



## LM-79-08 Test Report

for

**P.Q.L., Inc.**

2285 Ward Avenue / Simi Valley, CA 93065

**LED Replace lamp**

**Model: 91289, 91313**

**Laboratory: Leading Testing Laboratories**

**NVLAP CODE: 200960-0**

No.1805, DongLiu road, BinJiang District, Hangzhou, China

Tel: +86-571-56680806

www.ledtestlab.com

Report No.: HZ16080029a

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

Review by:

Engineer: April Zou  
Aug. 19, 2016

Approved by:



Manager: Jim Zhang  
Aug. 19, 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: 91289

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)/2	Power Factor
123.7	2043.0	16.51	0.9973
CCT (K)	CRI	Stabilization Time (Light & Power)	
3506	83.7	60	

Table 1: Executive Data Summary

Note: The above results are recorded/ derived from measurements made using an Integrating Sphere.

**Test specifications:**

<b>Date of Receipt</b>	: Aug. 16, 2016
<b>Date of Test</b>	: Aug. 16, 2016
<b>Test item</b>	: Total Luminous Flux, Luminous Distribution Intensity, Luminous Efficacy, Correlated Color Temperature, Color Rendering Index, Chromaticity Coordinate, Electrical parameters
<b>Reference Standard</b>	: IESNA LM-79-2008 Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products



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### Sample Photos

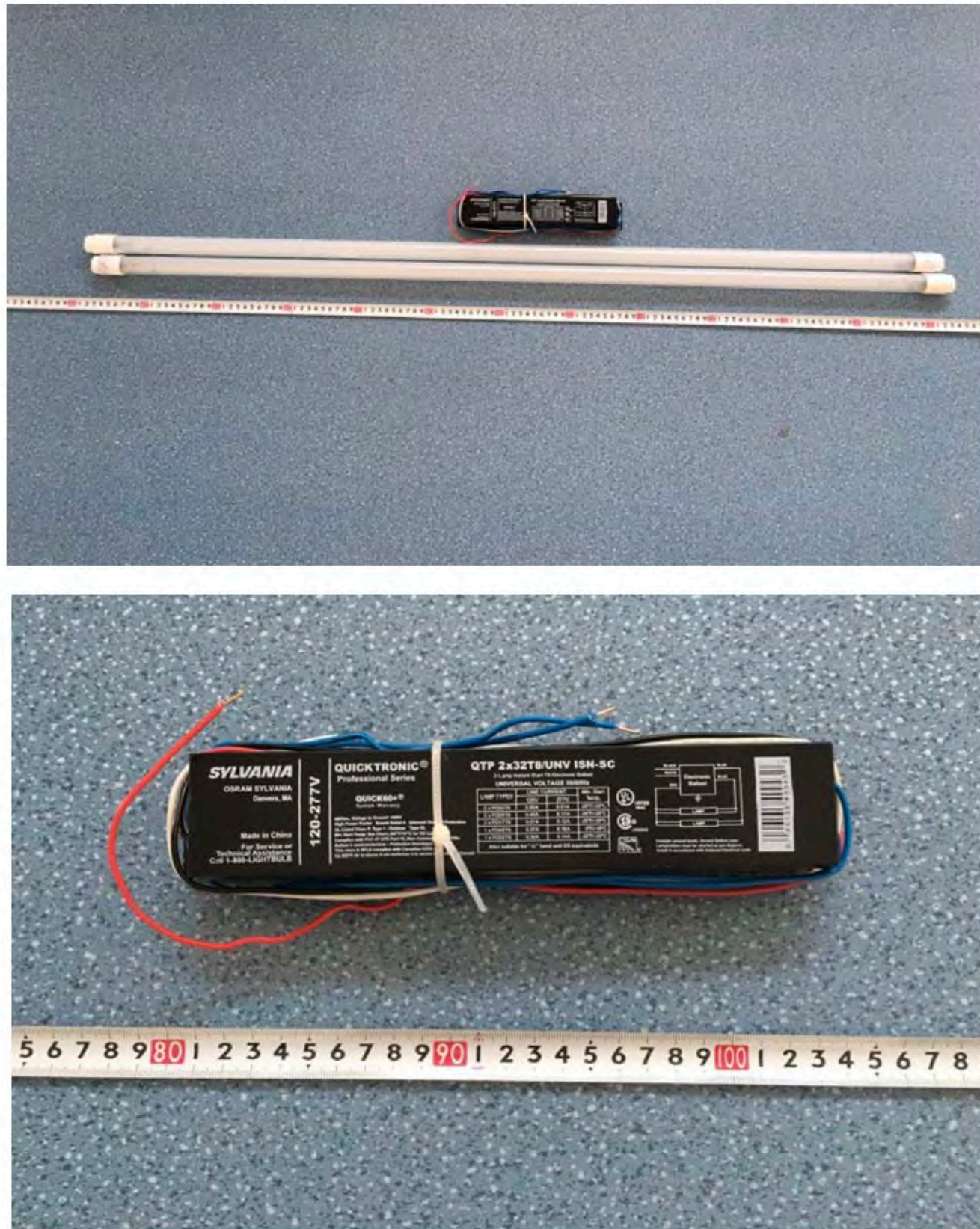


Figure 1- Overview of the sample

### Equipment Under Test (EUT)

<b>Name</b>	: LED Replace lamp
<b>Model</b>	: 91289, 91313
<b>Electrical Ratings</b>	: 120-277V, 60Hz, 16W
<b>Product Description</b>	: G13 base, fixed end caps, 3500K, frosted lens LED Tubes supplied by a high frequency fluorescent lamp ballast: QTP 2x32T8/UNV ISN-SC
<b>Manufacturer</b>	: P.Q.L., Inc.
<b>Address</b>	: 2285 Ward Avenue Simi Valley, CA 93065



