LM-79-08 Test Report

for

PQL INC.

2285 WARD AVENUE SIMI VALLEY, CA 93065

LED Tube

Model: 90729

Laboratory: Leading Testing Laboratories

NVLAP CODE: 200960-0

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Report No.: HZ18120028d/R1

This report is replaced the old report No. HZ18120028d dated Dec. 24, 2018

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

Review by: April Zou

Engineer: April Zou
Dec. 25, 2018

Approved by: Jim Zhang

Manager: Jim Zhang
Dec. 25, 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: **90729**

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)/2	Power Factor
130.7	1567.0	11.99	0.9966

CCT (K)	CRI	Stabilization Time (Light & Power)
5046	83.9	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	: Dec. 19, 2018
Date of Test	: Dec. 20, 2018
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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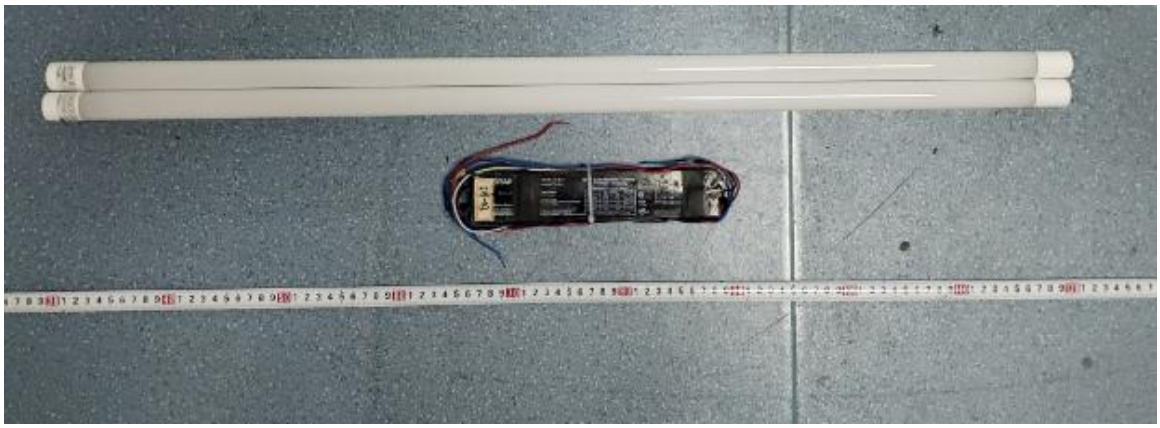
Sample Photo



Sample view

Equipment Under Test (EUT)	
Name	: LED Tube
Model	: 90729
Electrical Ratings	: 120-277V, 50/60HZ, 12W
Product Description	: 5000K LED Tubes supplied by a high frequency fluorescent lamp ballast: QTP 2x32T8/UNV ISN-SC
Manufacturer	: PQL INC.
Address	: 2285 WARD AVENUE SIMI VALLEY, CA 93065

TEST RESULTS

Test ambient temperature was 26.0℃.

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)	0.201	0.094
Power Factor	0.9966	0.9433
Test Power (W)/2	11.99	12.25
THD A%	4.80	17.73
Luminous Efficacy (lm/W)	130.7	128.0
Total Luminous Flux (lm)	1567.0	1567.0
Color Rendering Index (CRI)	83.9	
R9	7	
Correlated Color Temperature (CCT)(K)	5046	
Chromaticity Chroma x	0.3441	
Chromaticity Chroma y	0.3550	
Chromaticity Chroma u	0.2094	
Chromaticity Chroma v	0.3241	
Duv	0.0014	
Chromaticity Chroma u ’	0.2094	
Chromaticity Chroma v’	0.4862	

Special Color Rendering Indices	
R1	82.1
R2	90.1
R3	94.6
R4	83
R5	83
R6	85.7
R7	86.4
R8	66.4
R9	7
R10	76.2
R11	82.5
R12	65.3
R13	84.4
R14	97.4

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℃.

