



## LM-79-08 Test Report

for

### Philips Lighting (China) Investment Co., Ltd.

Building 9 #, Lane 888, Tianlin Road, Minhang District, Shanghai City.

### LED Tube

**Model: 9290013633A**

### 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.: HZ17120040e/R1

This report is replaced the old report No. HZ17120040e dated Dec. 18, 2017

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

Review by:

*April Zou*

Engineer: April Zou  
Mar. 07, 2018



Approved by:

*Jim Zhang*

Manager: Jim Zhang  
Mar. 07, 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: **9290013633A**

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)	Power Factor
141.0	2213.0	15.70	0.9820
CCT (K)	CRI	Stabilization Time (Light & Power)	
4093	83.1	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>	: Nov. 01, 2017
<b>Date of Test</b>	: Nov. 01, 2017
<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

## TABLE OF CONTENT

LM-79-08 Test Report.....	1
Test Summary.....	2
Sample Photo.....	4
TEST RESULTS .....	5
Goniophotometer Method .....	6
Spectral Power Distribution - Sphere Spectroradiometer Method .....	7
Chromaticity Diagram - Sphere Spectroradiometer Method.....	8
Nominal CCT Quadrangles – Sphere Spectroradiometer Method .....	9
Zonal Lumen Tabulation- Goniophotometer Method .....	10
Luminous Intensity Distribution Plots- Goniophotometer Method.....	12
Luminous Intensity Data- Goniophotometer Method.....	13
EQUIPMENT LIST .....	15
TEST METHODS .....	15
Seasoning of SSL Product.....	15
Sphere-Spectroradiometer Method- Photometric and Electrical Measurements.....	15
Goniophotometer Method .....	16
Photometric and Electrical Measurements.....	16
Color Characteristics Measurements.....	16
Color Spatial Uniformity .....	16

## Sample Photo



Sample view

### Equipment Under Test (EUT)

<b>Name</b>	: LED Tube
<b>Model</b>	: 9290013633A
<b>Electrical Ratings</b>	: 120-277V, 60HZ
<b>Product Description</b>	: 16.5T8PRO/48-840/BB21/G 10/1 FB
<b>Manufacturer</b>	: Philips Lighting (China) Investment Co., Ltd.
<b>Address</b>	: Building 9 #, Lane 888, Tianlin Road, Minhang District, Shanghai City

## 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	277.0
Voltage frequency (Hz)	60	60
Test Current (A)	0.133	0.059
Power Factor	0.9820	0.9811
Test Power (W)	15.70	15.89
THD A%	17.72	11.85
Luminous Efficacy (lm/W)	141.0	139.6
Total Luminous Flux (lm)	2213.0	2219.0
Color Rendering Index (CRI)	83.1	
R9	6.3	
Correlated Color Temperature (CCT)(K)	4093	
Chromaticity Chroma x	0.3768	
Chromaticity Chroma y	0.3762	
Chromaticity Chroma u	0.2230	
Chromaticity Chroma v	0.3339	
Duv	0.0003	
Chromaticity Chroma u'	0.2230	
Chromaticity Chroma v'	0.5008	

Special Color Rendering Indices	
R1	81.5
R2	91.7
R3	95.6
R4	79.8
R5	81.5
R6	87.8
R7	84.4
R8	62.6
R9	6.3
R10	79.8
R11	78.5
R12	63.6
R13	84.4
R14	98.1
Rf	82
Rg	93

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 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)	0.134
Power Factor	0.9757
Power (W)	15.74
Luminous Efficacy (lm/W)	140.5
Total Luminous Flux (lm)	2211.7
Beam Angle (°)	111.8 (0°-180°) / 183.8 (90°-270°)
Center Beam Candle Power (cd)	415
Maximum Beam Candle Power (cd)	416.1 (At: C=350.0, Gamma=1.5)
Spacing Criteria	1.25 (0°-180°) / 1.38 (90°-270°)
Zonal Lumens in the 0°-60°Zone	46.93%
Zonal Lumens in the 60°-90°Zone	26.50%
Zonal Lumens in the 90°-120°Zone	15.54%
Zonal Lumens in the 120°-180°Zone	11.04%

