



## LM-79-08 TEST REPORT

for

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

2285 Ward Avenue / Simi Valley, CA 93065

**LED Tube**

**Model: 91825, 91826, 91827**

91825 was selected as the representative model.

All measurements are the same except CCT.

**Laboratory: Leading Testing Laboratories**

**NVLAP CODE: 200960-0**

3rd Floor, Bld. 2, NO. 96 Longchuanwu Rd Qianjiang Economy Dev. Zone, YuhangDist,  
Hangzhou, Zhejiang Province, China 311100

Tel: +86571 86376106

[www.ledtestlab.com](http://www.ledtestlab.com)

Report No.: HZ20080018c

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

Review by:

Engineer: April Zou  
Aug. 19, 2020

Approved by:



Manager: Jim Zhang  
Aug. 19, 2020

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: 91825

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)/2	Power Factor
124.1	1424.2	11.48	0.9949
CCT (K)	CRI	Stabilization Time (Light & Power)	
3087	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** : Aug. 11, 2020

**Date of Test** : Aug. 14, 2020

**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

ANSI/IES TM-30-18 IES Method for Evaluating Light Source Color Rendition

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**SAMPLE PHOTO**

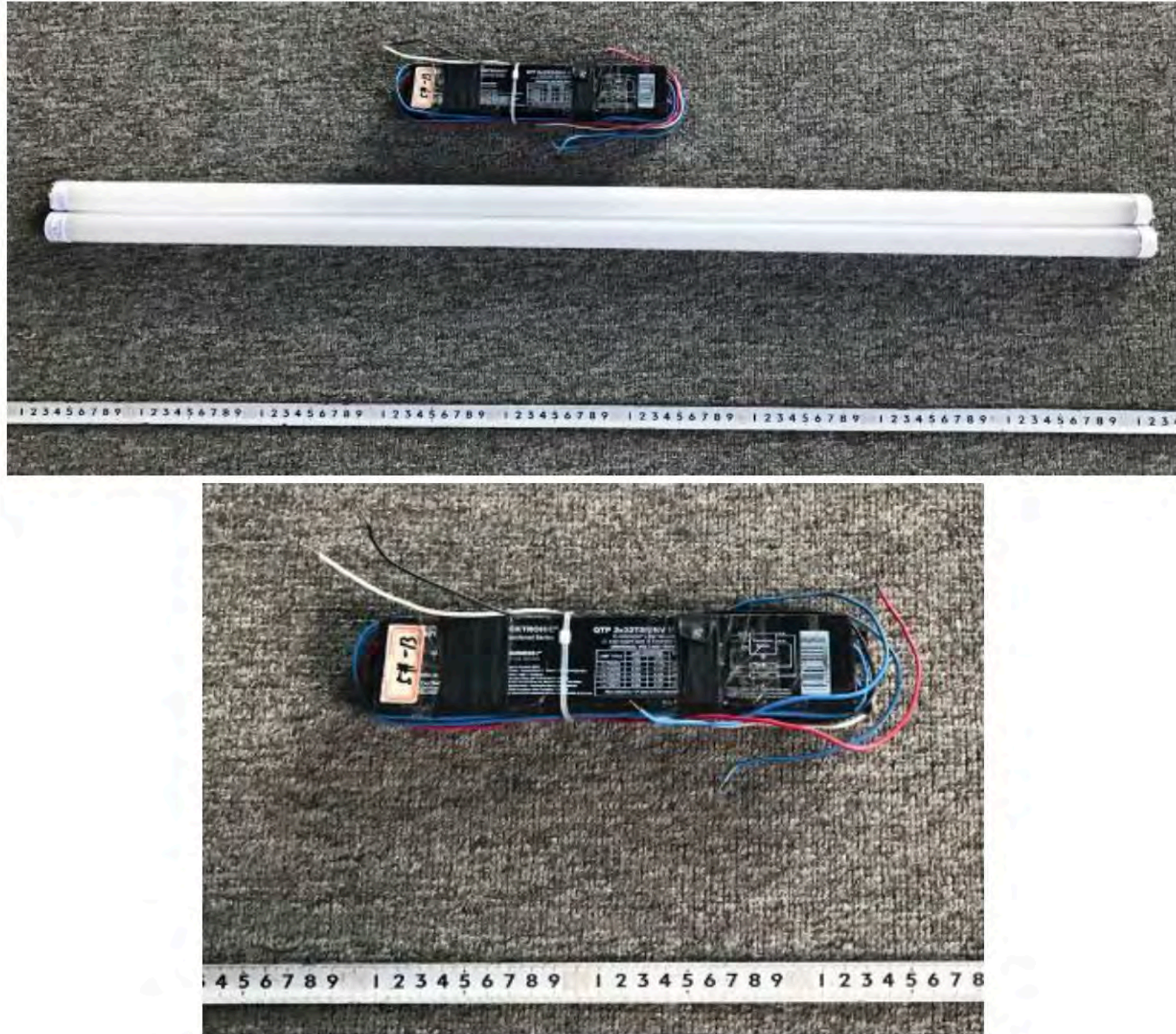


Figure 1- Overview of the sample

**Equipment Under Test(EUT)**

<b>Name</b>	: LED Tube
<b>Model</b>	: 91825
<b>Electrical Ratings</b>	: 120-277V, 50/60Hz, 10W
<b>Product Description</b>	: G13 Base, 3000K 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 25.2°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)	0.192	0.091
Power Factor	0.9949	0.9340
Test Power (W)/2	11.48	11.72
THD A%	6.19	20.64
Luminous Efficacy (lm/W)	124.1	121.6
Total Luminous Flux (lm)	1424.2	1424.6
Color Rendering Index (CRI)	82.4	
R9	6.7	
Correlated Color Temperature (CCT)(K)	3087	
Chromaticity Chroma x	0.4301	
Chromaticity Chroma y	0.4004	
Chromaticity Chroma u	0.2477	
Chromaticity Chroma v	0.3459	
Duv	-0.0005	
Chromaticity Chroma u'	0.2477	
Chromaticity Chroma v'	0.5189	

Special Color Rendering Indices	
R1	81
R2	91.5
R3	95.7
R4	79.5
R5	81.1
R6	89.3
R7	82.3
R8	58.7
R9	6.7
R10	80.4
R11	78.5
R12	69.1
R13	83.6
R14	98.4