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)	0.201
Power Factor	0.9959
Power (W)/2	12.03
Luminous Efficacy (lm/W)	128.4
Total Luminous Flux (lm)	1543.4
Beam Angle (°)	109.4（0^o-180^o）/ 204.9 (90^o-270^o)
Center Beam Candle Power (cd)	277
Maximum Beam Candle Power (cd)	277.4 (At: C=80.0, Gamma=2.0)
Spacing Criteria	1.24（0^o-180^o）/1.38 (90^o-270^o)
Zonal Lumens in the 0 °-60 °Zone	44.90%
Zonal Lumens in the 60 °-90 °Zone	26.65%
Zonal Lumens in the 90 °-120 °Zone	16.79%
Zonal Lumens in the 120 °-180 °Zone	11.67%

Table 3: Test data per Goniophotometer Method

Spectral Power Distribution - Sphere Spectroradiometer Method

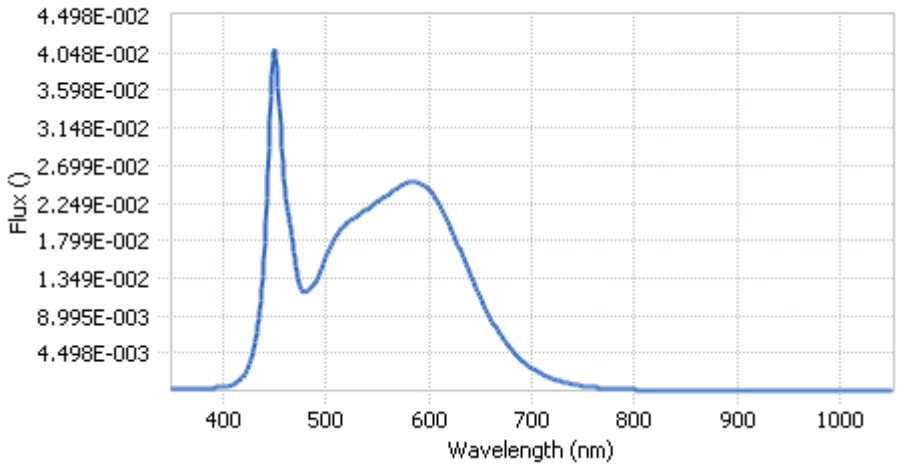
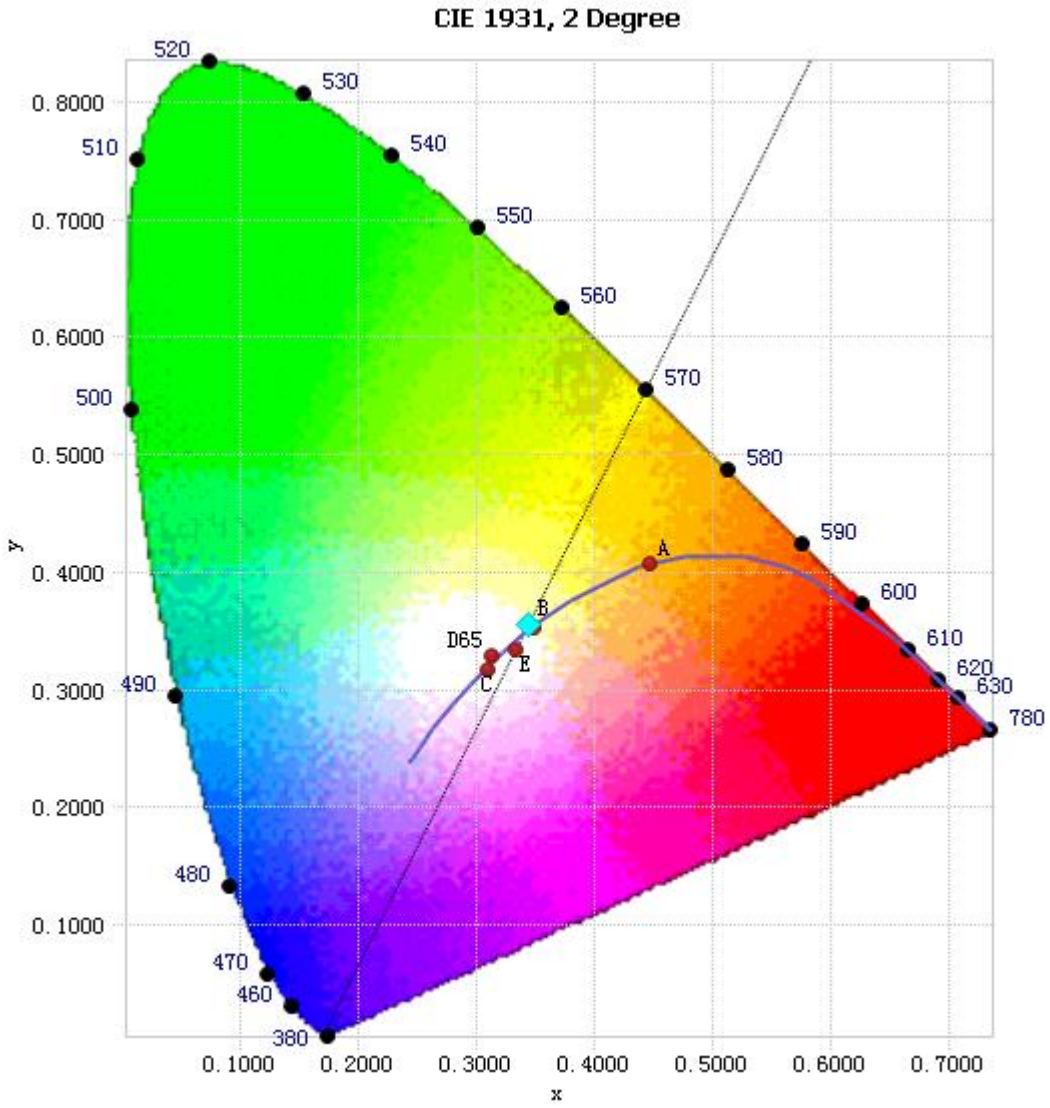