Table 3: Test data per Goniophotometer Method

## Spectral Power Distribution - Sphere Spectroradiometer Method

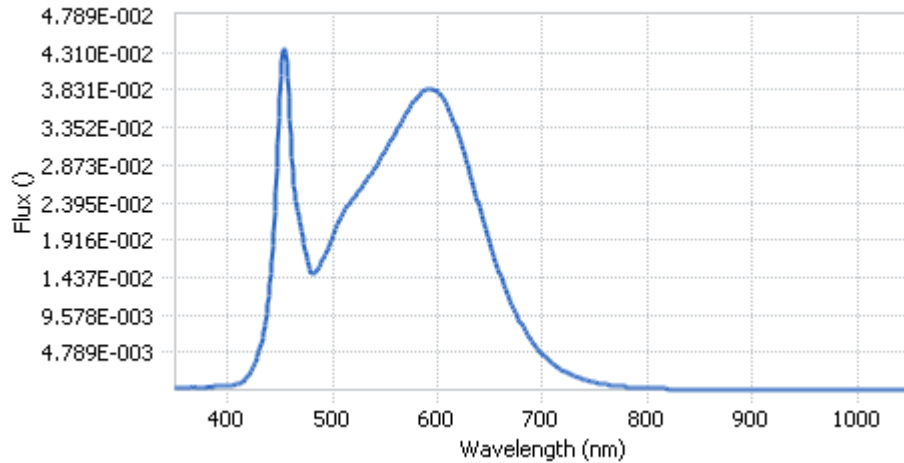
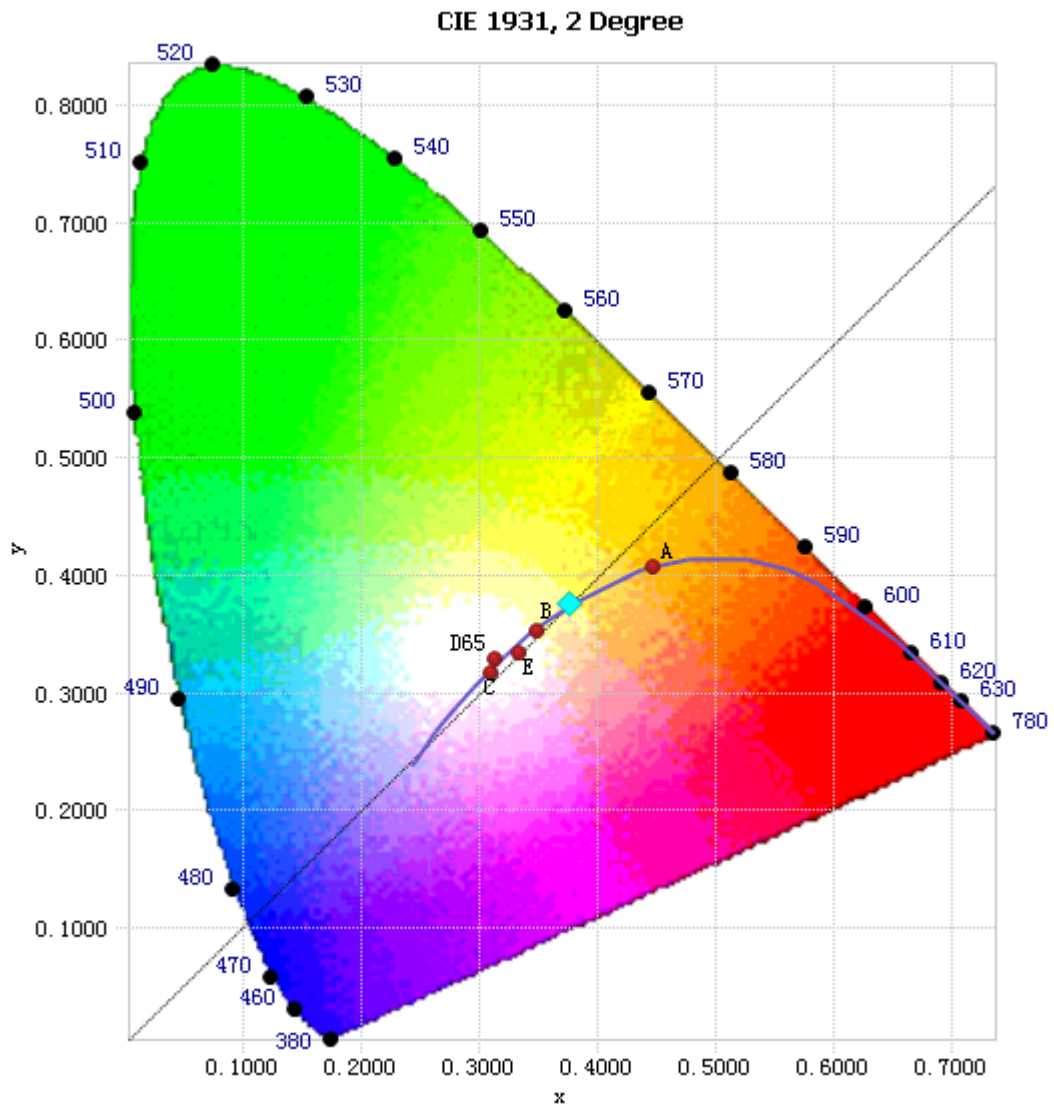


