26.6	26.2	26.0
180	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0

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	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557		
5	556	556	555	555	555	555	555	555	555	555	555	556	556	556	556	556	556		
10	549	548	549	550	551	551	552	552	552	552	552	552	551	551	550	550	550		
15	537	537	539	541	544	545	546	547	547	547	547	545	544	542	541	540	539		
20	520	522	525	528	531	533	532	531	530	530	531	531	531	530	527	525	524		
25	499	502	507	510	510	508	504	501	500	501	503	505	509	510	509	506	504		
30	472	477	483	483	478	473	469	467	466	467	468	471	476	482	484	482	480		
35	442	448	452	447	441	437	435	434	433	433	434	435	438	445	452	453	449		
40	407	414	413	405	402	400	399	398	398	398	398	398	400	403	411	416	413		
45	366	373	367	362	361	362	363	364	365	364	362	361	360	360	365	372	372		
50	321	326	320	318	321	327	334	339	341	339	334	326	320	317	317	322	325		
55	273	273	272	276	287	300	309	314	315	313	307	299	286	275	270	269	274		
60	221	221	226	239	257	271	280	285	286	284	279	270	256	239	224	218	220		
65	168	172	186	207	226	240	249	254	256	254	249	240	226	207	185	169	166		
70	120	130	153	177	195	209	218	223	224	223	219	210	197	178	153	129	117		
75	78.7	97.4	124	148	166	179	187	191	193	192	188	180	168	150	125	97.3	77.2		
80	48.1	72.5	99.8	123	140	151	158	162	163	162	159	153	142	125	102	73.5	48.0		
85	27.8	54.8	80.9	102	116	125	131	133	134	134	132	127	118	104	83.0	56.5	29.0		
90	16.9	42.4	66.4	84.9	97.3	105	109	111	112	112	110	106	98.8	86.9	68.5	44.4	18.5		
95	12.2	34.3	56.1	72.4	83.3	89.9	93.6	95.4	95.8	95.5	93.9	90.6	84.5	74.1	57.9	36.4	13.8		
100	11.7	29.8	49.0	63.6	73.3	79.3	82.7	84.2	84.6	84.2	82.8	79.7	74.2	64.9	50.7	31.9	13.0		
105	12.5	27.5	44.2	57.4	66.3	71.8	75.0	76.5	76.9	76.5	74.9	72.0	66.9	58.4	45.7	29.5	13.6		
110	13.6	26.4	40.8	52.6	60.8	66.1	69.1	70.7	71.0	70.5	68.9	66.1	61.2	53.6	42.4	28.4	14.6		
115	14.6	25.7	38.4	49.1	56.6	61.5	64.4	65.7	66.0	65.7	64.2	61.9	57.1	50.1	40.1	27.4	15.6		
120	15.4	24.9	36.2	46.2	53.3	58.0	60.8	62.3	62.6	62.1	60.7	58.1	53.8	47.3	37.8	26.2	16.3		
125	15.7	24.0	33.6	43.4	50.3	55.0	57.7	59.1	59.4	59.0	57.7	55.1	51.0	44.6	35.1	24.9	16.6		
130	16.8	22.9	30.9	39.7	47.2	52.0	54.8	56.3	56.6	56.2	54.8	52.2	47.9	40.8	32.0	23.3	17.5		
135	18.5	21.4	28.9	35.2	42.6	48.3	51.5	53.2	53.6	53.2	51.6	48.6	43.4	36.1	29.4	21.1	18.7		
140	20.3	19.0	27.4	31.4	36.7	42.5	46.7	48.8	49.4	48.8	46.8	42.9	37.4	30.8	27.5	19.2	20.5		
145	21.9	18.1	24.9	29.2	32.3	35.6	39.0	41.4	42.2	41.5	39.3	35.6	32.1	29.3	24.7	18.3	22.4		
150	22.9	20.3	18.8	25.2	30.0	31.6	33.3	34.5	34.9	34.6	32.3	28.2	25.3	25.1	19.0	20.7	23.4		
155	24.0	20.9	16.5	17.7	23.5	28.2	29.0	30.6	31.0	27.8	22.4	21.2	21.0	18.8	17.0	20.8	23.5		
160	24.8	25.1	20.4	14.3	15.3	17.8	21.1	24.2	28.5	19.5	20.4	18.3	15.9	15.6	17.8	21.0	23.1		
165	25.2	24.9	24.4	22.4	17.2	16.3	18.7	22.0	18.3	22.4	20.1	17.5	15.3	16.0	18.1	20.2	21.9		
170	25.6	25.4	24.7	24.1	23.6	23.5	22.8	23.9	15.7	16.3	18.4	18.6	17.7	17.6	18.5	20.5	22.3		
175	25.8	25.7	25.6	25.5	25.4	25.4	25.4	25.4	25.2	24.7	24.2	23.6	23.3	24.0	24.5	25.1	25.7		
180	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0		

