



LM-79-08 Test Report

for

P.Q.L., Inc.

2285 Ward Avenue / Simi Valley, CA 93065

LED REPLACE LAMP

Model: 91310

Laboratory: Leading Testing Laboratories

NVLAP CODE: 200960-0

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www.ledtestlab.com

Report No.: HZ16050046d

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

Review by:

Engineer: April Zou
May 31, 2016

Approved by:



Manager: Jim Zhang
May 31, 2016

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: 91310

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)	Power Factor
129.6	2211.0	34.12	0.9956
CCT (K)	CRI	Stabilization Time (Light & Power)	
3933	82.4	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 24, 2016
Date of Test	: May 26, 2016
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 Photos

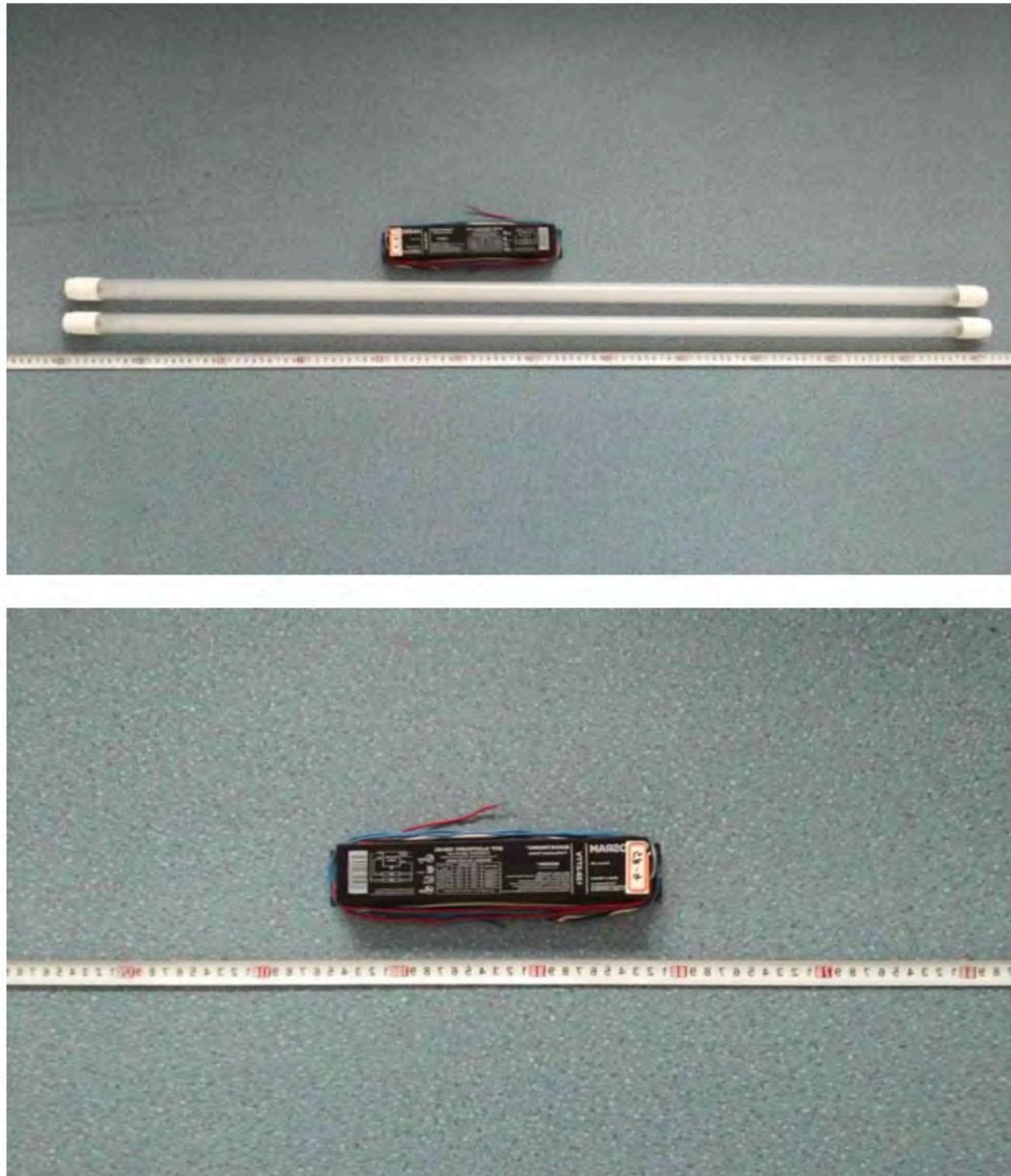


Figure 1- Overview of the sample

Equipment Under Test (EUT)

Name	: LED REPLACE LAMP
Model	: 91310
Electrical Ratings	: 120-277V, 50/60Hz, 18W
Product Description	: G13 base, fixed end caps, 4000K, Frosted lens LED Replace lamps supplied by a high frequency fluorescent lamp ballast: QTP 2x32T8/UNV ISN-SC
Manufacturer	: P.Q.L., Inc.
Address	: 2285 Ward Avenue Simi Valley, CA 93065

TEST RESULTS

Test ambient temperature was 24.8°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	277.0
Voltage frequency (Hz)	60	60
Test Current (A)	0.286	0.128
Power Factor	0.9956	0.9656
Test Power (W)	31.12	34.24
THD A%	5.80	11.52
Luminous Efficacy (lm/W)	129.6	129.1
Total Luminous Flux (lm)	2211.0	2211.0
Color Rendering Index (CRI)	82.4	
R9	5.8	
Correlated Color Temperature (CCT)(K)	3933	
Chromaticity Chroma x	0.3850	
Chromaticity Chroma y	0.3843	
Chromaticity Chroma u	0.2251	
Chromaticity Chroma v	0.3370	
Duv	0.0021	
Chromaticity Chroma u'	0.2251	
Chromaticity Chroma v'	0.5055	

Special Color Rendering Indices	
R1	80.3
R2	88.9
R3	95.3
R4	80.5
R5	80.1
R6	84.6
R7	86
R8	63.3
R9	5.8
R10	73.7
R11	79
R12	60
R13	82.4
R14	97.6

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 24.2°C.