## TEST RESULTS

Test ambient temperature was 25.1 °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)	0.276	0.122
Power Factor	0.9973	0.9775
Test Power (W)/2	16.51	16.49
THD A%	5.82	8.25
Luminous Efficacy (lm/W)	123.7	123.9
Total Luminous Flux (lm)	2043.0	2043.0
Color Rendering Index (CRI)	83.7	
R9	9.2	
Correlated Color Temperature (CCT)(K)	3506	
Chromaticity Chroma x	0.4046	
Chromaticity Chroma y	0.3899	
Chromaticity Chroma u	0.2356	
Chromaticity Chroma v	0.3405	
Duv	0.0004	
Chromaticity Chroma u'	0.2356	
Chromaticity Chroma v'	0.5108	

Special Color Rendering Indices	
R1	82.1
R2	91.4
R3	96.3
R4	82
R5	82.6
R6	88.8
R7	84.2
R8	62.1
R9	9.2
R10	80.2
R11	81.5
R12	70.3
R13	84.4
R14	98.5

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 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)	0.275
Power Factor	0.9983
Test Power (W)/2	16.47
Luminous Efficacy (lm/W)	124.6
Total Luminous Flux (lm)	2050.5
Beam Angle (°)	115.8
Center Beam Candle Power (cd)	557
Spacing Criteria	1.29 (0°-180°)/ 1.28 (90°-270°)
Zonal Lumens in the 0°-60°Zone	63.00%
Zonal Lumens in the 60°-90°Zone	22.84%
Zonal Lumens in the 90°-120°Zone	8.37%
Zonal Lumens in the 120°-180°Zone	5.79%