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	3.25E-04	485	1.22E-02	590	2.49E-02	695	3.18E-03
385	3.23E-04	490	1.31E-02	595	2.46E-02	700	2.72E-03
390	3.69E-04	495	1.45E-02	600	2.41E-02	705	2.33E-03
395	3.99E-04	500	1.60E-02	605	2.33E-02	710	1.98E-03
400	4.38E-04	505	1.74E-02	610	2.23E-02	715	1.70E-03
405	5.42E-04	510	1.84E-02	615	2.12E-02	720	1.46E-03
410	7.44E-04	515	1.94E-02	620	1.99E-02	725	1.25E-03
415	1.10E-03	520	2.00E-02	625	1.85E-02	730	1.07E-03
420	1.78E-03	525	2.05E-02	630	1.70E-02	735	9.11E-04
425	3.02E-03	530	2.09E-02	635	1.56E-02	740	7.79E-04
430	5.15E-03	535	2.13E-02	640	1.41E-02	745	6.70E-04
435	8.74E-03	540	2.18E-02	645	1.26E-02	750	5.74E-04
440	1.56E-02	545	2.22E-02	650	1.12E-02	755	4.94E-04
445	2.92E-02	550	2.26E-02	655	9.96E-03	760	4.26E-04
450	4.06E-02	555	2.31E-02	660	8.75E-03	765	3.66E-04
455	3.40E-02	560	2.34E-02	665	7.65E-03	770	3.15E-04
460	2.41E-02	565	2.40E-02	670	6.64E-03	775	2.75E-04
465	2.01E-02	570	2.44E-02	675	5.77E-03	780	2.40E-04
470	1.58E-02	575	2.47E-02	680	4.98E-03		
475	1.26E-02	580	2.49E-02	685	4.31E-03		
480	1.18E-02	585	2.50E-02	690	3.70E-03		