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	3.98E-04	485	1.53E-02	590	3.84E-02	695	5.30E-03
385	3.88E-04	490	1.66E-02	595	3.85E-02	700	4.55E-03
390	4.30E-04	495	1.79E-02	600	3.80E-02	705	3.91E-03
395	4.78E-04	500	1.97E-02	605	3.73E-02	710	3.33E-03
400	4.98E-04	505	2.14E-02	610	3.60E-02	715	2.86E-03
405	5.91E-04	510	2.26E-02	615	3.44E-02	720	2.44E-03
410	7.89E-04	515	2.36E-02	620	3.24E-02	725	2.09E-03
415	1.17E-03	520	2.45E-02	625	3.04E-02	730	1.79E-03
420	1.92E-03	525	2.54E-02	630	2.81E-02	735	1.53E-03
425	3.13E-03	530	2.63E-02	635	2.57E-02	740	1.31E-03
430	4.97E-03	535	2.73E-02	640	2.33E-02	745	1.12E-03
435	8.17E-03	540	2.84E-02	645	2.09E-02	750	9.58E-04
440	1.35E-02	545	2.94E-02	650	1.87E-02	755	8.33E-04
445	2.29E-02	550	3.06E-02	655	1.65E-02	760	7.12E-04
450	3.73E-02	555	3.18E-02	660	1.46E-02	765	6.08E-04
455	4.32E-02	560	3.29E-02	665	1.28E-02	770	5.26E-04
460	3.22E-02	565	3.41E-02	670	1.11E-02	775	4.62E-04
465	2.41E-02	570	3.52E-02	675	9.65E-03	780	4.00E-04
470	2.08E-02	575	3.64E-02	680	8.34E-03		
475	1.70E-02	580	3.73E-02	685	7.21E-03		
480	1.49E-02	585	3.81E-02	690	6.18E-03		

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

## Chromaticity Diagram - Sphere Spectroradiometer Method



Tristimulus values(x, y): (0.3768, 0.3762)