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°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)	0.193
Power Factor	0.9949
Power (W)/2	11.52
Luminous Efficacy (lm/W)	122.4
Total Luminous Flux (lm)	1409.4
Beam Angle (°)	108.2 (0°-180°) / 195.7 (90°-270°)
Center Beam Candle Power (cd)	260
Maximum Beam Candle Power (cd)	260.6 (At: C=90.0, Gamma=3.0)
Spacing Criteria	1.24 (0°-180°) / 1.38 (90°-270°)
Zonal Lumens in the 0°-60°Zone	45.67%
Zonal Lumens in the 60°-90°Zone	26.39%
Zonal Lumens in the 90°-120°Zone	16.28%
Zonal Lumens in the 120°-180°Zone	11.66%

Table 3: Test data per Goniophotometer Method

**Spectral Power Distribution - Sphere Spectroradiometer Method**

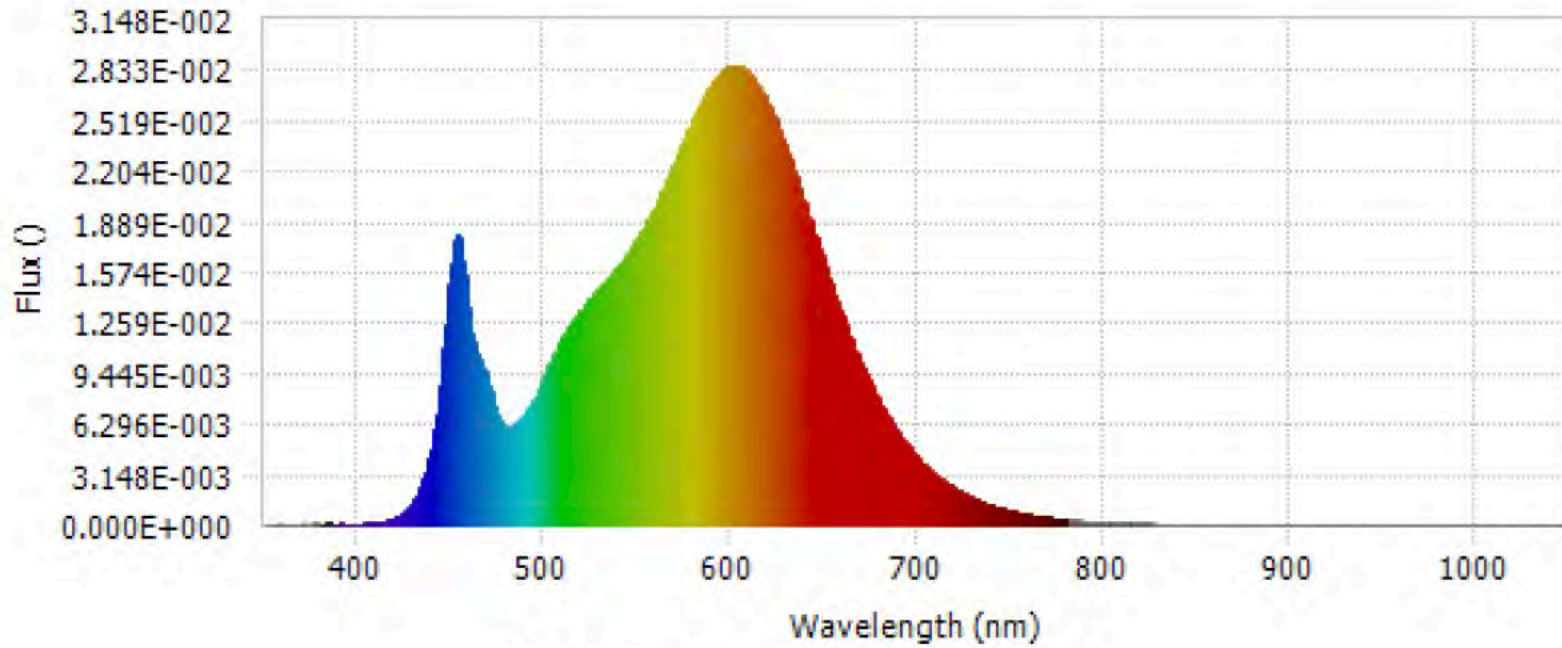
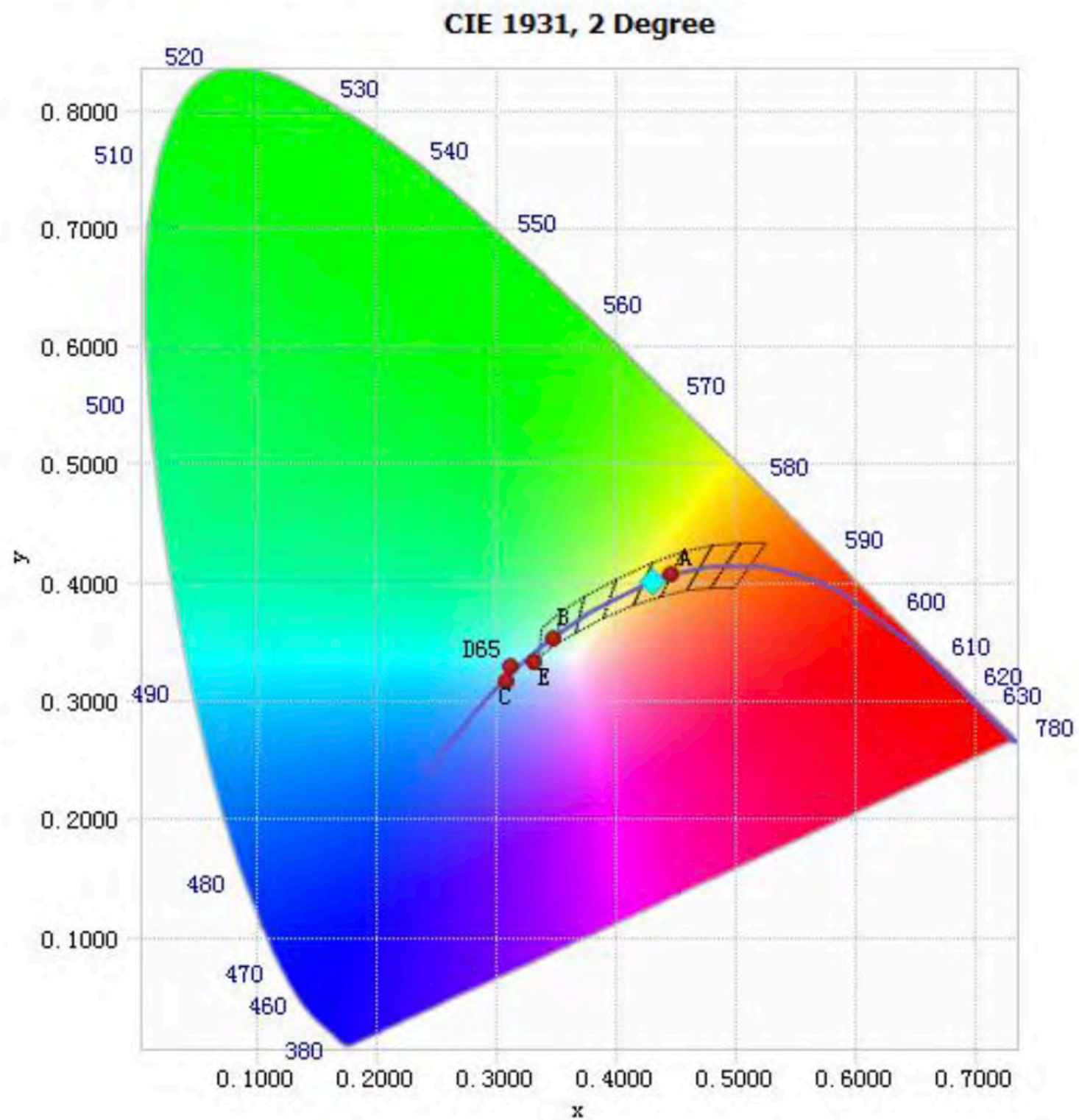