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

Chromaticity Diagram - Sphere Spectroradiometer Method



Tristimulus values(x, y): (0.3441, 0.3550)

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

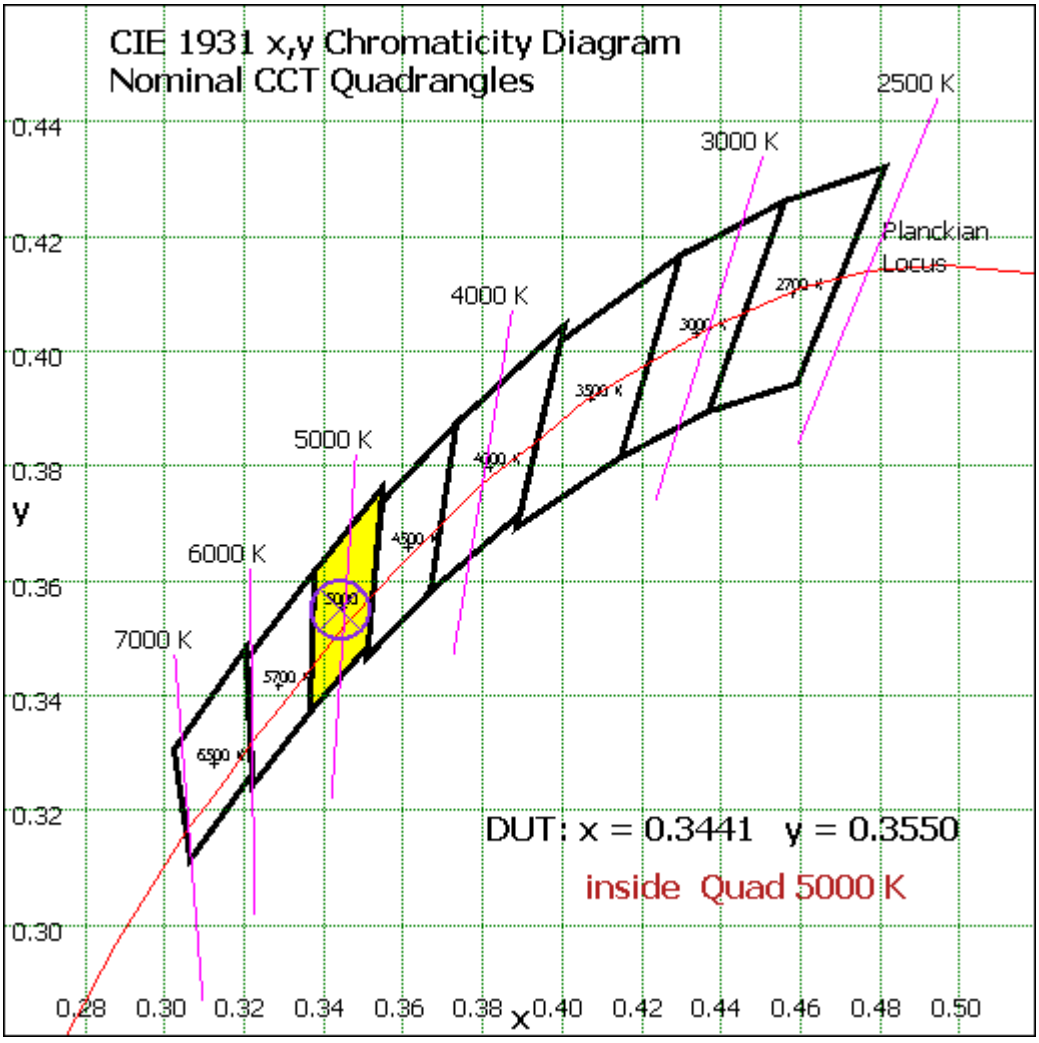


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

Zonal Lumen Tabulation- Goniophotometer Method

γ(°)	Lumens	% Total
0- 10	26.281	1.70%
10- 20	75.928	4.92%
20- 30	117.372	7.60%
30- 40	146.758	9.51%
40- 50	162.292	10.52%
50- 60	164.309	10.65%