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

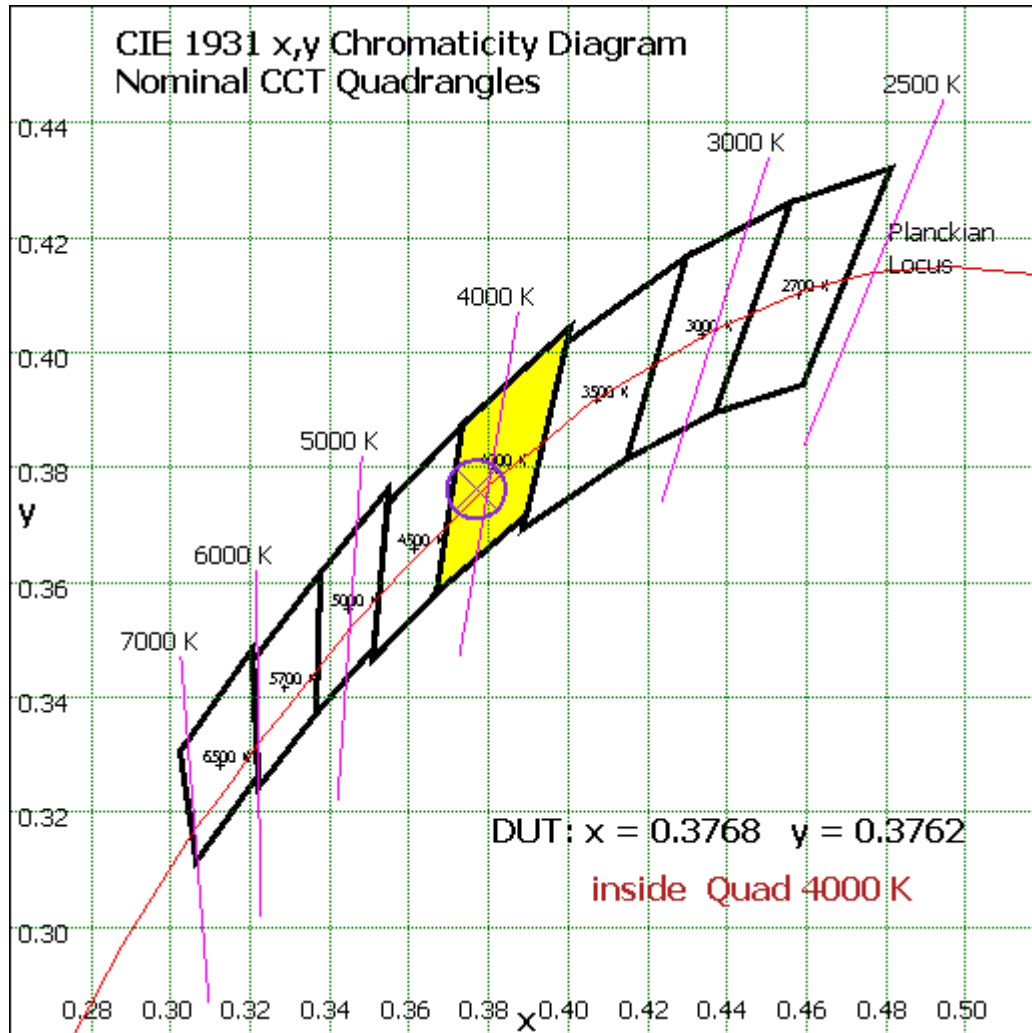


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

### Zonal Lumen Tabulation- Goniophotometer Method

$\gamma(^{\circ})$	Lumens	% Total
0- 10	39.409	1.78%
10- 20	113.993	5.15%
20- 30	176.423	7.98%
30- 40	220.651	9.98%
40- 50	243.271	11.00%
50- 60	244.092	11.04%
60- 70	226.376	10.24%
70- 80	196.373	8.88%
80- 90	163.382	7.39%
90-100	135.823	6.14%
100-110	113.359	5.13%
110-120	94.419	4.27%
120-130	77.797	3.52%
130-140	62.395	2.82%
140-150	47.589	2.15%
150-160	32.76	1.48%
160-170	17.776	0.80%
170-180	5.807	0.26%
Total	2211.7	100%

$\gamma(^{\circ})$	Lumens	% Total
0- 60	1037.839	46.93%
60- 90	586.131	26.50%
0-90	1623.97	73.43%
90- 180	587.725	26.57%
0- 180	2211.7	100%