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	8.71E-05	485	6.37E-03	590	2.75E-02	695	4.98E-03
385	9.12E-05	490	7.01E-03	595	2.82E-02	700	4.28E-03
390	8.50E-05	495	8.03E-03	600	2.85E-02	705	3.66E-03
395	8.42E-05	500	9.35E-03	605	2.86E-02	710	3.15E-03
400	8.13E-05	505	1.07E-02	610	2.81E-02	715	2.70E-03
405	8.96E-05	510	1.17E-02	615	2.73E-02	720	2.32E-03
410	1.42E-04	515	1.27E-02	620	2.63E-02	725	1.98E-03
415	2.62E-04	520	1.35E-02	625	2.50E-02	730	1.68E-03
420	4.62E-04	525	1.41E-02	630	2.34E-02	735	1.44E-03
425	8.76E-04	530	1.48E-02	635	2.17E-02	740	1.22E-03
430	1.60E-03	535	1.55E-02	640	2.00E-02	745	1.05E-03
435	2.93E-03	540	1.62E-02	645	1.82E-02	750	8.89E-04
440	5.31E-03	545	1.70E-02	650	1.64E-02	755	7.63E-04
445	9.80E-03	550	1.79E-02	655	1.47E-02	760	6.52E-04
450	1.62E-02	555	1.89E-02	660	1.30E-02	765	5.60E-04
455	1.73E-02	560	2.00E-02	665	1.15E-02	770	4.77E-04
460	1.27E-02	565	2.13E-02	670	1.01E-02	775	4.09E-04
465	1.03E-02	570	2.27E-02	675	8.85E-03	780	3.51E-04
470	8.74E-03	575	2.40E-02	680	7.70E-03		
475	6.79E-03	580	2.54E-02	685	6.68E-03		
480	6.06E-03	585	2.66E-02	690	5.77E-03		

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

**Chromaticity Diagram - Sphere Spectroradiometer Method**



Tristimulus values(x, y): (0.4301, 0.4004)