60- 70	154.85	10.03%
70- 80	137.842	8.93%
80- 90	118.602	7.68%
90-100	101.768	6.59%
100-110	86.025	5.57%
110-120	71.309	4.62%
120-130	57.839	3.75%
130-140	45.817	2.97%
140-150	34.862	2.26%
150-160	24.382	1.58%
160-170	13.559	0.88%
170-180	3.62	0.23%
Total	1543.4	100%

γ(°)	Lumens	% Total
0- 60	692.94	44.90%
60- 90	411.294	26.65%
0-90	1104.234	71.54%
90- 180	439.181	28.46%
0- 180	1543.4	100%

Table 5: Zonal Lumen Data

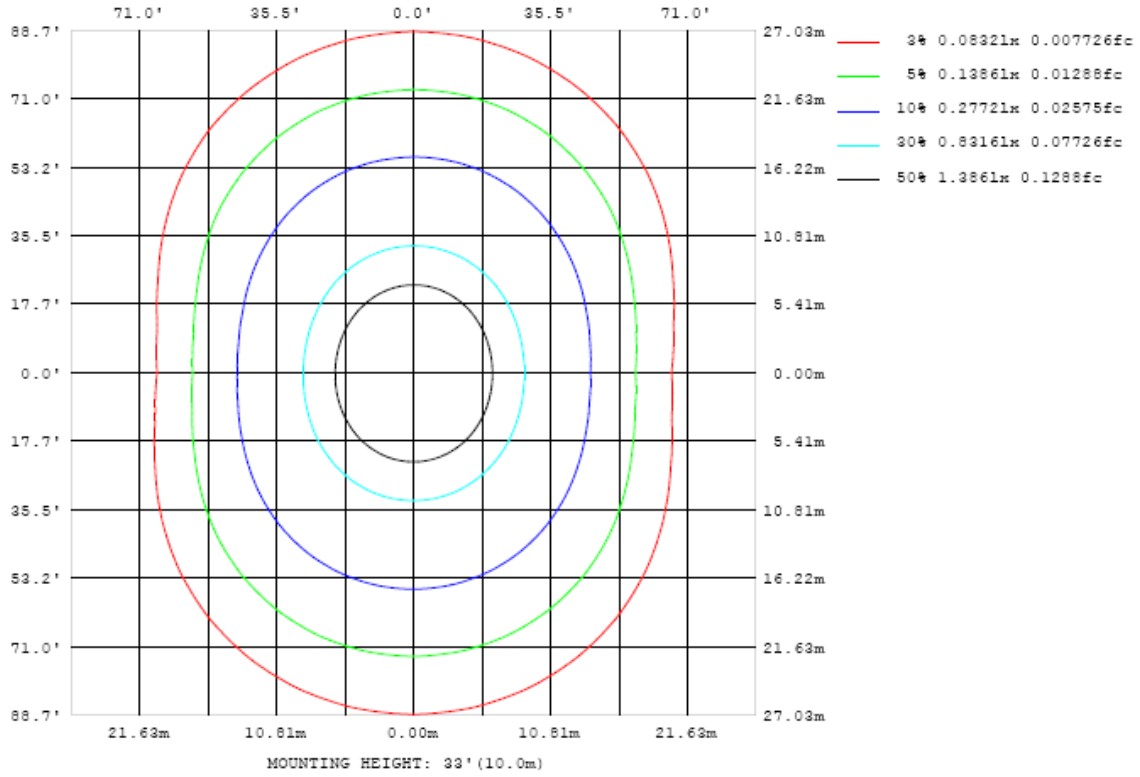


Chart 4: Illuminance Plot (Footcandles)