Table 5: Zonal Lumen Data

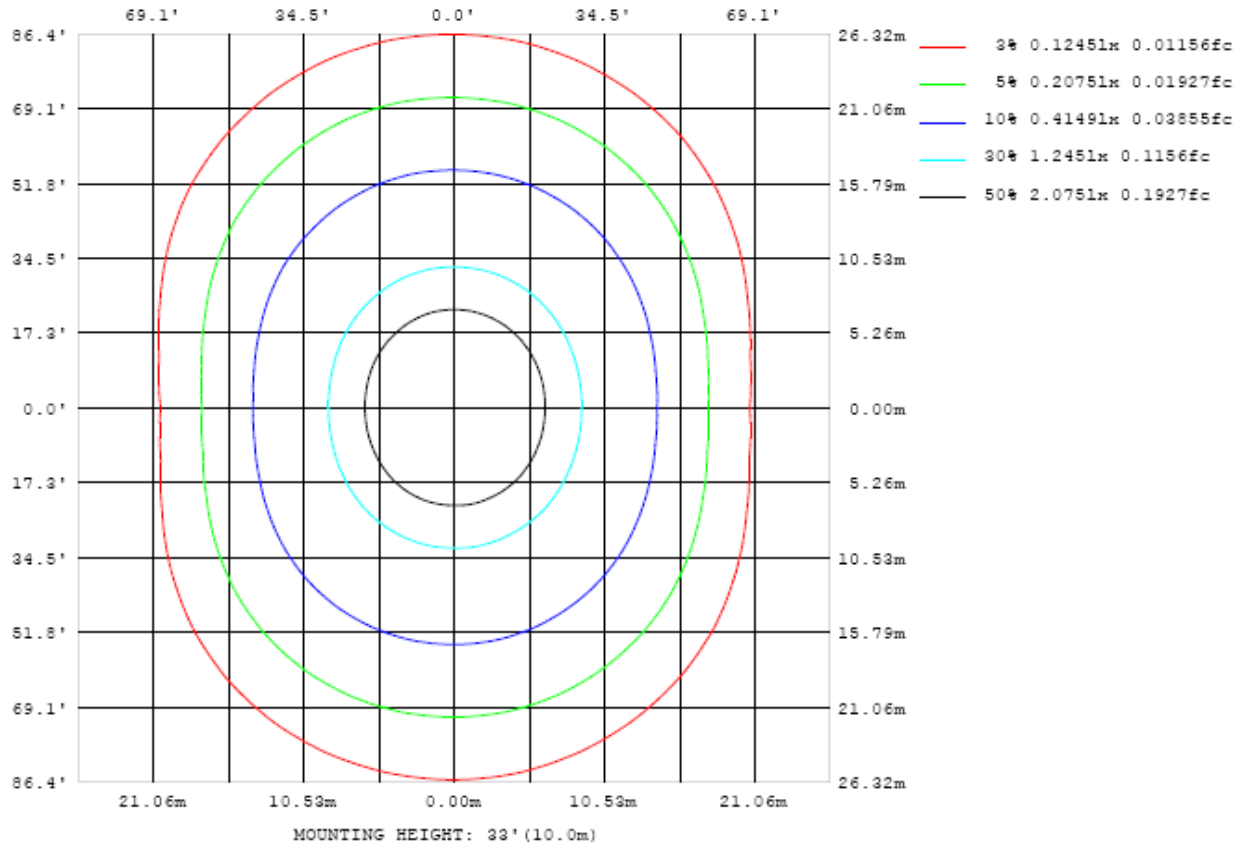


Chart 4: Illuminance Plot (Footcandles)