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

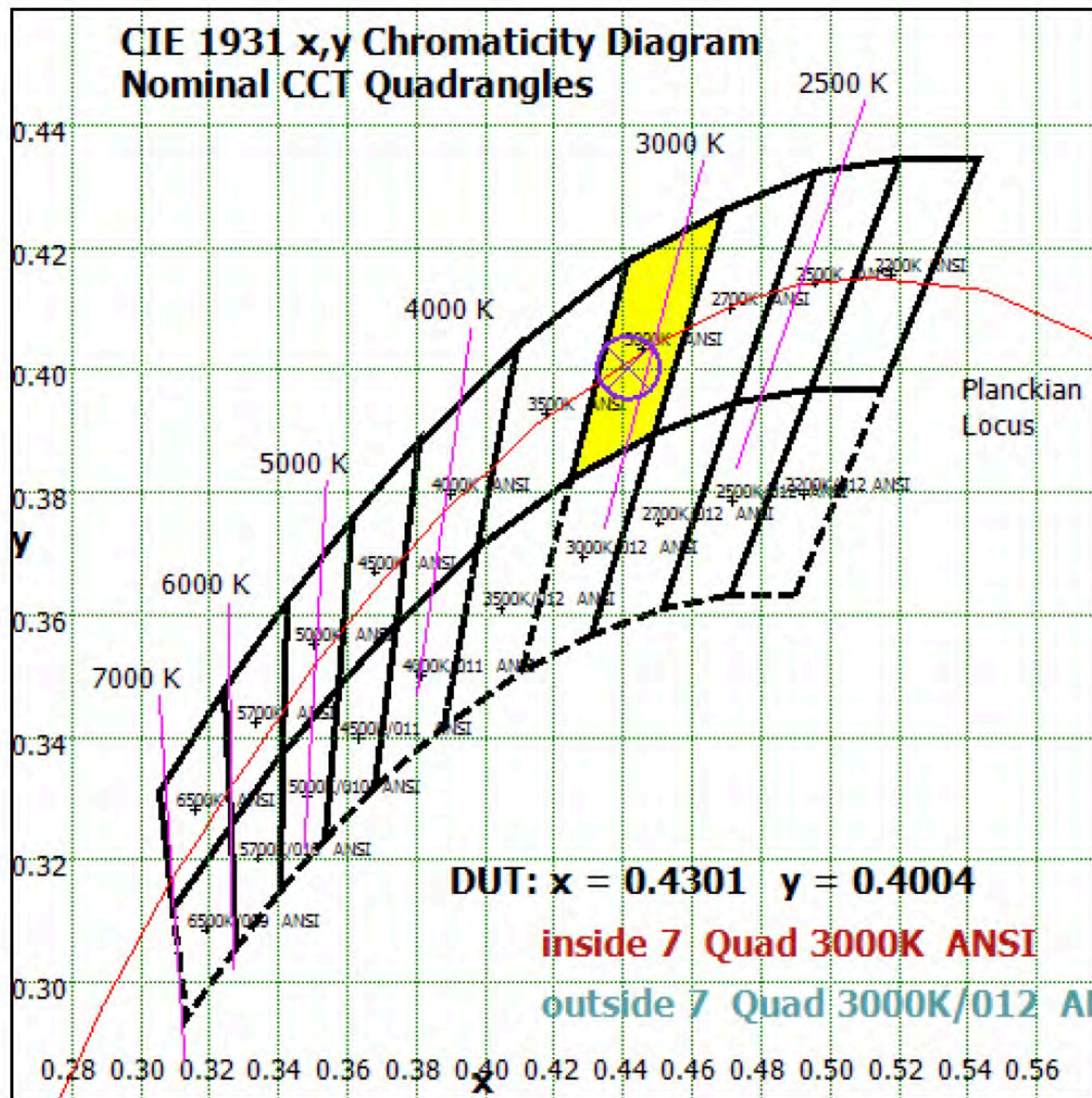


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

### Color Rendition Report – Sphere Spectroradiometer Method

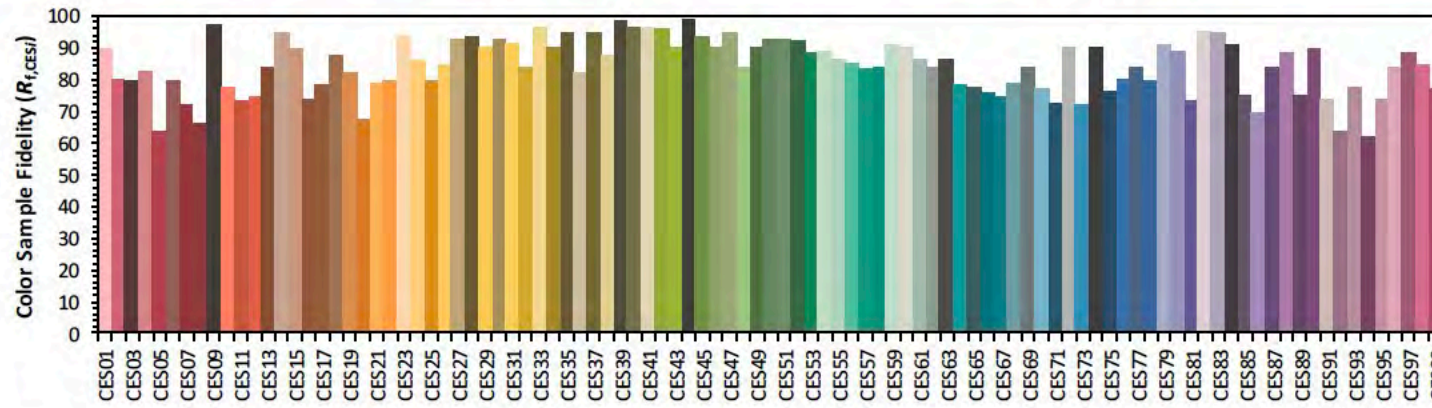
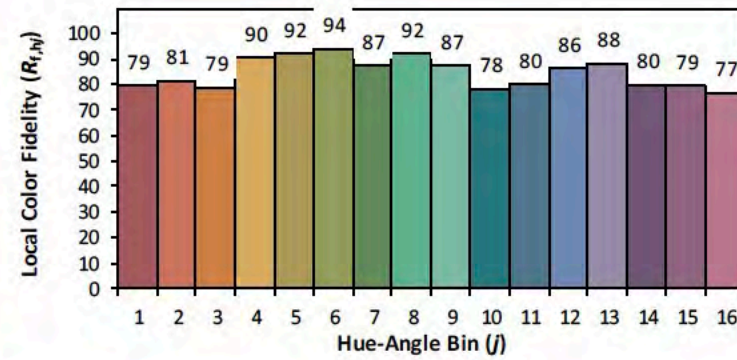
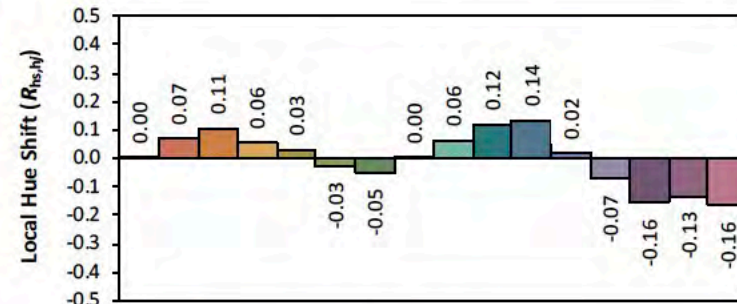
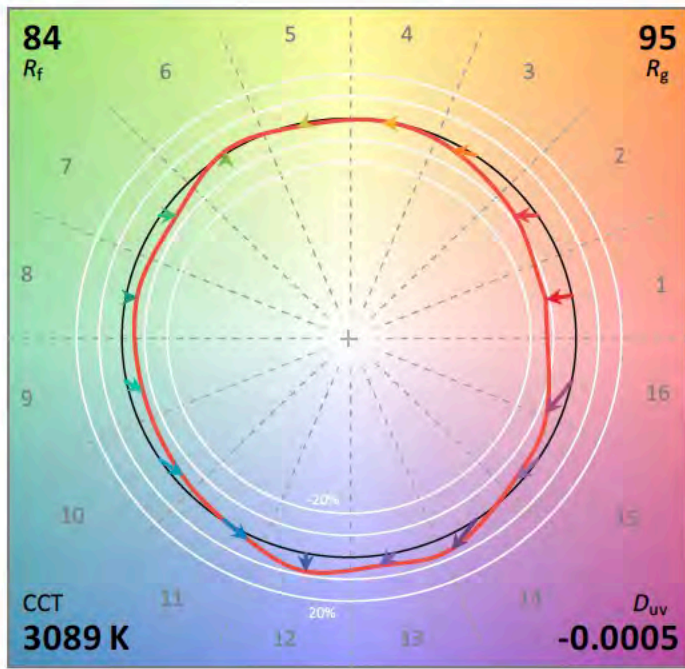
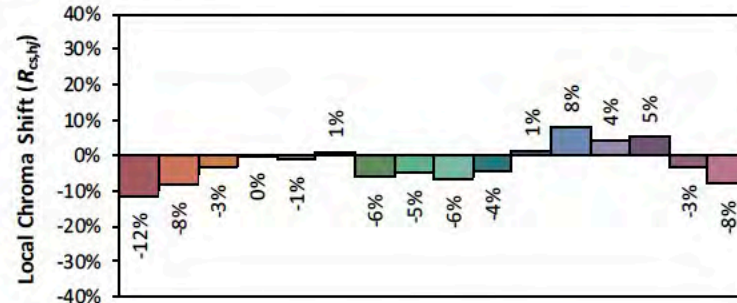
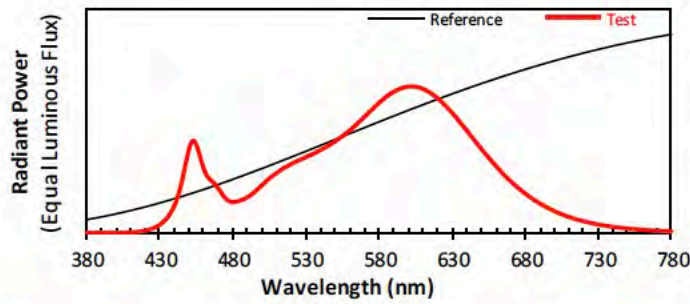
#### ANSI/IES TM-30-18 Color Rendition Report

Source: LED

Manufacturer: P.Q.L., INC.