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)	0.278
Power Factor	0.9960
Test Power (W)	33.27
Luminous Efficacy (lm/W)	129.8
Total Luminous Flux (lm)	2159.8
Beam Angle (°)	119.9
Center Beam Candle Power (cd)	545
Spacing Criteria	1.27 (0°-180°)/ 1.41 (90°-270°)
Zonal Lumens in the 0°-60°Zone	62.01%
Zonal Lumens in the 60°-90°Zone	23.22%
Zonal Lumens in the 90°-120°Zone	8.68%
Zonal Lumens in the 120°-180°Zone	6.09%

Table 3: Test data per Goniophotometer Method

Spectral Power Distribution - Sphere Spectroradiometer Method

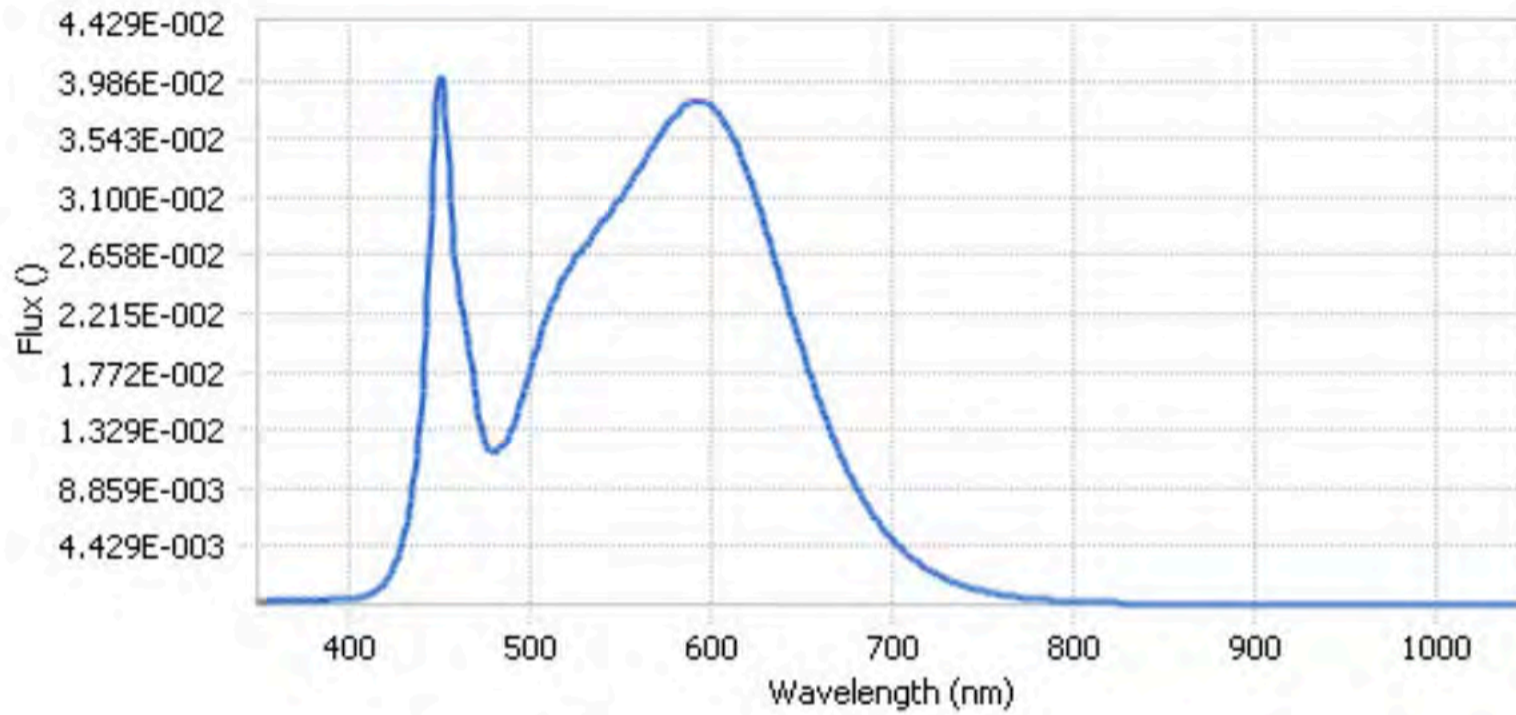
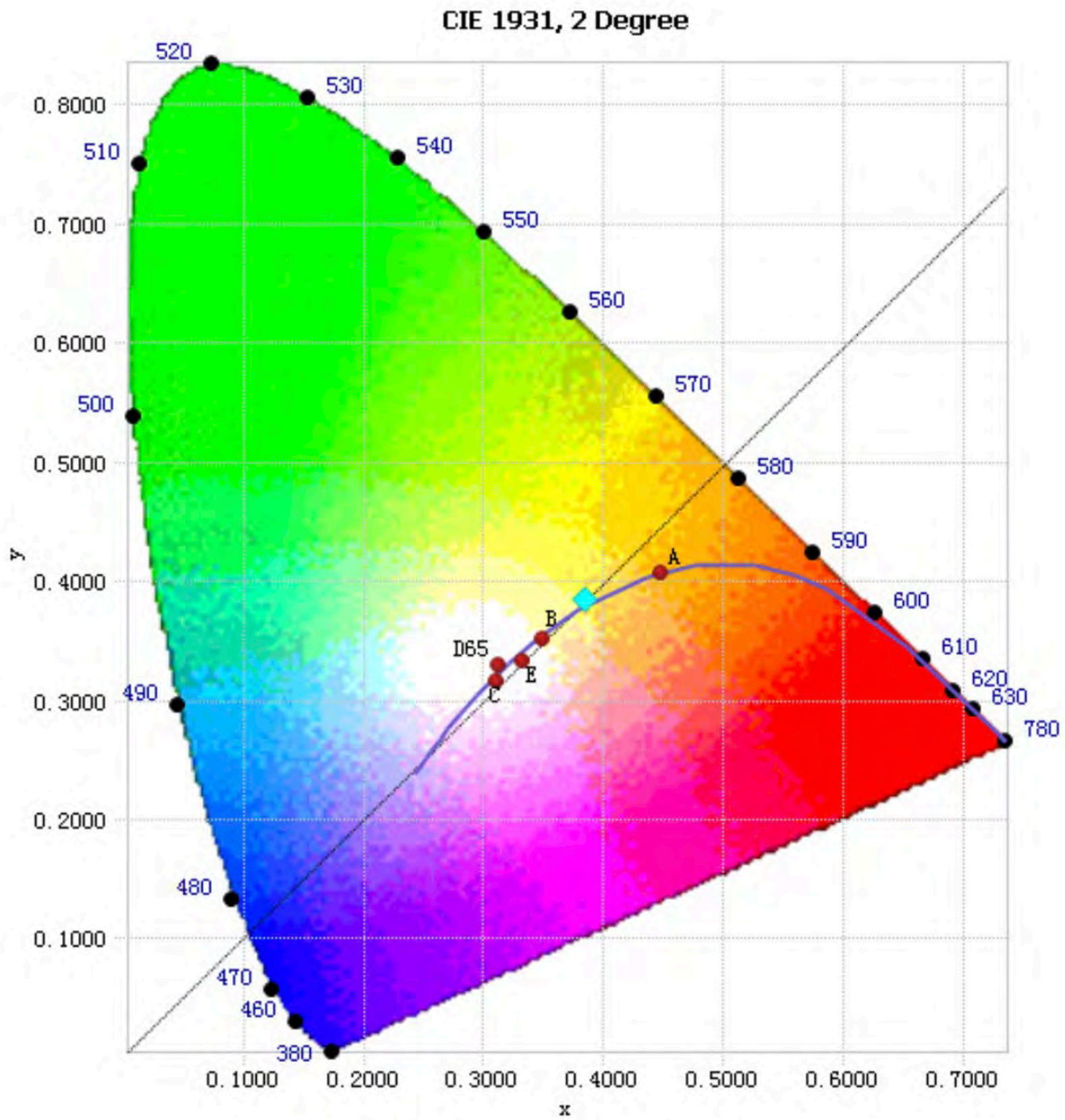