## Luminous Intensity Distribution Plots- Goniophotometer Method

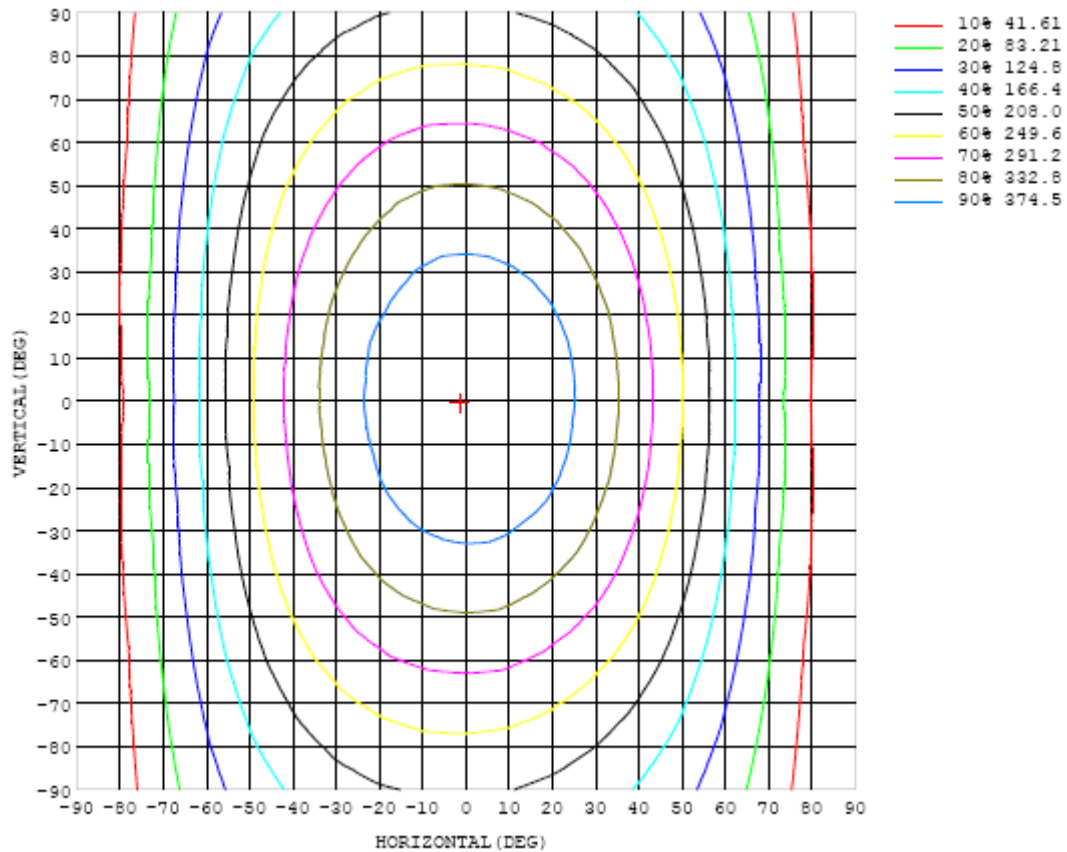


Chart 5: Isocandela Plot

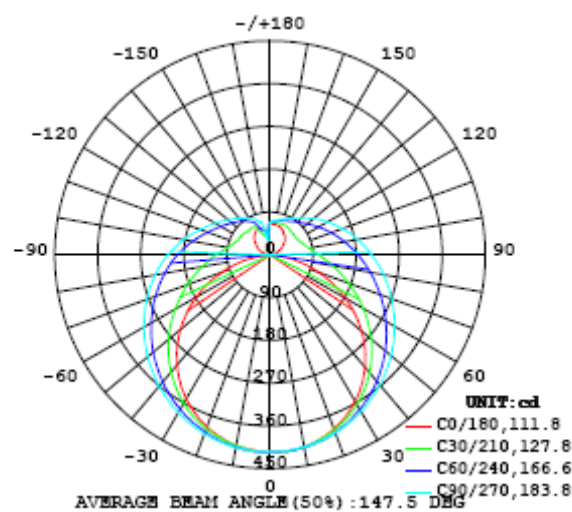


Chart 6: Polar Candela Distribution

## 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	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415
5	416	415	414	416	414	416	415	414	414	414	415	413	413	413	413	412	412	412	412
10	410	410	411	410	410	410	411	413	412	410	411	411	409	409	409	409	408	407	408
15	402	401	402	403	404	405	407	405	406	405	405	405	404	402	400	399	399	398	397
20	391	390	391	393	395	397	399	398	400	399	398	397	396	393	390	388	386	386	386
25	375	374	376	380	382	385	388	388	391	390	390	389	385	382	378	374	371	370	369
30	356	356	359	363	367	373	375	378	381	380	379	378	374	369	363	358	353	350	350
35	334	335	339	345	351	357	362	366	369	369	368	366	361	355	347	340	332	328	327
40	308	310	316	323	332	341	347	353	357	357	356	352	347	339	329	319	310	304	302
45	281	283	290	300	313	323	332	339	343	344	343	339	332	322	309	296	284	277	275
50	250	252	262	276	290	304	315	323	329	330	329	324	316	304	289	273	258	247	244
55	217	221	234	250	269	285	297	307	315	316	314	309	300	286	269	249	230	216	212
60	181	187	204	224	246	265	280	291	299	300	299	293	283	267	248	225	202	184	177
65	145	153	174	199	224	246	263	275	284	286	285	278	267	250	227	201	173	150	143
70	108	119	145	175	204	227	245	259	268	271	269	262	251	232	208	178	145	117	106
75	72.4	86.2	118	153	184	209	228	243	252	255	255	247	235	216	190	157	120	85.4	70.8
80	39.5	57.9	94.7	133	166	193	213	228	238	240	240	233	220	200	173	138	97.6	57.5	37.6
85	13.1	35.6	76.0	116	150	177	198	213	223	227	225	219	206	186	158	122	80.0	36.3	11.3
90	0.32	22.7	62.9	102	136	163	184	199	209	213	212	205	193	172	145	109	67.8	24.7	0.34
95	2.19	18.3	54.5	91.5	124	150	170	186	196	199	198	192	179	160	133	98.8	60.1	21.2	2.46
100	5.63	18.3	49.3	82.7	114	138	158	173	183	186	186	179	167	148	123	90.7	55.2	21.9	6.77
105	10.3	21.5	46.2	76.3	105	128	147	161	170	174	173	167	155	137	114	84.1	52.6	25.5	12.4
110	15.7	25.7	45.6	71.8	97.0	119	136	149	158	161	161	155	144	127	105	79.2	52.0	30.2	18.5
115	21.5	30.7	46.6	68.3	90.5	110	126	139	147	150	149	144	134	118	98.6	75.8	53.2	35.8	24.8
120	27.1	35.9	48.7	66.1	85.2	102	117	128	136	139	138	133	124	110	92.7	73.5	55.1	40.9	30.5
125	32.7	40.9	51.1	65.1	81.0	95.9	109	119	126	128	128	123	115	103	87.9	72.3	57.7	45.5	35.5
130	38.3	45.6	54.1	65.1	77.8	90.2	102	110	116	119	118	114	107	96.6	84.3	71.7	60.3	50.4	40.7
135	44.0	50.0	56.8	66.0	76.1	85.5	94.9	102	108	110	109	106	99.5	91.4	81.7	71.6	62.8	54.6	46.4
140	48.8	52.7	59.5	67.0	74.5	82.2	89.5	95.7	99.7	102	101	98.4	93.7	87.3	79.6	72.0	65.0	57.5	51.2
145	51.3	56.3	62.5	68.0	73.5	79.5	85.3	90.1	93.5	94.7	94.4	92.5	88.9	83.9	78.2	72.4	67.3	59.7	55.0
150	56.2	59.5	64.3	69.0	72.9	77.4	81.8	85.5	88.0	88.9	88.9	87.2	84.6	81.0	76.7	72.7	68.3	62.2	58.5
155	59.0	62.3	65.4	69.6	72.6	75.7	78.9	81.6	83.4	84.0	84.1	83.0	81.0	78.6	76.0	72.6	68.7	64.5	62.0
160	62.9	64.5	66.7	69.3	72.0	74.6	76.6	78.4	79.7	80.2	80.0	79.5	78.3	76.9	74.7	72.2	68.7	62.9	58.9
165	64.2	66.7	67.7	69.3	71.2	72.8	74.7	76.0	76.7	77.0	77.0	76.6	75.9	74.9	73.1	71.5	67.4	61.2	55.6
170	64.5	66.4	67.6	69.0	69.8	70.7	71.6	72.7	73.4	73.6	73.7	73.5	72.9	72.3	71.5	69.1	63.5	57.5	52.4
175	64.6	65.8	67.7	69.0	69.7	70.1	70.6	70.7	70.2	69.8	69.8	69.9	70.0	70.0	69.6	67.7	63.7	58.5	53.9
180	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3