Date: 2020/8/14

Model: 91825



Notes: This is a recommended method for displaying ANSI/IES TM-30-18 information.

x 0.4301  
y 0.4004  
u' 0.2477  
v' 0.5189

CIE 13.3-1995 (CRI)	
R <sub>a</sub>	82
R <sub>g</sub>	7

Colors are for visual orientation purposes only. Created with the ANSI/IES TM-30-18 Calculator Version 2.00.

Chart 4: Full Report Created with the IES TM-30 Calculator

Note: The values in this diagram might be a little different from the values in Table 2 due to rounding.

**Zonal Lumen Tabulation- Goniophotometer Method**

$\gamma(^{\circ})$	Lumens	% Total
0- 10	24.687	1.75%
10- 20	71.234	5.05%
20- 30	109.792	7.79%
30- 40	136.665	9.70%
40- 50	150.273	10.66%
50- 60	151.034	10.72%
60- 70	141.172	10.02%
70- 80	124.594	8.84%
80- 90	106.11	7.53%
90-100	90.113	6.39%
100-110	76.016	5.39%
110-120	63.325	4.49%
120-130	52.177	3.70%
130-140	42.166	2.99%
140-150	32.307	2.29%
150-160	22.365	1.59%
160-170	11.856	0.84%
170-180	3.503	0.25%
Total	1409.4	100%

$\gamma(^{\circ})$	Lumens	% Total
0- 60	643.685	45.67%
60- 90	371.876	26.39%
0-90	1015.561	72.06%
90- 180	393.828	27.94%
0- 180	1409.4	100%

Table 5: Zonal Lumen

**Illuminance Plots- Goniophotometer Method**

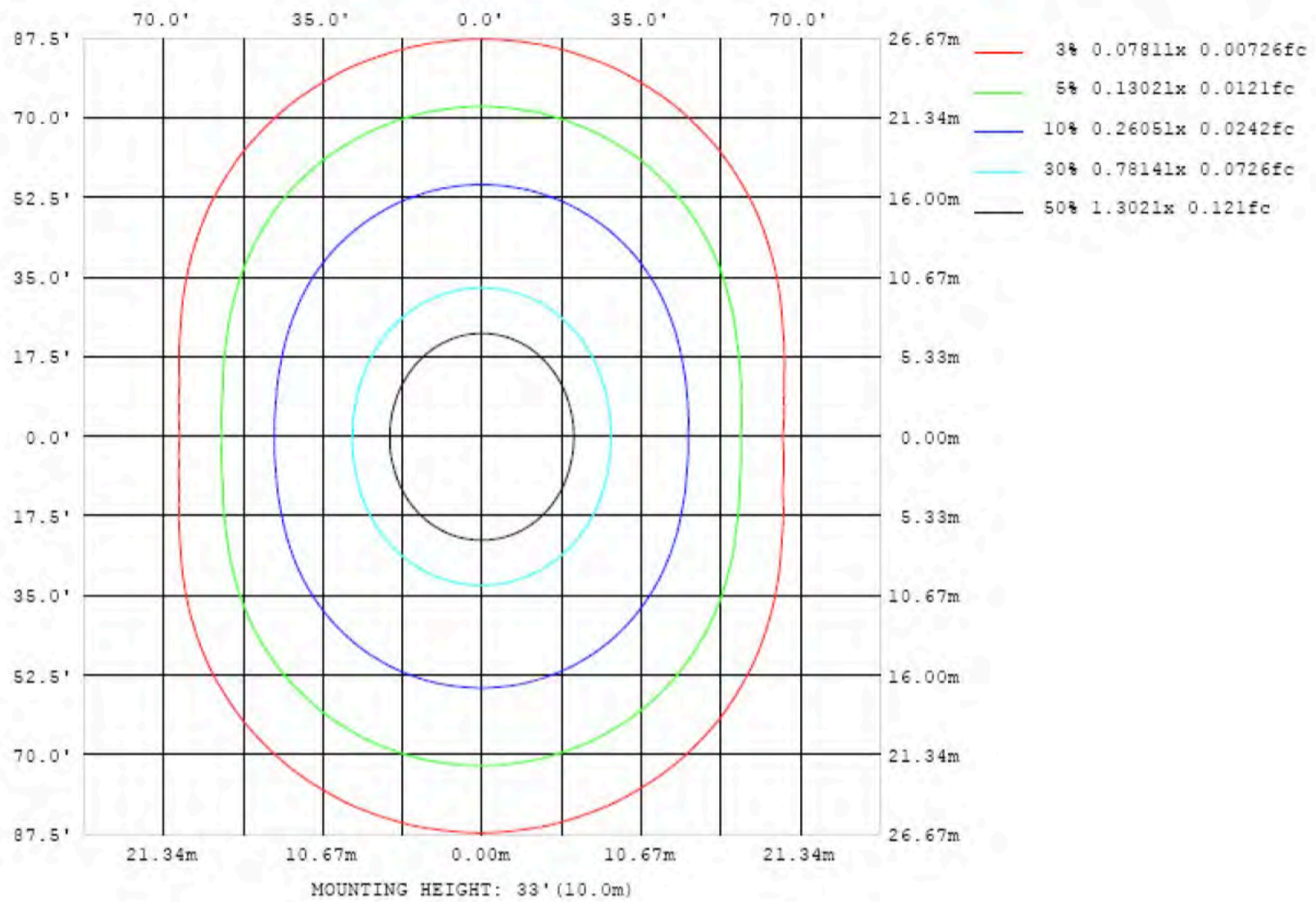


Chart 5: Illuminance Plot (Footcandles)