Table 3: Test data per Goniophotometer Method



### Spectral Power Distribution - Sphere Spectroradiometer Method

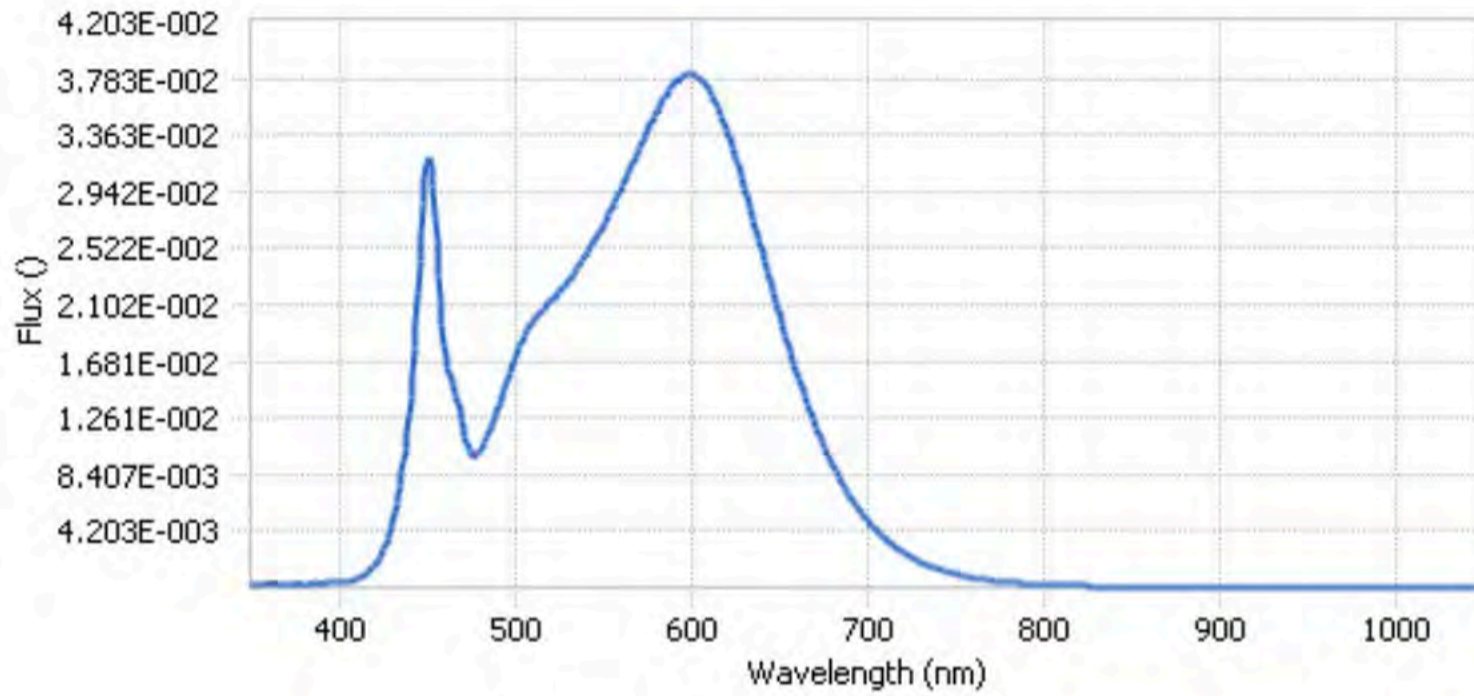


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	2.98E-04	485	1.14E-02	590	3.74E-02	695	5.91E-03
385	3.04E-04	490	1.31E-02	595	3.80E-02	700	5.07E-03
390	3.21E-04	495	1.51E-02	600	3.82E-02	705	4.34E-03
395	3.37E-04	500	1.70E-02	605	3.78E-02	710	3.70E-03
400	3.85E-04	505	1.86E-02	610	3.71E-02	715	3.16E-03
405	4.39E-04	510	1.97E-02	615	3.58E-02	720	2.70E-03
410	6.11E-04	515	2.06E-02	620	3.42E-02	725	2.30E-03
415	9.47E-04	520	2.13E-02	625	3.22E-02	730	1.95E-03
420	1.57E-03	525	2.19E-02	630	3.01E-02	735	1.65E-03
425	2.69E-03	530	2.26E-02	635	2.77E-02	740	1.41E-03
430	4.51E-03	535	2.35E-02	640	2.53E-02	745	1.19E-03
435	7.60E-03	540	2.46E-02	645	2.29E-02	750	1.01E-03
440	1.29E-02	545	2.57E-02	650	2.06E-02	755	8.74E-04
445	2.19E-02	550	2.68E-02	655	1.83E-02	760	7.47E-04
450	3.15E-02	555	2.82E-02	660	1.62E-02	765	6.42E-04
455	2.76E-02	560	2.94E-02	665	1.42E-02	770	5.45E-04
460	1.81E-02	565	3.10E-02	670	1.24E-02	775	4.72E-04
465	1.50E-02	570	3.23E-02	675	1.08E-02	780	4.13E-04
470	1.24E-02	575	3.38E-02	680	9.32E-03		
475	1.00E-02	580	3.52E-02	685	8.05E-03		
480	1.01E-02	585	3.64E-02	690	6.92E-03		

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



### Chromaticity Diagram - Sphere Spectroradiometer Method

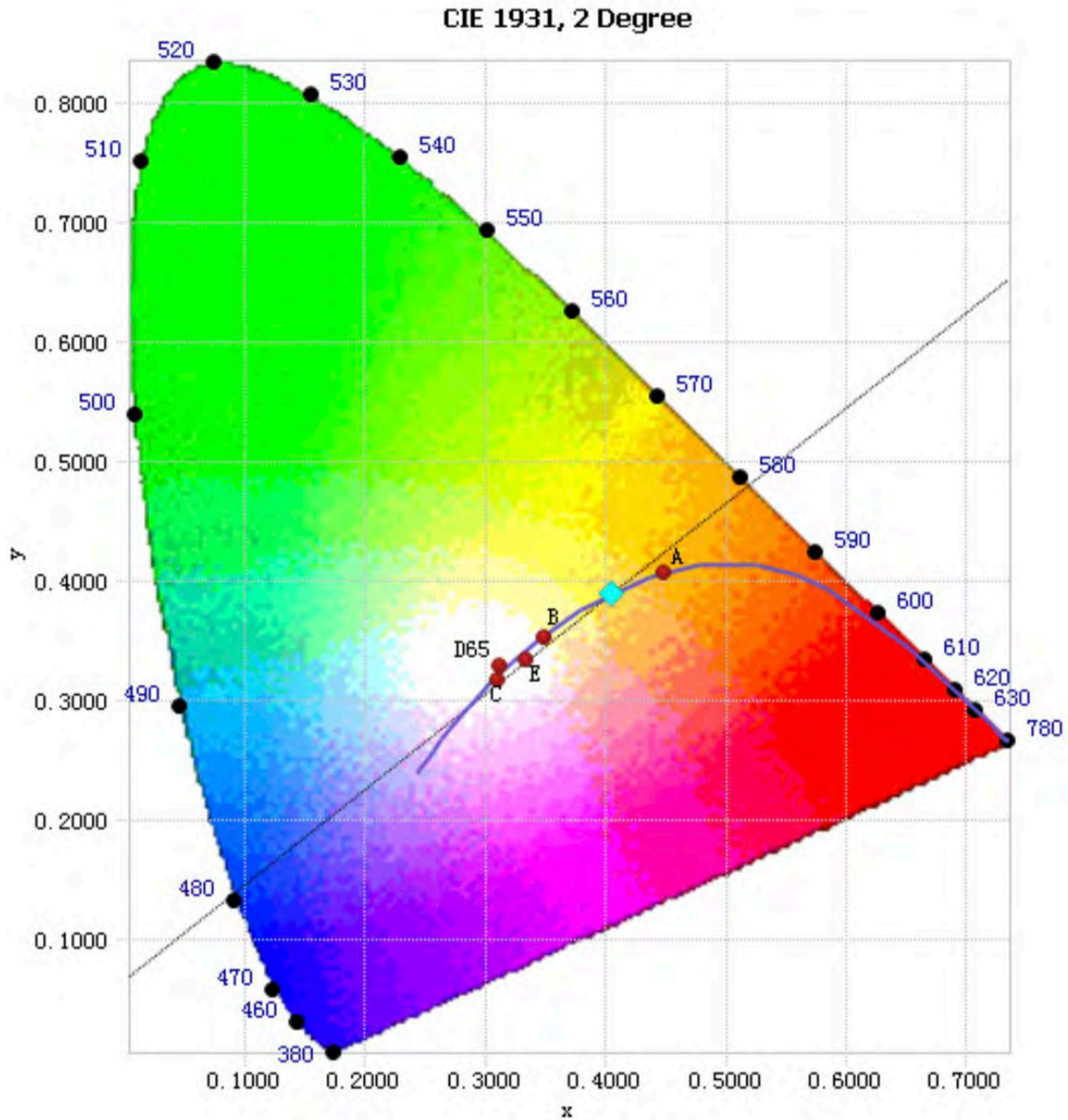


Chart 2: Chromaticity Diagram per Sphere - Spectroradiometer Method

Note: The location on the diagram of the tristimulus coordinates are indicated by the blue diamond.