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	3.45E-04	485	1.20E-02	590	3.83E-02	695	5.90E-03
385	3.54E-04	490	1.32E-02	595	3.84E-02	700	5.05E-03
390	3.64E-04	495	1.51E-02	600	3.79E-02	705	4.33E-03
395	3.80E-04	500	1.77E-02	605	3.73E-02	710	3.71E-03
400	4.53E-04	505	2.00E-02	610	3.63E-02	715	3.18E-03
405	5.11E-04	510	2.21E-02	615	3.49E-02	720	2.73E-03
410	6.76E-04	515	2.38E-02	620	3.31E-02	725	2.32E-03
415	1.00E-03	520	2.50E-02	625	3.11E-02	730	1.98E-03
420	1.61E-03	525	2.61E-02	630	2.90E-02	735	1.70E-03
425	2.76E-03	530	2.71E-02	635	2.66E-02	740	1.45E-03
430	4.72E-03	535	2.80E-02	640	2.43E-02	745	1.24E-03
435	8.01E-03	540	2.91E-02	645	2.20E-02	750	1.06E-03
440	1.42E-02	545	2.99E-02	650	1.98E-02	755	9.10E-04
445	2.68E-02	550	3.07E-02	655	1.77E-02	760	7.83E-04
450	3.97E-02	555	3.19E-02	660	1.56E-02	765	6.79E-04
455	3.52E-02	560	3.30E-02	665	1.38E-02	770	5.77E-04
460	2.54E-02	565	3.42E-02	670	1.21E-02	775	4.99E-04
465	2.10E-02	570	3.52E-02	675	1.05E-02	780	4.36E-04
470	1.65E-02	575	3.63E-02	680	9.14E-03		
475	1.27E-02	580	3.71E-02	685	7.94E-03		
480	1.17E-02	585	3.79E-02	690	6.85E-03		

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

Chromaticity Diagram - Sphere Spectroradiometer Method



Tristimulus values(x, y): (0.3850, 0.3843)