**Luminous Intensity Distribution Plots- Goniophotometer Method**

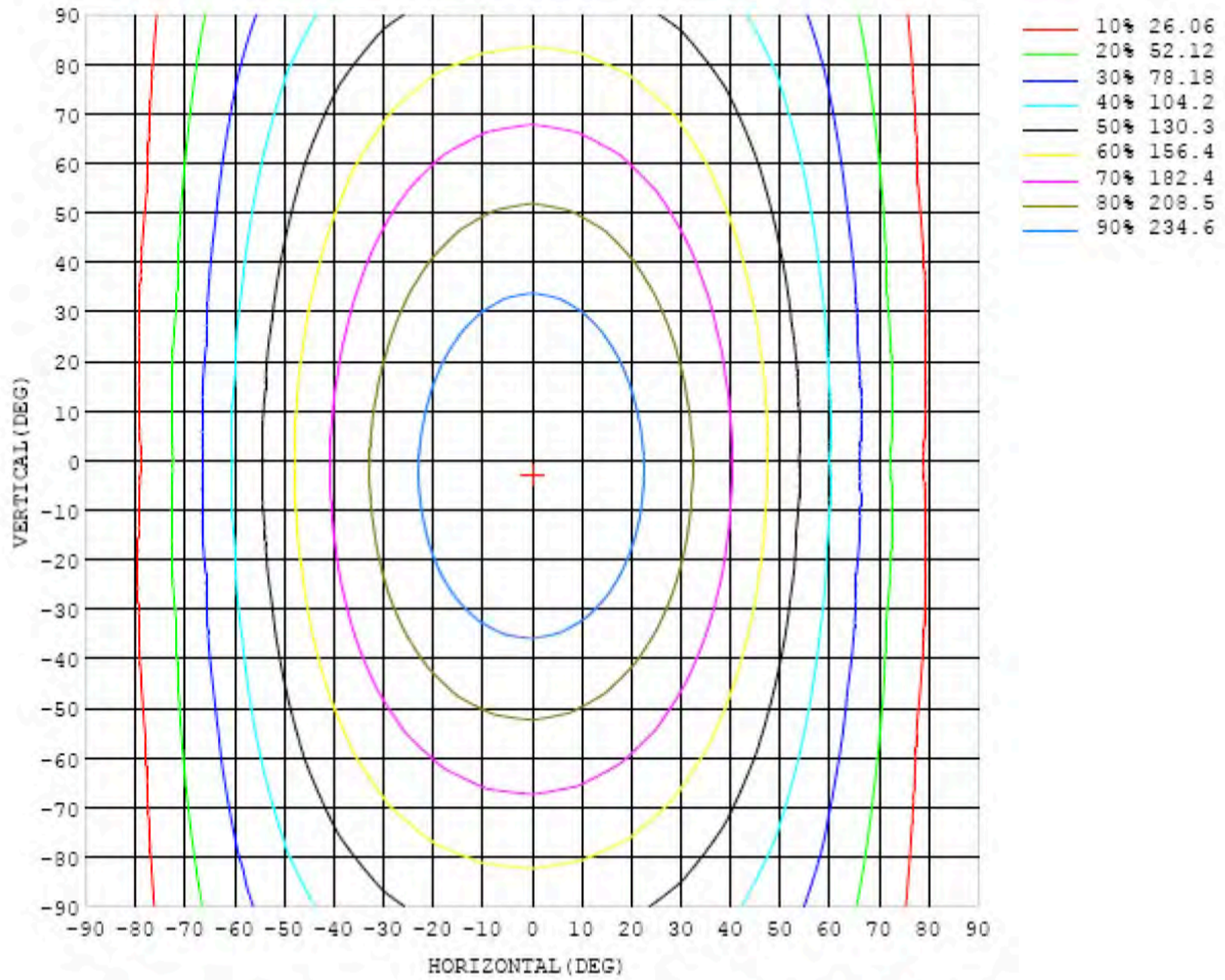


Chart 6: Isocandela Plot

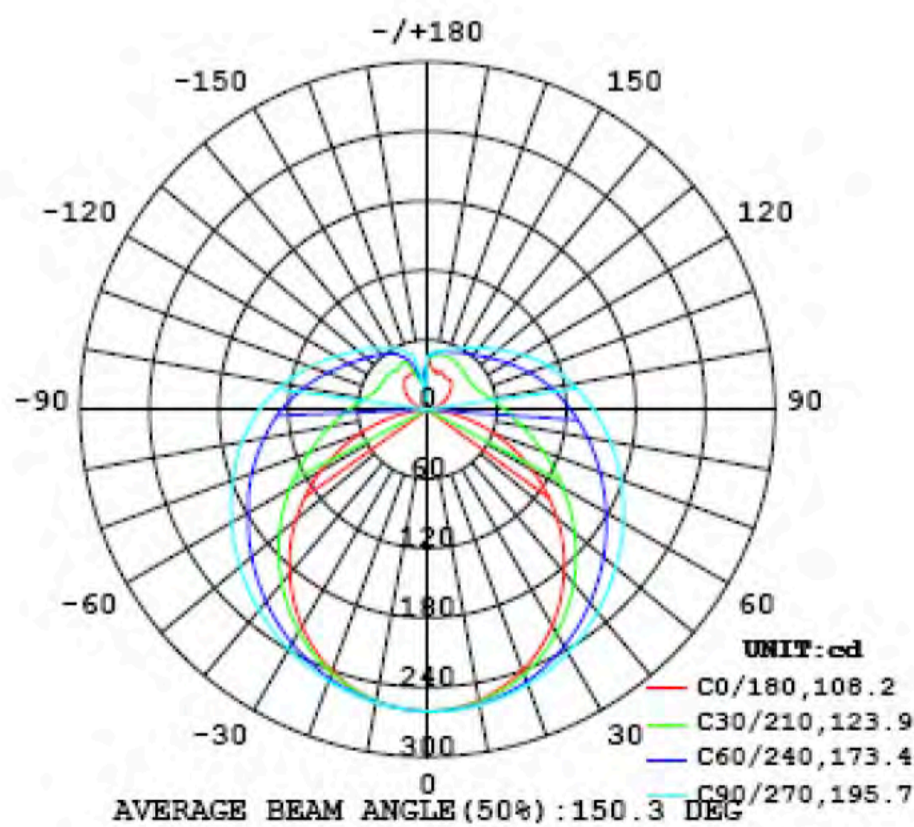


Chart 7: Polar Candela Distribution

**Luminous Intensity Data- Goniophotometer Method**

Table--1 UNIT: cd

C (DEG) γ (DEG)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
0	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260
5	259	259	259	260	260	260	260	260	260	260	260	260	260	260	260	260	260	259	259
10	255	255	256	257	257	258	258	259	259	259	259	259	259	258	257	257	256	256	256
15	249	249	250	251	252	254	255	256	257	257	257	256	255	254	253	252	251	250	249
20	240	241	242	244	246	248	250	252	253	253	253	252	250	249	246	244	243	241	241
25	229	229	231	234	237	241	244	246	248	248	248	247	244	242	238	235	232	231	230
30	216	216	219	223	227	232	236	240	242	243	242	240	237	233	229	224	220	218	217
35	200	202	205	210	216	222	228	232	235	236	235	233	229	224	218	212	207	203	202
40	183	185	190	196	204	212	218	224	227	228	228	225	220	213	206	198	191	187	185
45	166	167	173	182	191	200	209	215	219	221	220	216	210	202	193	184	175	170	168
50	146	148	156	166	178	189	198	206	211	212	211	207	200	191	180	168	158	151	148
55	125	128	138	150	164	177	188	197	202	204	203	198	190	180	167	153	140	131	128
60	104	108	120	135	151	166	178	187	193	195	194	189	180	169	154	138	122	111	106
65	82.7	87.9	102	120	139	155	168	178	184	187	185	180	171	158	142	123	104	90.0	84.5
70	61.7	68.6	85.4	106	127	144	159	169	175	178	176	171	161	147	130	109	87.9	70.2	62.6
75	41.0	49.7	70.7	93.9	116	135	149	160	167	169	168	162	152	137	119	96.9	72.6	51.3	41.4
80	22.3	33.3	57.6	82.9	106	125	140	151	158	160	159	153	143	128	109	86.1	60.3	35.0	22.2
85	7.85	20.8	47.3	74.1	97.1	117	132	143	149	152	150	145	134	120	100	76.9	50.2	22.6	7.16