**Nominal CCT Quadrangles – Sphere Spectroradiometer Method**

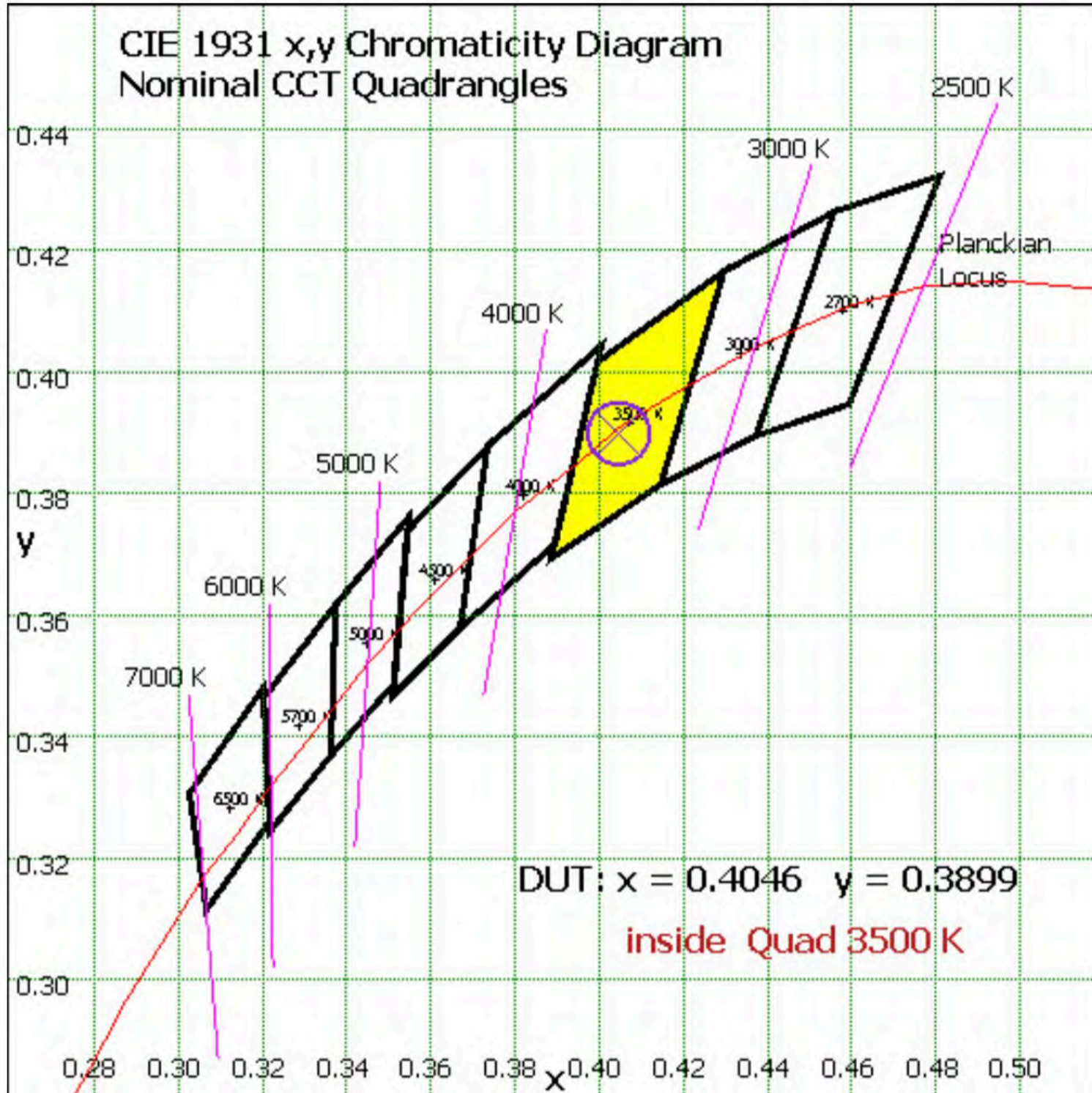


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram



### Zonal Lumen Tabulation- Goniophotometer Method

$\gamma(^{\circ})$	Lumens	% Total
0- 10	52.764	2.57%
10- 20	152.215	7.42%
20- 30	234.067	11.41%
30- 40	285.636	13.93%
40- 50	297.487	14.51%
50- 60	269.599	13.15%
60- 70	216.019	10.53%
70- 80	152.93	7.46%
80- 90	99.469	4.85%
90-100	69.516	3.39%
100-110	55.3	2.70%
110-120	46.74	2.28%
120-130	39.557	1.93%
130-140	32.027	1.56%
140-150	23.773	1.16%
150-160	14.844	0.72%
160-170	6.81	0.33%
170-180	1.792	0.09%
Total	2050.5	100%

$\gamma(^{\circ})$	Lumens	% Total
0- 60	1291.768	63.00%
60- 90	468.418	22.84%
0-90	1760.186	85.84%
90- 180	290.359	14.16%
0- 180	2050.5	100%