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

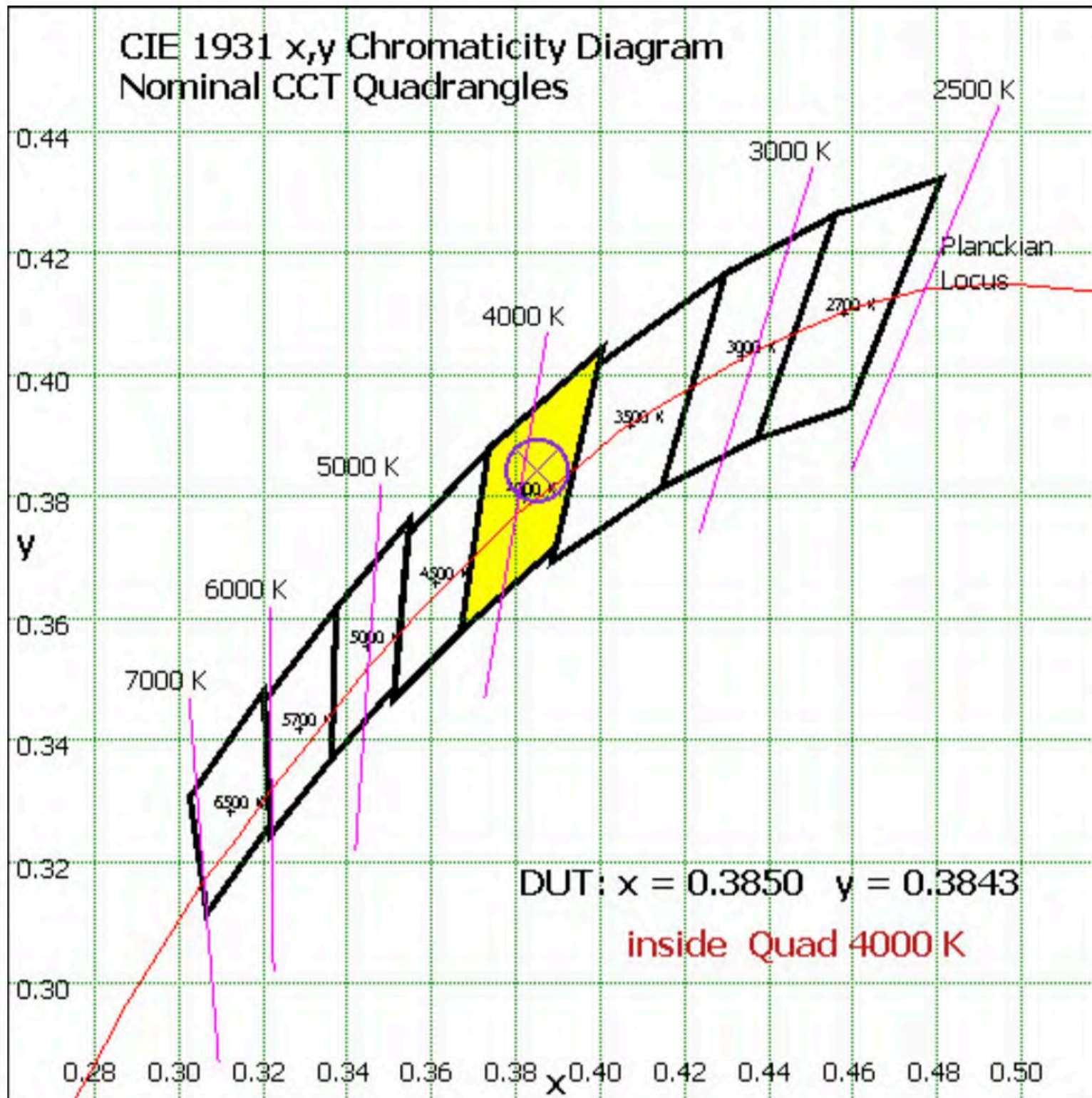


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

Zonal Lumen Tabulation- Goniophotometer Method

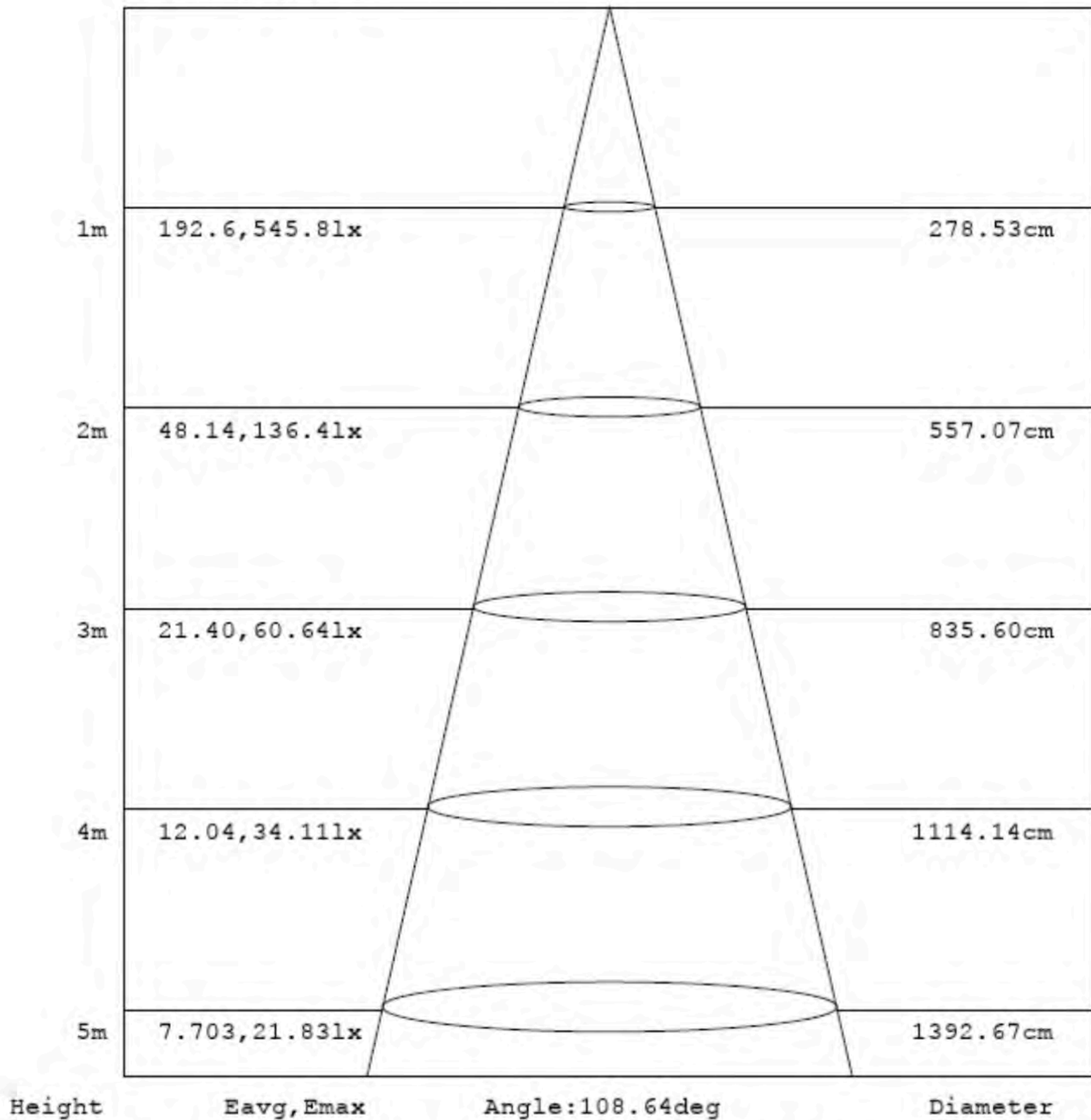
$\gamma(^{\circ})$	Lumens	% Total
0- 10	51.805	2.40%
10- 20	151.625	7.02%
20- 30	240.994	11.16%
30- 40	299.755	13.88%
40- 50	312.255	14.46%
50- 60	282.857	13.10%
60- 70	228.294	10.57%
70- 80	163.912	7.59%
80- 90	109.341	5.06%
90-100	76.31	3.53%
100-110	60.214	2.79%
110-120	50.851	2.35%
120-130	43.1	2.00%
130-140	35.236	1.63%
140-150	26.532	1.23%
150-160	16.728	0.77%
160-170	7.748	0.36%
170-180	2.258	0.10%
Total	2159.8	100%

$\gamma(^{\circ})$	Lumens	% Total
0- 60	1339.291	62.01%
60- 90	501.547	23.22%
0-90	1840.838	85.23%
90- 180	318.977	14.77%
0- 180	2159.8	100%

Table 5: Zonal Lumen Data

Illuminance Plots- Goniophotometer Method

Flux out: 1189 lm



Note: The Curves indicate the illuminated area and the average illumination when the luminaire is at different distance.