Luminous Intensity Distribution Plots- Goniophotometer Method

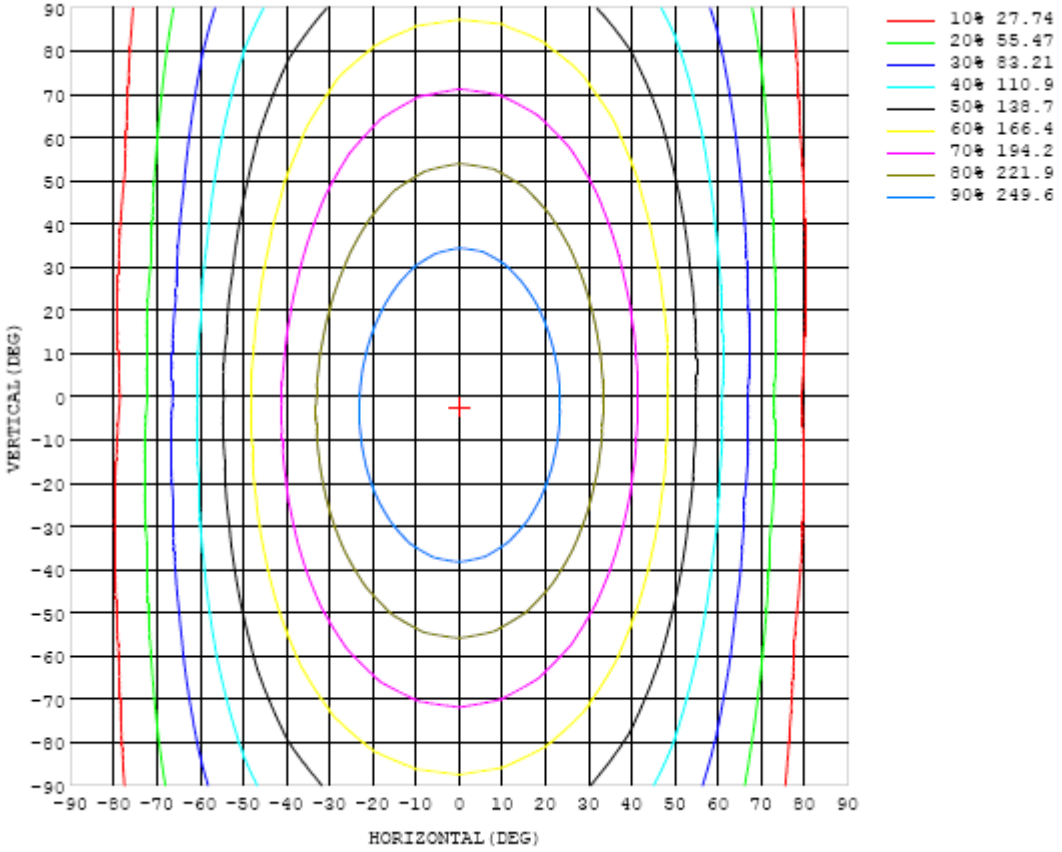


Chart 5: Isocandela Plot

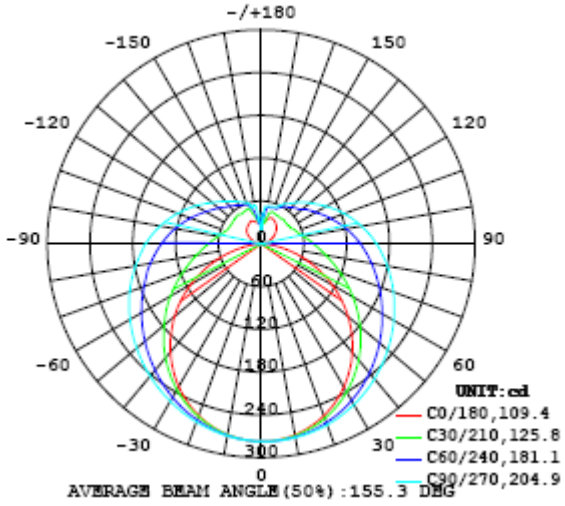


Chart 6: Polar Candela Distribution

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	277	277	277	277	277	277	277	277	277	277	277	277	277	277	277	277	277	277	277
5	276	276	276	276	277	277	277	277	277	277	277	277	277	277	277	276	276	276	276
10	272	272	273	273	274	275	275	276	276	276	276	276	275	274	274	273	273	272	272
15	266	266	267	268	269	271	272	273	273	274	273	273	272	271	269	268	267	266	265
20	257	258	259	261	263	265	267	269	270	270	270	269	267	265	263	261	259	257	256
25	245	246	248	251	254	258	261	263	265	266	265	264	261	258	255	251	248	246	245
30	232	233	236	240	245	249	254	257	260	260	260	258	254	250	245	240	236	233	231
35	216	218	222	227	233	240	245	250	253	254	253	251	246	240	234	227	222	218	215
40	199	201	206	213	221	229	236	242	246	247	246	243	237	230	222	213	206	201	198
45	180	182	188	197	208	218	227	234	238	240	238	234	228	219	209	198	189	182	179
50	159	162	170	181	194	206	217	225	230	232	230	226	218	208	196	183	171	162	159
55	138	141	151	165	180	194	206	216	221	223	222	217	208	196	182	167	152	141	137
60	115	119	132	149	166	183	196	206	213	215	213	207	198	185	169	151	134	120	114