Table 5: Zonal Lumen Data



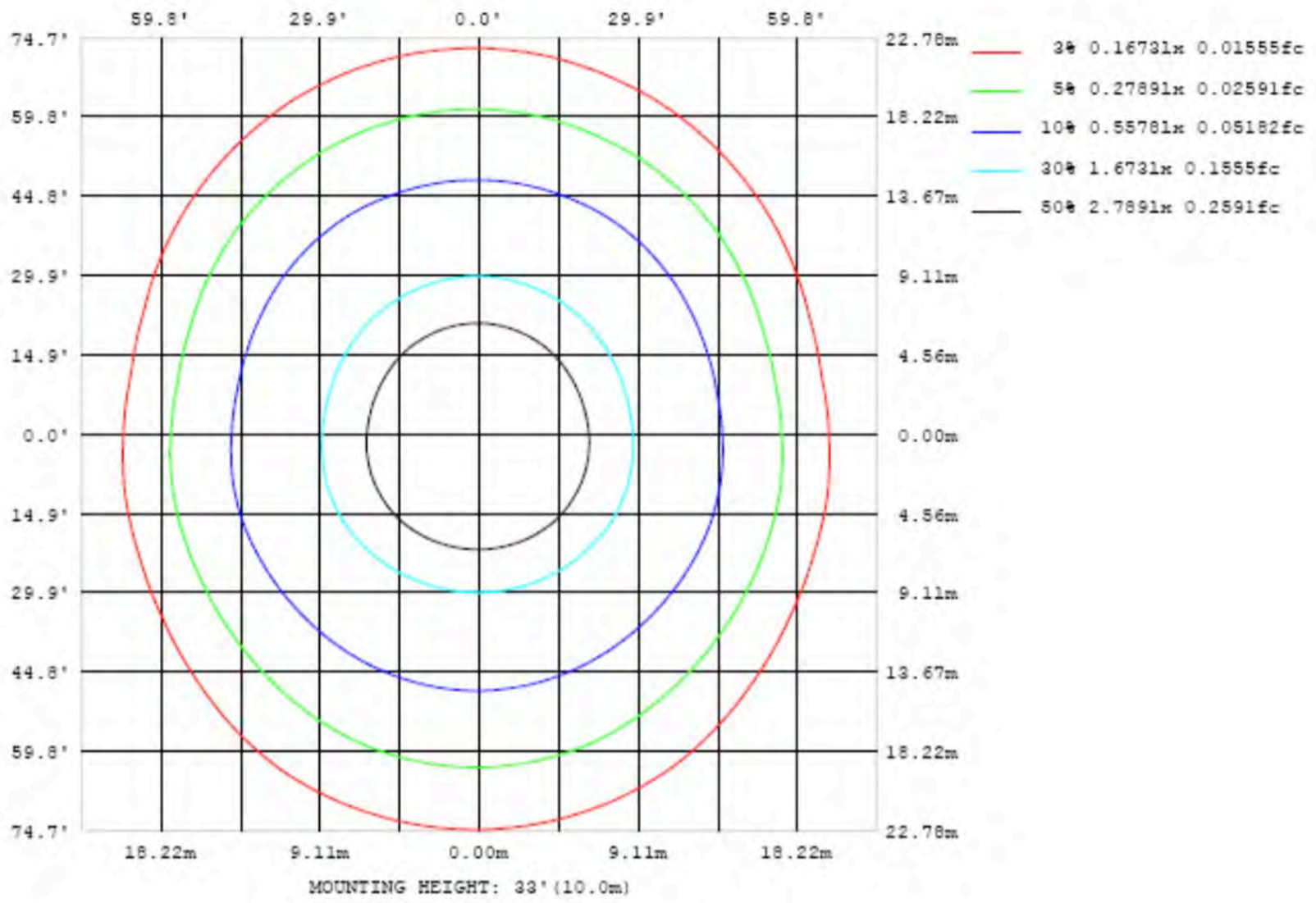


Chart 4: Illuminance Plot (Footcandles)