Chart 4: Beam Angle

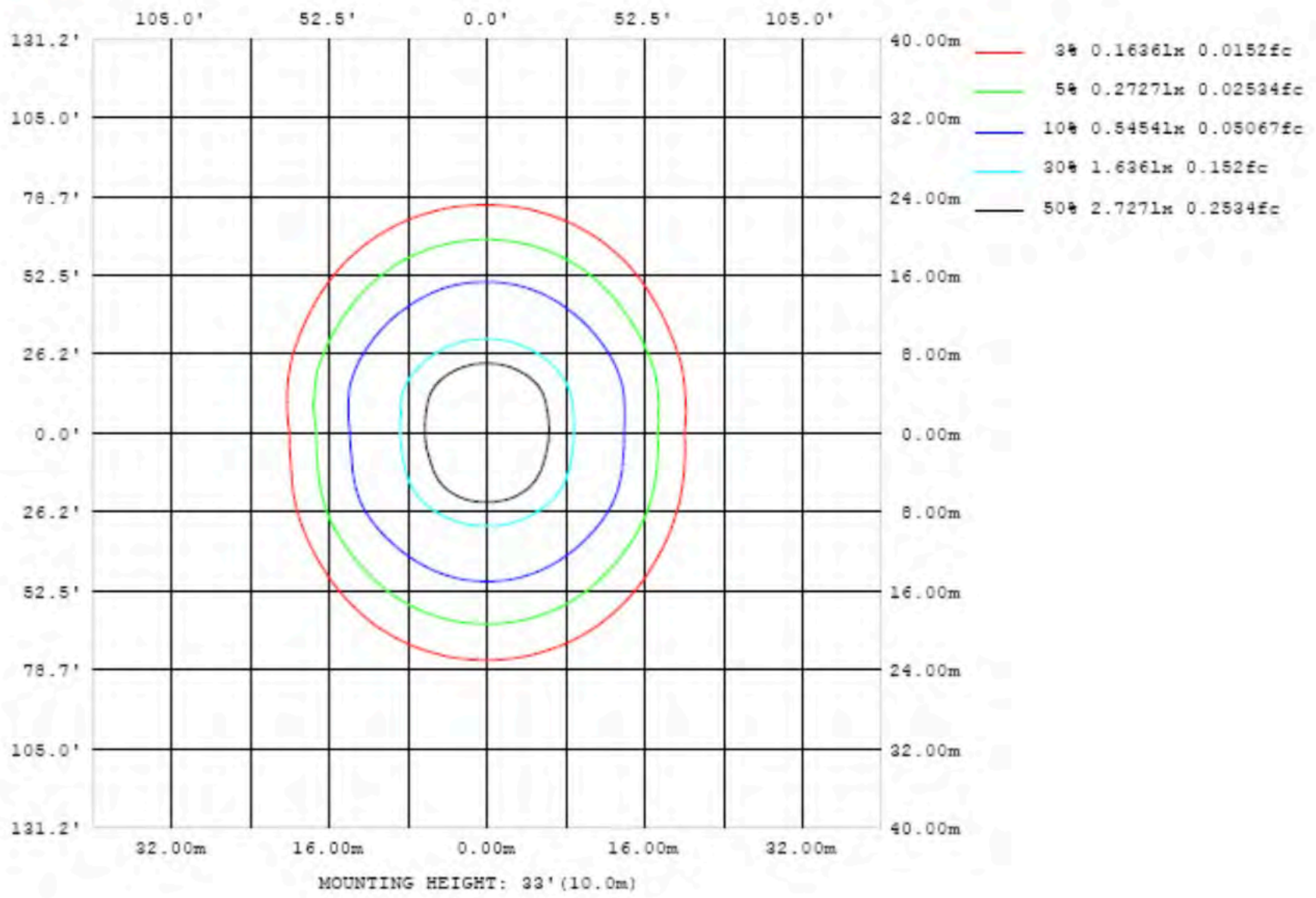


Chart 5: Illuminance Plot (Footcandles)