Table 7: Luminous Intensity Data

EQUIPMENT LIST

Test Equipment	Model	Equipment No.	Calibration Date	Calibration Due date
Goniophotometer system	GO-R5000	HZTE011-01	Jul. 27, 2016	Jul. 26, 2017
Digital Power Meter	PF2010A	HZTE028-01	Jul. 27, 2016	Jul. 26, 2017
AC Power Supply	PCR 500L	HZTE001-08	Jul. 27, 2016	Jul. 26, 2017
DC Power Supply	WY12010	HZTE004-03	Jul. 27, 2016	Jul. 26, 2017
Temperature Meter	TES1310	HZTE017-01	Jul. 27, 2016	Jul. 26, 2017
Standard source	D908	HZTE012-01	Jul. 27, 2016	Jul. 26, 2017
Integrate Sphere system	2M	HZTE015-01	Jul. 27, 2016	Jul. 26, 2017
Digital Power Meter	WT210	HZTE008-01	Jul. 27, 2016	Jul. 26, 2017
AC Power Supply	PCR 500L	HZTE001-07	Jul. 27, 2016	Jul. 26, 2017
DC Power Supply	6154	HZTE004-04	Jul. 27, 2016	Jul. 26, 2017
Temperature and humidity recorder	JR900	HZTE018-01	Jul. 27, 2016	Jul. 26, 2017
Standard source	SCL-1400	HZTE012-02	Jul. 27, 2016	Jul. 26, 2017

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 TUBEs) 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 TUBEs) 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

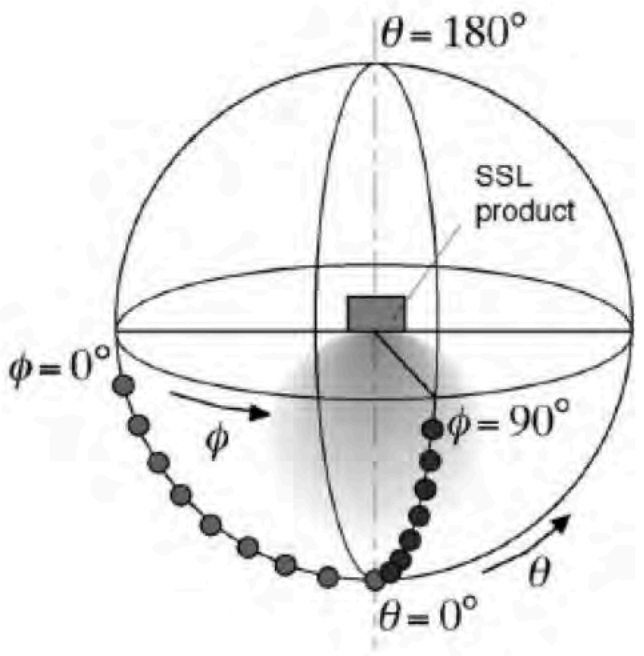
The color characteristics of SSL products include chromaticity coordinates, correlated color temperature, and color rendering index. These characteristics of SSL products may be spatially non-uniform, and thus, in order that they can be specified accurately, the color quantities shall be measured as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