### Luminous Intensity Distribution Plots- Goniophotometer Method

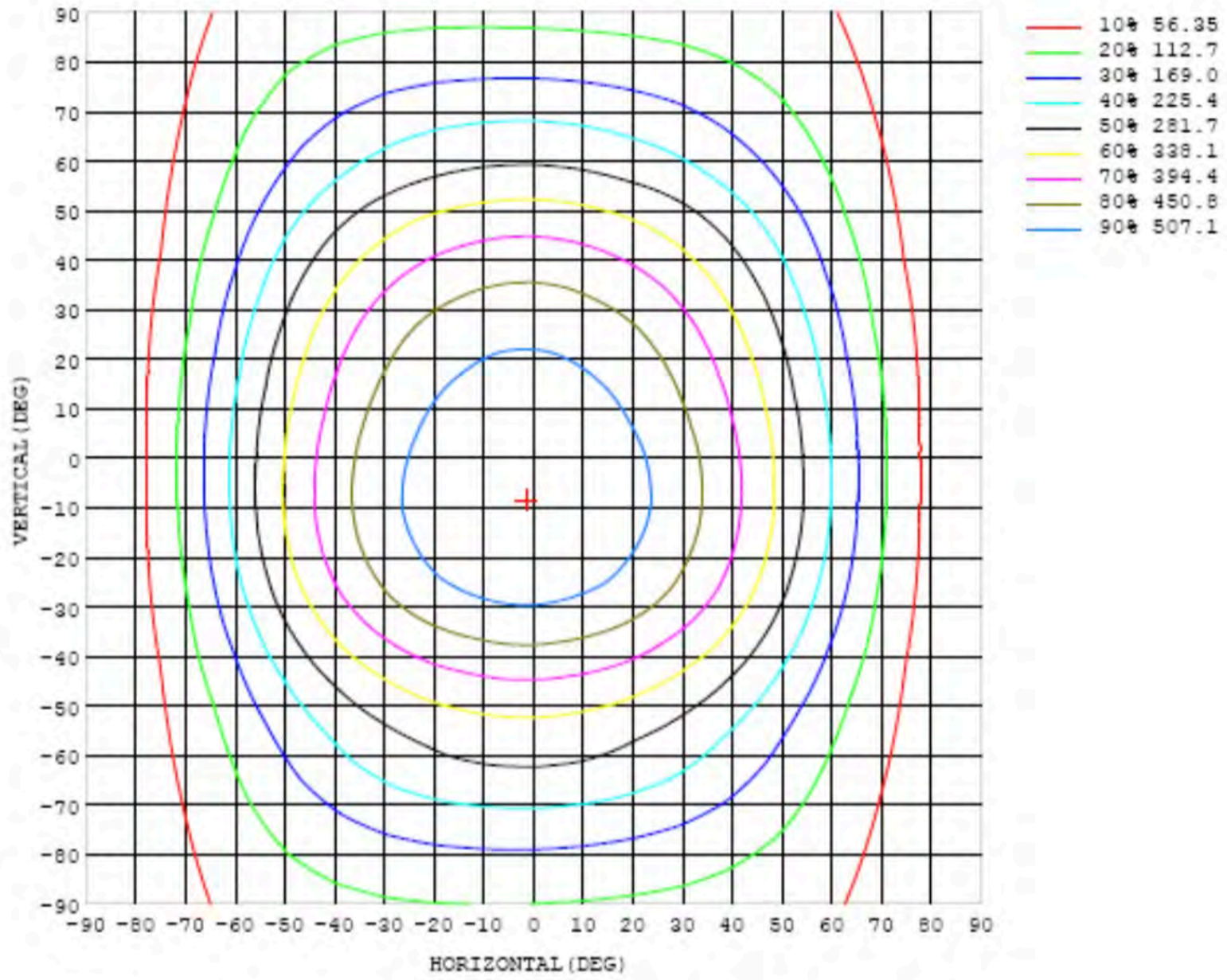


Chart 5: Isocandela Plot

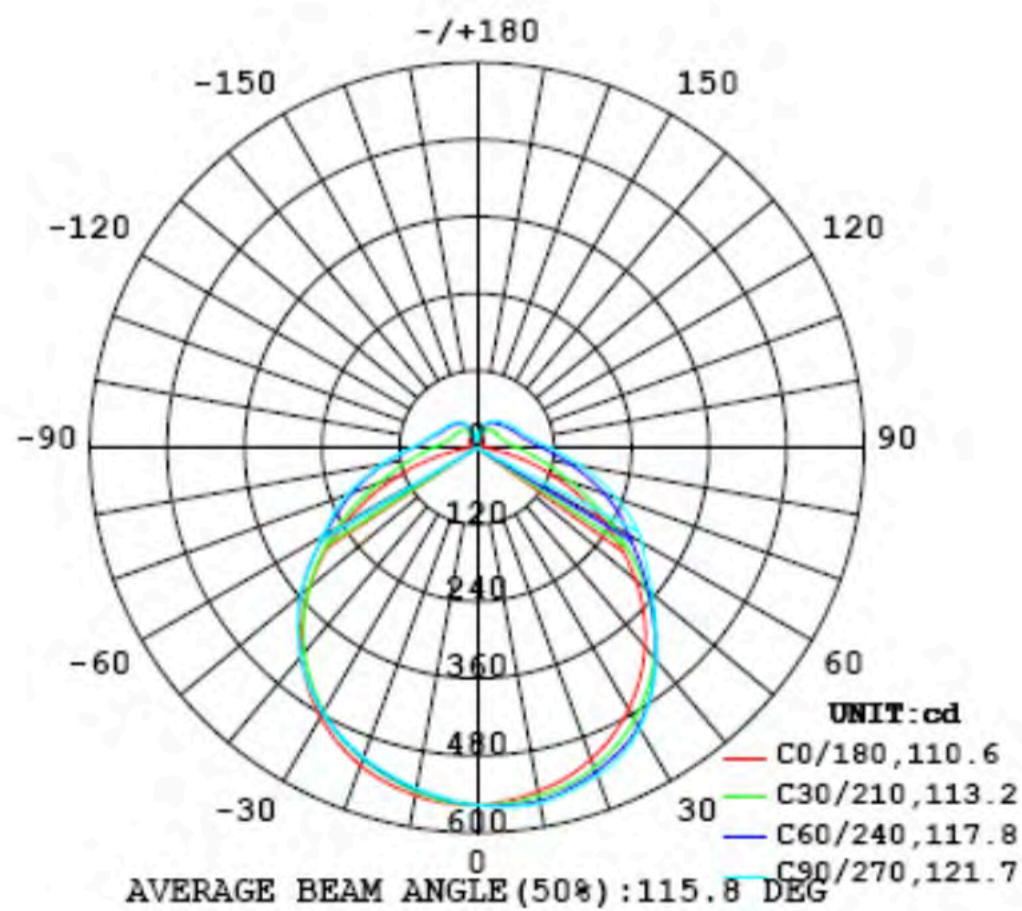


Chart 6: Polar Candela Distribution



### Luminous Intensity Data- Goniophotometer Method

Table--1 UNIT: cd

C (DEG) \ y (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	552	553	555	556	557	558	559	560	561	562	562	562	561	561	560	559	558	557	556
10	544	546	548	551	554	556	559	560	561	562	563	563	562	561	559	557	554	552	551
15	533	536	540	544	547	548	550	552	554	555	556	556	556	555	553	551	547	543	541
20	517	521	526	531	534	537	538	540	542	544	545	545	544	543	541	540	537	532	527
25	496	502	508	512	516	519	523	525	528	530	531	531	529	528	527	524	521	515	508
30	470	477	484	489	494	498	501	501	503	505	506	507	508	508	506	503	499	492	485
35	440	448	455	461	466	469	470	469	469	471	472	474	477	480	480	476	472	465	457
40	405	414	421	427	432	432	431	430	431	433	434	435	439	443	445	444	439	432	423
45	366	375	383	389	390	389	389	390	390	392	394	394	398	400	404	405	401	394	384
50	321	331	339	343	343	344	347	350	352	355	356	355	355	355	357	358	357	351	340
55	273	283	289	293	296	300	307	313	318	321	321	318	316	311	308	307	307	301	290
60	223	231	236	242	250	260	271	282	291	296	295	289	281	272	262	255	251	247	238
65	172	178	183	194	209	226	243	254	261	264	264	260	253	238	221	206	195	190	184
70	122	127	136	153	175	195	210	220	227	231	231	227	221	207	188	165	145	135	130
75	77.6	82.1	97.2	121	145	163	177	186	192	196	196	194	188	175	157	132	104	86.0	81.6
80	40.6	48.5	69.7	95.1	118	134	147	154	160	163	163	162	156	146	129	105	75.2	50.3	41.1
85	14.0	27.2	51.2	75.5	95.6	110	121	128	132	135	135	134	129	120	106	83.8	56.0	28.2	12.9
90	0.36	16.2	39.7	62.3	79.8	92.5	101	107	110	113	113	112	108	101	88.0	69.1	43.8	17.5	0.60