Luminous Intensity Distribution Plots- Goniophotometer Method

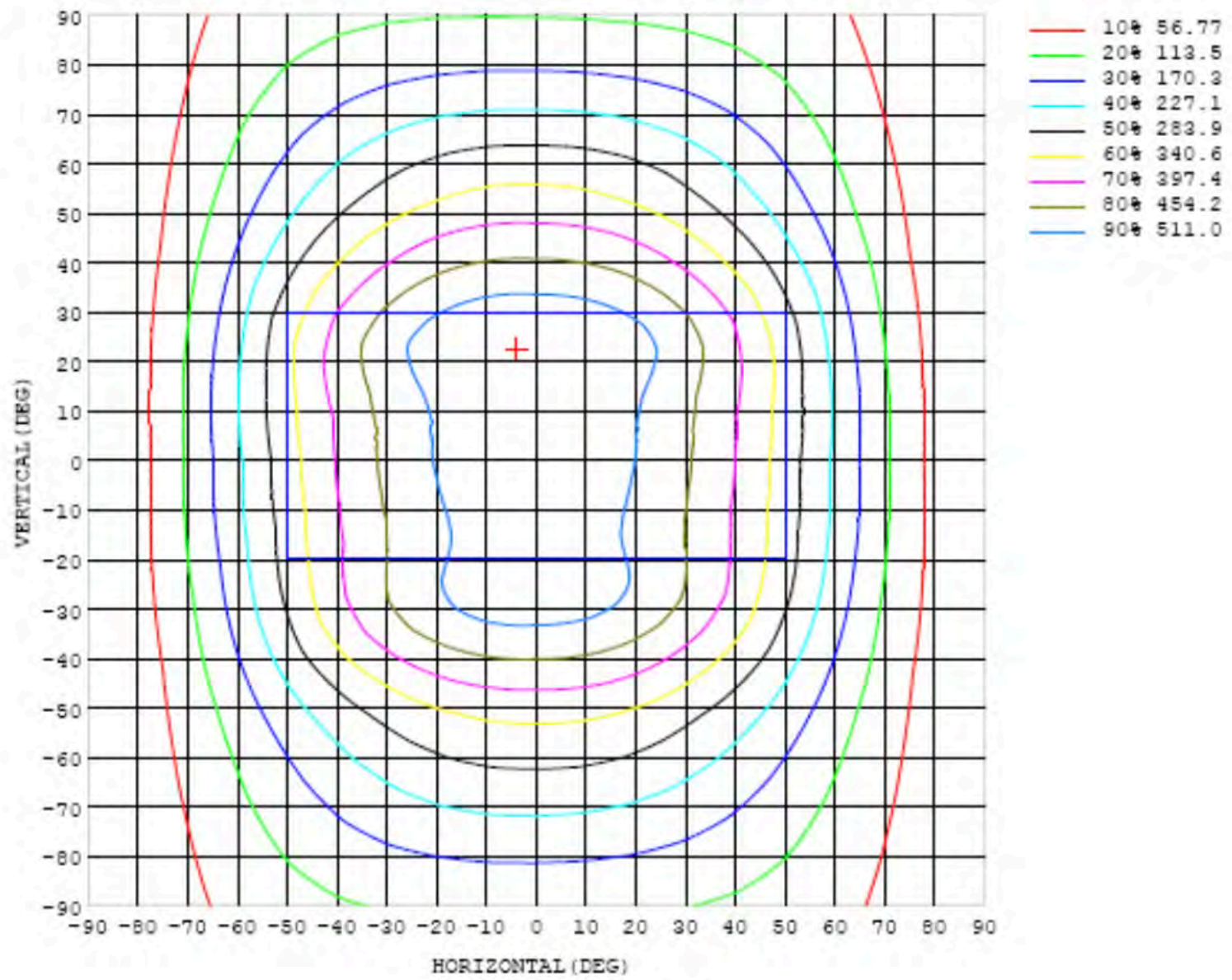


Chart 6: Isocandela Plot

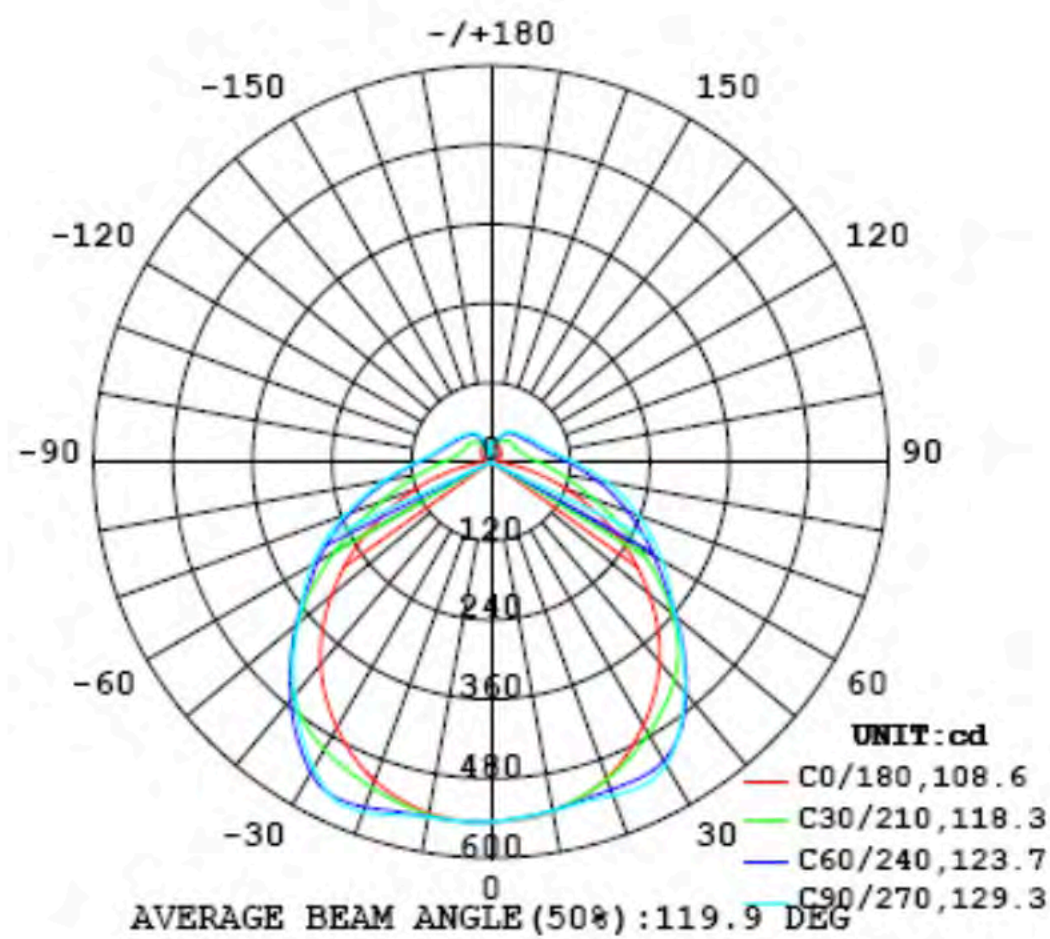


Chart 7: Polar Candela Distribution

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	545	545	545	545	545	545	545	545	545	545	545	545	545	545	545	545	545	545	545
5	544	543	542	542	541	541	541	541	541	541	541	541	542	542	543	543	544	545	545
10	538	537	536	536	536	536	537	537	537	537	537	537	538	538	538	537	538	539	540
15	527	525	525	526	527	529	531	533	534	534	534	533	532	530	529	528	527	528	529
20	510	509	509	512	516	522	529	534	537	538	537	534	529	522	517	514	512	512	514
25	488	487	489	495	505	518	529	537	541	542	542	538	529	517	505	496	492	491	492
30	460	460	464	476	494	511	522	528	529	530	531	531	525	512	494	476	467	464	465
35	431	430	437	455	477	493	499	500	498	497	500	503	503	497	479	455	439	434	435
40	396	397	409	431	450	458	459	458	456	455	458	461	464	466	455	432	408	400	400
45	356	359	376	400	410	412	413	413	411	410	412	415	417	420	418	403	375	361	360
50	312	317	338	358	362	364	366	366	365	364	365	366	368	369	370	363	337	317	315
55	265	273	293	308	312	315	320	326	329	330	329	326	321	317	316	314	293	271	267
60	217	226	243	256	263	272	284	293	298	299	299	294	285	274	265	259	244	223	218
65	169	178	192	206	222	237	251	261	266	268	267	263	253	238	222	207	192	174	169
70	122	129	145	165	187	205	220	230	236	238	238	233	223	207	187	164	144	127	121
75	77.9	86.7	107	133	157	176	190	200	206	208	208	203	194	179	158	132	105	84.1	76.5
80	41.6	54.4	79.3	107	131	150	163	171	176	178	178	174	167	153	133	106	76.8	50.6	40.0
85	14.7	32.6	60.1	87.3	110	126	137	144	148	149	149	146	140	129	111	86.8	57.6	28.9	12.9
90	0.64	20.3	47.1	72.2	92.2	106	115	121	124	125	125	122	117	108	93.2	71.3	44.8	17.2	0.76