90	1.22	13.9	40.1	66.5	89.3	109	124	134	141	143	142	136	126	111	92.5	69.8	43.0	16.1	0.61
95	1.83	11.4	35.4	60.4	82.4	101	116	126	133	135	134	128	118	104	85.6	63.7	38.2	13.7	1.40
100	4.30	11.9	32.0	55.3	76.6	94.1	108	118	125	127	126	120	111	97.0	79.3	58.5	34.9	13.8	3.64
105	7.61	13.9	30.3	50.9	70.7	87.3	101	111	117	119	117	112	103	90.1	73.9	54.1	33.0	15.7	6.83
110	11.4	17.1	30.1	47.5	65.7	81.9	93.5	103	108	111	109	104	95.6	83.5	68.5	50.6	32.9	18.7	10.5
115	15.3	20.6	30.9	45.5	61.0	75.2	86.4	95.1	100	102	101	96.6	88.5	77.7	63.8	48.4	33.7	22.2	14.4
120	19.4	24.3	32.3	44.5	57.5	69.9	80.2	87.8	92.7	94.6	93.4	89.1	81.8	72.1	60.1	47.2	35.1	25.8	18.4
125	23.2	28.0	34.3	44.1	55.0	65.5	74.3	80.8	85.2	87.0	86.0	82.1	76.1	67.5	57.4	46.7	36.8	29.3	22.0
130	26.7	31.4	36.5	44.2	53.2	62.0	69.5	75.3	78.8	80.0	79.2	76.4	71.0	63.8	55.5	46.7	38.5	32.7	25.3
135	29.7	34.7	38.8	44.7	52.0	59.2	65.4	70.2	73.3	74.6	73.9	71.2	66.8	60.8	54.0	46.9	40.4	35.8	28.5
140	31.9	37.5	41.1	45.5	51.1	56.9	61.9	65.9	68.4	69.5	68.9	66.7	63.1	58.3	52.8	47.2	42.2	38.1	30.9
145	32.0	40.0	43.2	46.4	50.7	55.1	59.0	62.1	64.2	65.0	64.5	62.8	59.9	56.2	51.9	47.6	43.8	40.5	33.2
150	31.5	41.2	44.9	47.4	50.4	53.6	56.6	58.9	60.4	61.1	60.7	59.4	57.3	54.4	51.2	48.0	45.2	41.0	33.2
155	33.2	43.6	46.3	48.2	50.3	52.5	54.5	56.2	57.3	57.8	57.5	56.6	55.0	53.0	50.7	48.5	46.0	39.4	33.5
160	34.4	43.2	46.8	48.9	50.2	51.6	52.9	54.0	54.7	55.0	54.8	54.2	53.2	51.9	50.4	48.3	45.4	42.6	34.6
165	31.8	44.1	46.9	48.7	50.2	50.9	51.6	52.2	52.6	52.8	52.7	52.3	51.8	51.0	49.7	47.5	43.2	37.0	31.4
170	34.2	42.5	46.7	47.7	48.6	49.8	50.7	50.9	51.1	51.1	51.1	50.9	50.7	50.1	48.2	44.8	40.2	34.2	29.8
175	36.9	41.4	44.0	46.0	47.3	47.7	48.1	48.4	48.6	48.8	48.8	48.8	49.2	49.1	46.8	42.1	36.1	31.1	27.6
180	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2