95	1.52	12.2	33.0	53.3	69.2	79.9	87.2	91.8	94.8	96.5	96.8	95.9	92.7	86.4	75.3	58.8	36.6	13.6	1.69
100	3.57	11.7	29.4	47.5	61.6	71.1	77.5	81.5	84.1	85.4	85.7	84.6	81.9	76.3	66.8	52.0	32.8	13.5	3.89
105	5.64	12.9	27.7	43.8	56.4	65.2	70.8	74.2	76.4	77.6	77.8	76.6	74.1	69.4	60.8	47.8	31.0	15.1	6.63
110	7.89	14.9	27.2	41.2	52.7	61.0	66.2	69.4	71.3	72.2	72.2	71.4	69.2	64.5	56.5	44.8	30.7	17.4	9.36
115	10.1	17.2	27.4	39.4	49.8	57.3	62.5	65.8	67.8	68.8	68.7	67.6	65.0	60.2	52.9	42.8	31.0	19.7	11.7
120	12.0	19.2	28.2	38.1	47.3	54.3	59.2	62.4	64.3	65.2	65.1	63.9	60.8	56.8	50.3	41.5	31.5	21.4	13.6
125	13.4	20.7	28.9	37.4	45.3	51.7	56.2	59.3	61.2	62.0	61.9	60.7	58.0	54.0	48.2	40.6	32.1	22.7	14.8
130	14.4	21.7	29.6	37.0	43.7	49.3	53.5	56.5	58.3	59.0	58.8	57.5	55.1	51.4	46.4	39.9	32.3	22.9	15.7
135	15.5	21.8	29.6	36.6	42.5	47.4	51.1	53.8	55.4	56.1	55.9	53.9	52.5	49.2	44.8	39.2	31.9	22.5	16.3
140	16.3	21.2	28.6	35.7	41.3	45.6	48.8	51.2	52.7	53.4	53.1	51.8	49.9	47.1	43.3	38.0	30.6	21.8	16.9
145	16.3	20.3	27.2	34.1	39.7	43.7	46.7	48.8	50.1	50.6	50.4	49.2	47.6	45.0	41.4	35.8	28.1	21.3	17.3
150	16.5	19.2	25.9	31.5	37.1	41.3	44.2	46.2	47.4	47.8	47.5	46.4	45.0	42.4	38.4	32.8	27.1	20.1	16.7
155	15.8	16.2	22.8	29.0	33.2	37.6	40.8	42.9	44.1	44.5	42.5	43.1	41.5	38.3	32.7	27.6	23.8	17.8	16.0
160	14.5	14.0	19.5	26.6	29.8	32.7	35.3	37.7	39.1	39.6	38.7	37.8	35.8	30.7	25.5	23.5	19.2	15.6	15.0
165	13.5	13.8	15.4	20.5	26.2	28.1	30.2	31.6	32.3	32.6	31.6	31.1	25.3	21.4	20.2	17.8	15.9	14.4	14.8
170	14.8	15.2	15.7	15.6	16.8	22.9	25.0	26.1	27.5	26.8	26.3	19.3	17.8	17.9	17.7	17.4	16.1	15.2	15.0
175	18.2	18.3	19.3	19.6	19.4	18.6	18.4	20.5	19.9	18.3	12.6	17.2	18.7	19.7	19.7	19.3	18.8	18.7	18.6
180	7.59	7.59	7.59	7.59	7.59	7.59	7.59	7.59	7.59	7.59	7.59	7.59	7.59	7.59	7.59	7.59	7.59	7.59	7.59