95	1.84	15.4	39.2	61.9	79.2	91.2	98.8	103	106	107	106	105	100	92.6	79.7	61.0	37.1	13.1	1.89
100	4.32	14.2	34.6	54.6	70.2	80.5	87.2	91.1	93.1	93.9	93.7	91.9	88.2	81.3	70.3	53.8	32.8	12.7	4.48
105	7.13	15.4	32.1	49.7	63.7	73.7	78.6	82.1	84.1	84.7	84.4	82.7	79.3	73.4	63.6	48.9	30.9	14.8	7.83
110	10.3	18.0	31.4	46.4	58.7	67.4	72.8	76.0	77.8	78.4	78.1	76.4	73.1	67.6	58.6	45.9	30.7	17.3	10.6
115	13.3	20.3	31.4	44.5	54.9	62.7	68.1	71.3	72.9	73.4	73.1	71.5	68.3	62.9	54.9	44.3	31.2	20.4	13.0
120	15.9	23.2	33.0	43.3	52.3	59.1	63.9	67.1	68.8	69.4	68.9	67.2	64.1	59.3	52.5	43.0	32.6	23.2	15.6
125	18.3	25.2	34.0	42.7	50.7	56.4	60.7	63.5	65.1	65.6	65.2	63.6	60.8	56.7	50.9	42.7	33.5	25.0	18.0
130	20.0	26.3	34.8	42.8	49.1	54.6	58.2	60.6	62.0	62.5	62.1	60.7	58.4	54.9	49.1	42.5	34.1	26.4	20.2
135	21.5	27.0	34.6	42.7	48.5	52.8	56.3	58.5	59.7	60.1	59.7	58.5	56.5	52.7	48.2	42.0	33.7	27.4	22.1
140	22.9	27.8	33.6	41.3	47.5	51.6	54.5	56.5	57.6	57.9	57.6	56.4	54.1	51.1	47.0	40.4	32.8	28.1	23.6
145	23.7	28.0	32.5	38.8	45.2	49.7	52.6	54.4	55.5	55.8	55.5	54.2	52.2	49.3	44.5	37.8	32.2	28.7	25.2
150	25.8	28.7	31.5	35.9	41.5	46.5	49.7	51.7	52.8	53.1	52.7	51.5	49.4	45.8	40.4	35.2	31.4	29.0	26.7
155	26.5	29.0	30.7	33.7	37.2	41.3	45.0	47.4	48.7	49.1	48.6	47.2	44.4	40.4	36.5	33.4	30.9	28.8	25.8
160	26.6	29.3	30.0	31.6	34.2	36.4	38.7	40.6	41.8	42.1	41.6	40.3	38.2	35.9	33.8	31.6	29.4	26.9	23.3
165	24.5	28.2	29.9	30.5	31.9	33.3	34.4	35.2	35.8	36.0	35.7	35.0	33.9	32.7	31.9	30.0	27.2	24.1	21.8
170	24.1	25.6	27.8	29.9	30.4	31.3	32.0	32.3	32.4	32.3	32.2	31.9	31.5	30.6	28.6	25.9	23.6	21.3	21.2
175	22.6	22.5	24.0	26.9	28.9	29.6	30.0	30.3	30.3	30.2	30.2	29.9	29.0	27.1	24.6	22.6	20.8	19.4	19.2
180	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3