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	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260		
5	259	259	259	259	259	259	259	259	259	259	259	259	259	259	259	259	259		
10	255	255	256	256	256	257	257	257	257	257	257	257	256	256	255	255	255		
15	249	249	250	251	252	253	253	254	254	254	253	252	252	251	250	249	249		
20	240	241	242	244	246	247	249	249	250	249	249	247	245	244	242	240	240		
25	230	231	233	236	238	241	243	244	245	244	243	241	238	235	232	230	229		
30	217	219	222	226	230	234	237	239	239	238	236	233	229	225	221	218	216		
35	202	205	209	215	220	225	229	232	233	232	229	225	220	214	209	204	201		
40	186	190	196	203	210	217	222	225	226	225	222	217	210	202	195	189	185		
45	169	174	181	191	200	208	214	218	219	218	214	207	199	190	181	173	168		
50	150	157	167	178	189	198	205	210	211	210	205	198	188	177	166	156	149		
55	131	140	152	166	178	189	197	202	204	202	197	188	177	165	151	139	130		
60	110	122	137	153	168	179	188	194	195	193	188	179	167	153	136	121	109		
65	89.8	104	123	141	157	170	179	185	187	185	179	170	157	140	122	104	89.1		
70	69.7	87.5	109	129	147	161	171	177	179	177	171	161	147	129	108	86.9	69.3		
75	50.6	72.2	96.3	119	137	152	163	169	171	169	163	152	137	118	95.7	71.8	50.6		
80	34.0	59.1	85.3	109	128	143	154	160	163	160	154	143	128	108	84.8	58.8	34.3		
85	21.6	48.8	75.9	99.7	119	135	145	152	154	152	145	134	119	99.2	75.5	48.5	22.0		
90	14.8	41.4	68.0	91.5	111	126	137	143	145	143	136	125	110	91.0	67.6	41.1	15.2		
95	11.8	35.6	60.9	83.7	103	117	127	134	136	133	127	117	102	83.1	60.5	35.3	12.1		
100	12.2	32.0	55.0	76.4	94.4	108	118	124	126	124	118	108	93.9	75.9	54.5	31.5	12.1		
105	14.2	30.8	50.5	70.0	86.9	100	110	115	117	115	109	99.6	86.3	69.4	49.9	30.0	13.9		
110	17.2	31.0	47.7	64.6	79.9	92.2	101	106	108	106	101	91.7	79.3	63.9	46.7	30.0	16.9		
115	20.3	32.1	46.2	60.8	73.9	84.9	93.0	98.0	99.6	97.8	92.7	84.4	73.2	59.7	44.7	31.0	19.9		
120	22.6	33.4	45.4	57.8	69.3	78.8	85.8	90.1	91.5	89.9	85.4	78.2	68.5	56.7	43.9	32.8	23.0		
125	25.2	35.1	45.2	55.6	65.4	73.7	79.8	83.5	84.8	83.3	79.4	73.1	64.6	54.4	43.8	35.0	25.5		
130	28.2	37.2	45.2	54.0	62.2	69.3	74.5	77.8	78.8	77.5	74.1	68.7	61.4	52.8	44.3	37.1	27.5		
135	29.7	38.5	45.0	52.6	59.5	65.3	69.8	72.6	73.5	72.4	69.5	64.9	58.8	51.8	45.0	39.2	29.1		
140	30.2	39.5	43.7	50.3	57.0	61.8	65.6	67.9	68.7	67.8	65.3	61.6	56.7	51.1	45.7	41.0	29.6		
145	29.4	40.7	43.8	48.8	54.6	58.5	61.7	63.7	64.4	63.7	61.7	58.8	54.9	50.6	46.3	42.2	28.7		
150	27.9	40.8	45.3	45.8	50.7	55.7	57.9	59.9	60.6	60.0	58.5	56.4	53.5	50.0	47.2	42.7	26.0		
155	27.2	36.3	45.1	46.9	47.0	50.5	54.4	55.7	57.1	56.7	55.8	54.2	51.8	49.9	48.0	39.6	25.7		
160	26.3	27.9	35.1	40.5	42.5	43.7	46.7	49.7	51.7	53.1	52.6	52.0	50.8	49.3	43.2	30.1	25.2		
165	24.6	24.2	25.7	28.5	32.2	33.2	34.6	38.7	48.6	49.1	49.9	44.9	43.0	40.5	30.0	24.4	26.0		
170	25.2	23.9	23.5	23.0	25.8	28.5	30.9	26.9	12.6	30.4	33.8	31.5	28.3	23.9	23.9	24.6	26.0		
175	25.5	26.0	27.4	29.1	30.9	32.3	33.2	28.1	13.5	27.5	32.0	31.0	28.9	26.7	26.2	27.7	31.6		
180	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2		

Table 7: Luminous Intensity Data

## EQUIPMENT LIST

Test Equipment	Model	Equipment No.	Calibration Date	Calibration Due date
Goniophotometer system	GO-R5000	HZTE011-01	Aug. 05, 2020	Aug. 04, 2021
Digital Power Meter	PF2010A	HZTE028-01	Aug. 05, 2020	Aug. 04, 2021
AC Power Supply	DPS1060	HZTE001-06	Aug. 05, 2020	Aug. 04, 2021
DC Power Supply	WY12010	HZTE004-03	Aug. 05, 2020	Aug. 04, 2021
Temperature recorder	JM624U	HZTE018-08	Aug. 05, 2020	Aug. 04, 2021
Temperature and humidity recorder	JR900	HZTE018-01	Aug. 05, 2020	Aug. 04, 2021
Standard source	D908	HZTE012-01	Aug. 05, 2020	Aug. 04, 2021
Integrate Sphere system	3M	HZTE015-04	Aug. 05, 2020	Aug. 04, 2021
Digital Power Meter	WT210	HZTE008-01	Aug. 05, 2020	Aug. 04, 2021
AC Power Supply	PCR 500L	HZTE001-07	Aug. 05, 2020	Aug. 04, 2021
DC Power Supply	IT6154	HZTE004-04	Aug. 05, 2020	Aug. 04, 2021
Standard source	SCL-1400	HZTE012-02	Aug. 05, 2020	Aug. 04, 2021
Temperature and humidity recorder	JR900	HZTE018-02	Aug. 05, 2020	Aug. 04, 2021
Temperature Meter	TES1310	HZTE017-01	Aug. 05, 2020	Aug. 04, 2021

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 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**

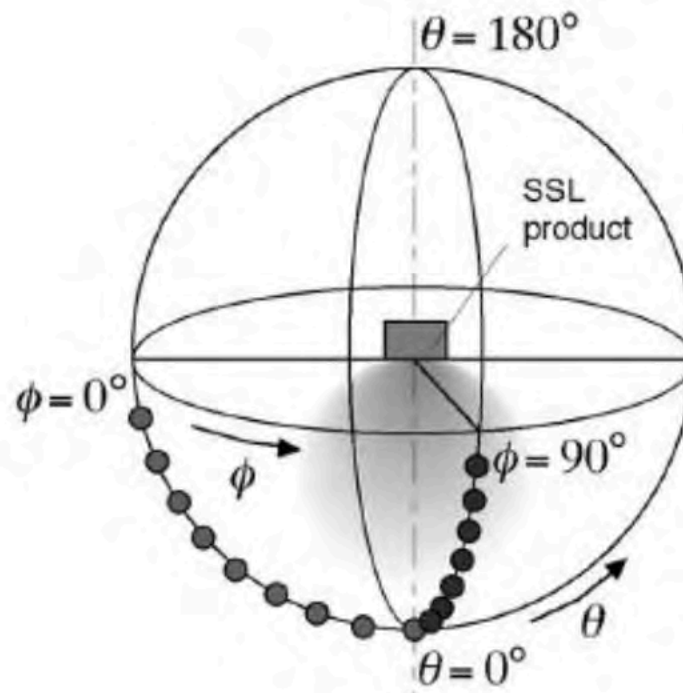
The color characteristics of SSL products include chromaticity coordinates, correlated color temperature, and color rendering index. These characteristics of SSL products may be spatially non-uniform, and thus, in order that they can be specified accurately, the color quantities shall be measured as 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  $10^\circ$  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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