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	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557		
5	555	554	553	552	551	551	550	549	549	548	549	549	549	550	551	551	552		
10	549	547	544	542	541	541	540	539	539	539	538	537	537	537	539	541	543		
15	538	534	532	531	530	529	528	527	527	526	525	524	524	524	525	527	530		
20	523	519	517	516	515	515	515	514	513	512	510	509	508	508	508	509	513		
25	503	500	499	498	497	497	496	496	496	496	493	491	489	488	487	488	491		
30	479	475	475	476	477	478	478	478	477	475	472	470	467	464	462	461	464		
35	450	447	447	450	452	453	454	454	454	451	447	444	441	437	433	431	433		
40	416	414	416	419	423	424	425	426	425	422	418	415	410	405	400	397	398		
45	377	376	380	385	389	392	393	394	393	390	386	382	376	370	364	359	359		
50	333	334	340	346	352	356	356	357	356	353	349	345	339	331	323	316	315		
55	284	287	296	305	311	316	315	315	314	311	309	306	299	290	279	271	267		
60	232	238	250	261	268	273	276	277	277	273	268	263	257	247	234	222	217		
65	179	188	204	217	228	238	243	246	246	242	235	227	216	204	190	175	167		
70	128	142	162	180	195	206	212	214	213	210	203	195	182	166	149	130	119		
75	83.3	103	128	150	165	175	180	181	180	177	171	164	151	136	115	93.3	77.6		
80	49.7	74.4	102	123	137	146	149	150	149	146	141	135	124	110	89.7	66.1	46.1		
85	28.8	55.5	81.5	101	113	119	122	122	121	119	115	110	102	89.1	71.1	48.4	25.9		
90	18.2	43.7	67.2	84.1	94.1	99.3	101	101	101	98.8	96.1	91.8	85.1	74.5	58.6	37.7	15.4		
95	13.5	36.6	57.6	72.5	81.4	86.0	87.9	88.1	87.5	86.0	83.7	80.2	74.4	65.1	50.7	31.5	11.0		
100	13.6	31.4	50.6	64.2	72.4	76.8	78.8	79.3	78.8	77.6	75.6	72.3	67.0	58.4	45.1	27.4	10.8		
105	15.0	30.4	45.0	57.3	65.4	70.0	72.2	72.9	72.6	71.6	69.6	66.5	61.2	53.1	41.0	26.1	12.3		
110	17.1	30.1	42.9	52.4	59.5	64.1	66.6	67.5	67.5	66.5	64.6	61.6	56.5	49.2	38.7	25.9	14.5		
115	18.9	30.2	41.5	50.2	56.1	59.7	61.9	62.9	63.0	62.2	60.5	57.9	53.3	46.6	37.3	26.2	16.4		
120	20.6	30.4	40.3	48.2	53.8	57.3	59.3	60.2	60.3	59.6	58.0	55.2	50.9	44.8	36.5	27.0	17.8		
125	21.1	30.3	39.1	46.4	51.5	55.2	57.1	58.0	58.1	57.3	55.7	53.1	49.1	43.4	35.8	27.4	18.6		
130	21.5	29.6	38.3	44.6	49.6	52.7	55.0	55.9	56.0	55.2	53.7	51.2	47.5	42.0	35.5	27.2	19.2		
135	21.7	29.0	36.9	43.1	47.4	50.7	52.6	53.8	53.9	53.3	51.8	49.4	45.7	40.9	34.5	26.7	21.0		
140	22.7	28.0	34.3	41.2	45.3	48.1	50.2	51.6	51.8	51.2	49.7	47.3	43.9	39.3	32.3	26.0	22.1		
145	22.9	26.3	31.8	37.8	42.8	45.9	47.6	49.0	49.2	48.6	47.3	45.0	41.5	36.1	30.3	24.9	21.4		
150	21.3	24.9	29.6	33.6	38.6	42.4	44.4	45.4	45.9	45.4	44.1	41.6	37.4	32.4	28.5	24.0	20.8		
155	20.3	23.5	26.4	30.6	33.2	36.2	38.9	40.4	41.0	40.4	38.6	35.7	32.6	29.8	26.4	24.5	20.7		
160	17.5	20.6	22.6	25.7	29.8	31.2	32.4	33.3	33.8	33.4	32.5	31.1	29.5	27.4	24.7	23.8	20.0		
165	15.1	17.0	19.1	20.3	22.8	26.4	28.4	28.9	29.1	29.2	28.7	27.8	26.4	24.8	23.3	21.6	18.4		
170	15.0	15.5	16.9	17.6	18.1	18.8	20.5	23.2	24.5	24.6	24.3	24.2	24.5	23.3	20.6	20.5	17.6		
175	18.0	18.0	17.4	16.9	15.9	14.0	13.4	14.4	17.0	22.5	23.8	21.1	18.1	18.9	19.8	19.0	18.8		
180	7.59	7.59	7.59	7.59	7.59	7.59	7.59	7.59	7.59	7.59	7.59	7.59	7.59	7.59	7.59	7.59	7.59		

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  $4\pi$ . 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.

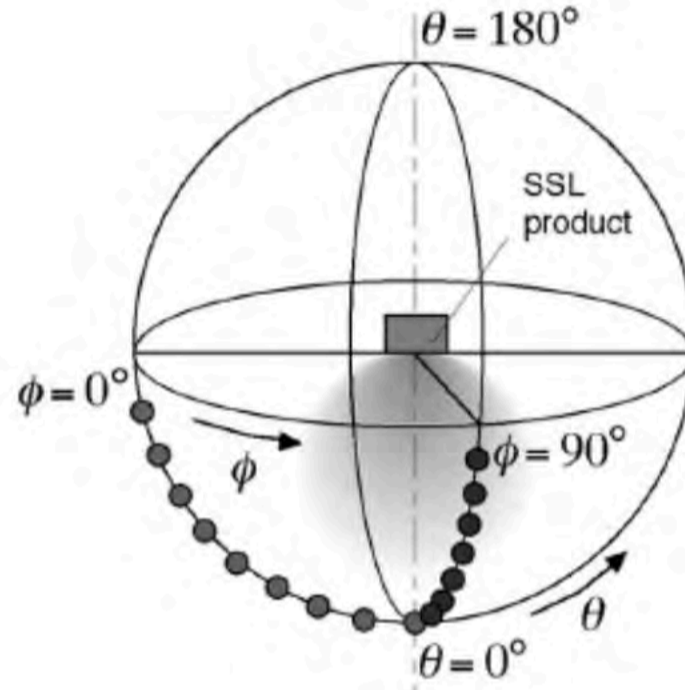
### Color Spatial Uniformity

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  $10^{\circ}$  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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