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	545	545	545	545	545	545	545	545	545	545	545	545	545	545	545	545	545		
5	546	546	546	547	547	547	547	547	546	546	546	546	546	545	545	545	544		
10	541	542	543	544	545	546	547	547	547	546	545	544	543	542	541	540	539		
15	531	533	535	539	544	549	552	554	554	553	550	546	542	537	533	530	528		
20	516	519	525	535	547	557	563	566	565	563	560	553	543	532	522	516	513		
25	495	502	515	533	549	560	565	565	563	562	560	554	543	527	510	498	491		
30	469	481	503	527	541	544	542	538	535	536	538	539	534	518	496	476	465		
35	441	459	487	508	513	510	507	504	500	501	504	505	506	499	477	452	436		
40	409	436	464	473	473	471	467	464	460	461	463	465	466	465	452	426	404		
45	373	407	428	429	428	427	426	425	421	421	421	420	420	420	416	395	367		
50	333	367	382	381	381	384	385	384	381	381	380	377	372	370	371	355	326		
55	289	319	328	331	335	340	344	347	346	344	339	333	326	319	316	307	282		
60	240	265	273	282	291	303	311	314	312	311	306	296	282	270	261	254	233		
65	188	207	221	237	253	265	273	275	274	273	268	259	244	226	209	197	181		
70	137	154	176	198	215	226	233	236	235	233	228	220	206	187	165	145	131		
75	90.0	112	139	163	179	190	196	198	197	196	191	183	170	152	128	103	85.7		
80	54.0	80.4	109	132	148	158	162	164	163	162	158	151	139	123	99.8	72.8	49.9		
85	31.6	59.7	87.3	108	122	130	134	135	134	133	130	124	114	99.6	78.7	52.6	26.9		
90	20.1	46.8	71.8	90.3	102	108	111	112	112	111	108	103	95.5	82.9	64.2	40.1	15.2		
95	15.4	38.8	61.2	77.5	87.5	93.2	95.8	96.6	96.3	95.4	93.1	89.2	82.5	71.4	54.5	32.6	10.9		
100	15.1	34.6	54.1	68.6	77.7	82.9	85.4	86.3	86.1	85.3	83.2	79.7	73.6	63.4	48.3	29.0	11.2		
105	16.5	33.0	49.6	62.5	70.6	75.4	77.9	78.9	78.9	78.1	76.1	72.8	67.2	58.0	44.4	27.9	13.0		
110	18.5	32.9	46.8	58.0	65.6	70.2	72.6	73.6	73.6	73.0	71.2	68.0	62.6	54.1	42.1	28.0	15.3		
115	20.3	33.5	45.1	54.8	61.7	66.0	68.4	69.6	69.7	69.0	67.2	64.1	59.0	51.3	40.9	28.9	17.6		
120	21.7	34.4	44.1	52.3	58.5	62.5	64.9	66.1	66.3	65.7	63.9	60.8	56.1	49.3	40.4	29.9	19.4		
125	22.3	35.0	43.6	50.5	55.9	59.5	61.8	63.0	63.3	62.6	60.8	58.0	53.9	47.9	40.2	30.6	20.2		
130	22.0	34.9	43.1	49.1	53.7	57.0	59.1	60.2	60.4	59.9	58.3	55.8	52.1	46.9	39.9	30.7	20.2		
135	20.8	33.4	41.7	47.9	51.9	54.8	56.8	57.8	58.0	57.5	56.1	53.9	50.6	45.8	39.0	29.8	19.3		
140	19.6	31.0	40.0	46.1	50.2	52.7	54.5	55.7	55.9	55.4	54.2	52.1	48.9	44.2	37.1	28.0	18.9		
145	18.7	27.6	36.4	41.6	48.0	50.5	52.3	53.4	53.7	53.3	52.0	50.0	46.6	41.3	34.4	26.2	18.5		
150	19.3	24.7	32.5	37.7	41.5	47.6	49.0	50.4	50.9	50.5	49.3	46.9	43.1	37.6	31.0	22.9	19.3		
155	19.8	19.7	24.9	29.8	34.0	38.6	44.6	45.5	46.6	46.2	44.8	42.3	38.4	34.0	26.5	18.5	20.3		
160	19.3	16.9	16.0	21.6	24.1	27.7	30.2	36.9	39.7	39.5	38.5	36.4	33.5	30.2	20.2	16.1	18.0		
165	19.3	16.9	16.1	16.4	18.0	20.8	20.3	22.9	28.8	33.1	31.1	29.6	25.5	19.1	15.4	15.0	19.1		
170	20.9	20.0	18.5	19.0	20.1	20.9	20.2	19.2	13.0	20.0	19.3	19.6	19.7	18.4	16.6	16.4	21.5		
175	20.3	20.8	20.7	21.2	21.7	21.0	20.0	14.7	11.5	17.8	21.3	21.7	21.1	21.1	22.2	22.8	22.9		
180	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3		

Table 7: Luminous Intensity Data

EQUIPMENT LIST

Test Equipment	Model	Equipment No.	Calibration Date	Calibration Due date
Goniophotometer system	GO-R5000	HZTE011-01	Jul. 17, 2015	Jul. 16, 2016
Digital Power Meter	PF2010A	HZTE028-01	Jul. 17, 2015	Jul. 16, 2016
AC Power Supply	PCR 500L	HZTE001-08	Jul. 17, 2015	Jul. 16, 2016
DC Power Supply	WY12010	HZTE004-03	Jul. 17, 2015	Jul. 16, 2016
Temperature Meter	TES1310	HZTE017-01	Jul. 17, 2015	Jul. 16, 2016
Standard source	D908	HZTE012-01	Jul. 23, 2015	Jul. 22, 2016
Integrate Sphere system	2M	HZTE015-01	Jul. 16, 2015	Jul. 15, 2016
Digital Power Meter	WT210	HZTE008-01	Jul. 17, 2015	Jul. 16, 2016
AC Power Supply	PCR 500L	HZTE001-07	Jul. 17, 2015	Jul. 16, 2016
DC Power Supply	6154	HZTE004-04	Jul. 17, 2015	Jul. 16, 2016
Temperature and humidity recorder	JR900	HZTE018-01	Jul. 21, 2015	Jul. 20, 2016
Standard source	SCL-1400	HZTE012-02	Oct. 21, 2015	Oct. 20, 2016

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 REPLACE 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 1.06% 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 REPLACE 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 1.94% with a coverage factor $k=2$.

Color Characteristics Measurements

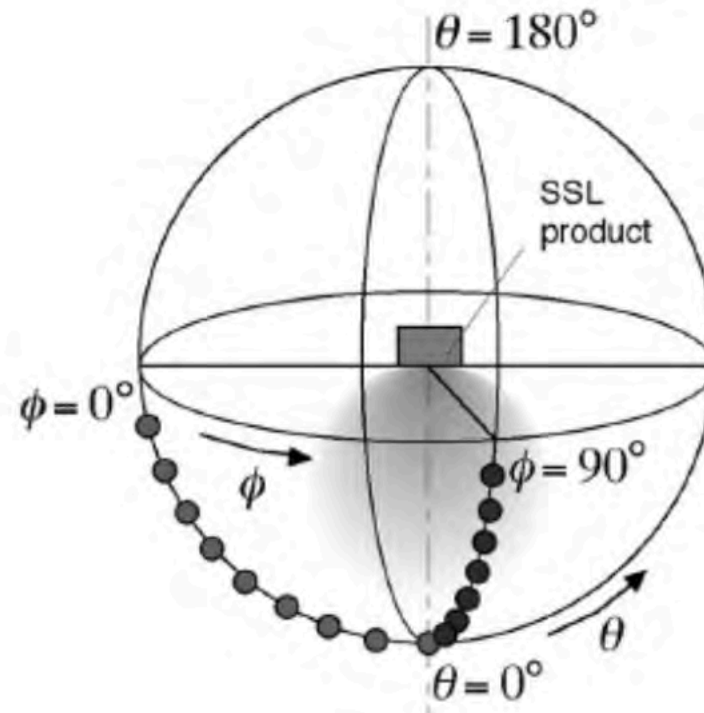
The color characteristics of SSL products include chromaticity coordinates, correlated color temperature, and color rendering index. These characteristics of SSL products may be spatially non-uniform, and thus, in order that they can be specified accurately, the color quantities shall be measured as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