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	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415		
5	413	413	413	414	414	415	415	414	414	414	414	415	415	415	414	415	415		
10	408	408	408	408	409	411	412	412	412	412	412	411	411	412	411	410	412		
15	400	400	400	400	403	406	407	408	407	406	407	406	406	405	404	403	403		
20	386	388	390	392	394	397	400	401	400	401	400	399	398	395	394	392	391		
25	370	373	377	378	383	387	390	393	392	392	392	389	388	384	381	378	376		
30	351	355	361	365	370	375	380	383	383	383	381	378	374	369	365	361	358		
35	330	334	342	349	356	362	369	372	373	372	369	365	360	353	346	341	336		
40	305	312	322	331	340	349	356	360	360	359	356	351	343	334	326	317	311		
45	278	287	300	313	324	334	342	347	347	346	343	335	326	315	302	292	284		
50	250	261	277	293	306	319	328	333	334	332	327	319	307	293	279	264	255		
55	219	233	253	273	289	303	313	319	320	317	311	301	288	272	253	236	222		
60	186	205	229	253	272	286	298	305	305	302	295	284	269	250	228	206	189		
65	153	177	206	233	254	271	283	289	289	286	278	267	250	228	203	176	155		
70	120	150	183	213	237	255	267	274	274	271	262	250	231	207	179	148	120		
75	88.3	125	163	195	220	239	252	260	259	256	247	233	213	188	157	121	87.6		
80	59.8	103	144	178	204	223	237	243	244	240	231	217	196	170	137	98.0	58.9		
85	38.8	84.4	127	163	189	208	221	229	229	225	215	201	180	154	120	79.0	36.7		
90	26.5	70.8	113	148	174	193	207	213	214	210	200	186	165	139	105	64.8	23.9		
95	21.4	60.3	100	135	160	179	191	198	198	194	185	171	152	125	92.0	54.0	18.2		
100	21.6	54.1	89.7	122	147	164	177	183	183	179	171	157	138	112	81.3	47.6	18.2		
105	24.7	51.9	82.3	111	134	151	163	169	169	165	157	144	125	101	73.8	45.2	21.5		
110	28.8	51.7	77.7	103	123	139	150	156	156	152	144	132	114	93.2	68.9	45.0	25.4		
115	32.5	53.0	74.7	96.3	115	128	138	143	144	140	133	122	106	87.1	66.3	46.7	29.4		
120	35.8	54.3	73.0	91.2	107	119	128	133	133	130	123	113	99.2	82.8	65.2	49.0	32.7		
125	38.8	56.1	71.8	87.3	101	112	119	123	124	121	115	106	93.8	79.6	65.2	51.8	35.3		
130	40.8	57.9	70.6	84.2	95.5	104	111	115	115	113	107	99.6	89.3	77.5	65.3	54.2	37.0		
135	42.1	59.1	69.0	80.5	91.2	98.5	104	107	107	106	101	94.3	85.7	76.2	65.5	56.3	37.2		
140	42.5	60.7	68.4	77.3	85.7	93.3	97.7	101	100	98.9	95.1	89.7	82.6	74.5	65.8	56.5	35.0		
145	44.7	59.2	68.6	74.1	81.4	87.7	92.1	94.5	94.5	93.1	90.1	85.7	79.8	72.9	66.2	53.2	38.5		
150	48.5	54.4	68.2	71.8	76.5	81.0	85.7	88.7	88.8	87.9	85.6	81.8	77.1	72.7	65.5	49.9	45.4		
155	53.7	47.1	58.8	65.3	67.7	73.3	78.4	80.3	82.9	82.3	80.9	78.4	75.6	72.9	57.6	40.3	48.5		
160	53.6	45.8	46.8	52.3	55.8	58.5	61.8	72.3	76.2	78.1	77.3	75.0	73.4	64.8	43.3	38.7	51.8		
165	51.1	43.4	42.8	43.4	45.5	52.2	54.2	47.1	71.3	73.3	70.9	65.1	51.3	39.7	35.1	40.3	54.8		
170	52.0	50.4	47.2	44.4	49.4	53.6	56.4	58.3	31.6	56.7	54.1	51.8	48.6	43.9	44.5	50.6	60.5		
175	49.8	47.1	46.6	47.2	47.7	47.2	43.8	33.9	51.6	51.6	53.7	53.2	52.9	55.1	59.8	62.2	63.5		
180	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3		

Table 7: Luminous Intensity Data

## EQUIPMENT LIST

Test Equipment	Model	Equipment No.	Calibration Date	Calibration Due date
Goniophotometer system	GO-R5000	HZTE011-01	Aug. 23, 2017	Aug. 22, 2018
Digital Power Meter	PF2010A	HZTE028-01	Aug. 10, 2017	Aug. 09, 2018
AC Power Supply	DPS1060	HZTE001-06	Aug. 10, 2017	Aug. 09, 2018
DC Power Supply	WY12010	HZTE004-03	Aug. 10, 2017	Aug. 09, 2018
Temperature recorder	JM624U	HZTE018-08	Aug. 17, 2017	Aug. 16, 2018
Temperature and humidity recorder	JR900	HZTE018-01	Aug. 16, 2017	Aug. 15, 2018
Standard source	D908	HZTE012-01	Aug. 20, 2017	Aug. 19, 2018
Integrate Sphere system	2M	HZTE015-01	Aug. 23, 2017	Aug. 22, 2018
Digital Power Meter	WT210	HZTE008-01	Aug. 10, 2017	Aug. 09, 2018
AC Power Supply	PCR 500L	HZTE001-07	Aug. 10, 2017	Aug. 09, 2018
DC Power Supply	IT6154	HZTE004-04	Aug. 10, 2017	Aug. 09, 2018
Standard source	SCL-1400	HZTE012-02	Aug. 20, 2017	Aug. 19, 2018
Temperature and humidity recorder	JR900	HZTE018-02	Aug. 16, 2017	Aug. 15, 2018
Temperature Meter	TES1310	HZTE017-01	Aug. 17, 2017	Aug. 16, 2018

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 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 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 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 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.

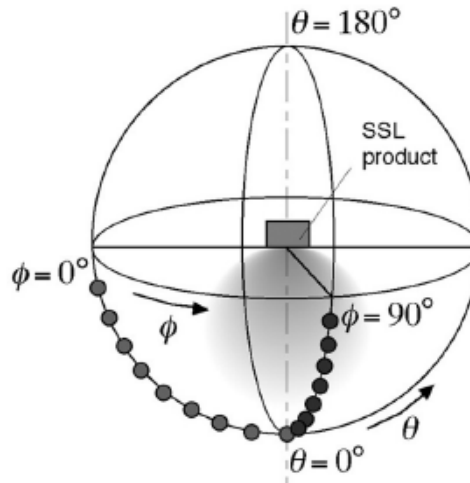
### **Color Spatial Uniformity**

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 \*\*\*

This report is considered invalidated without the Special Seal for Inspection of the LTL. This report shall not be altered, increased or deleted. The results shown in this test report refer only to the sample(s) tested. Without written approval of LTL, this test report shall not be copied except in full and published as advertisement.