65	91.7	97.3	113	133	153	171	186	197	204	206	204	198	188	173	156	135	115	97.9	90.0
70	68.6	75.0	94.5	118	140	160	176	188	195	197	195	189	178	163	143	121	97.4	76.6	66.1
75	46.0	55.1	77.7	104	129	150	166	179	186	189	187	180	169	152	132	108	81.5	57.2	43.0
80	25.1	36.6	63.7	92.0	118	140	157	169	177	180	178	171	159	143	122	96.4	68.4	40.1	22.6
85	8.59	22.5	52.1	81.8	109	131	148	160	168	171	169	162	150	134	112	86.7	57.8	27.6	6.86
90	0.92	14.7	44.1	73.8	100	122	139	152	159	162	160	153	142	125	104	78.7	50.0	20.7	0.66
95	1.61	11.5	38.0	66.7	91.9	114	130	143	150	153	151	144	133	117	96.4	72.1	44.2	17.2	1.80
100	4.21	12.1	34.1	60.3	84.2	105	121	133	140	143	141	135	124	108	88.8	65.9	40.2	17.0	4.69
105	7.65	14.0	32.6	55.5	77.4	97.1	113	124	131	133	132	126	115	100	81.9	60.7	38.0	18.0	8.42
110	11.5	16.5	32.4	52.0	72.1	89.5	104	115	121	124	122	116	107	92.8	75.3	56.9	37.3	19.9	12.2
115	15.7	18.8	32.6	49.6	67.3	82.7	95.9	106	112	114	113	107	98.3	85.6	71.1	54.0	35.7	23.9	16.0
120	19.8	20.9	32.7	47.0	63.5	77.0	88.5	97.3	103	105	104	98.7	90.5	79.6	66.8	49.3	34.2	27.1	19.6
125	23.6	22.9	33.8	46.0	58.4	72.6	82.2	90.0	94.8	96.6	95.4	91.2	84.0	74.2	60.3	48.7	36.5	29.2	23.3
130	27.0	24.7	34.8	45.4	56.6	66.1	75.5	83.3	87.6	89.1	88.0	84.3	77.2	66.9	58.1	45.7	39.9	29.9	26.6
135	30.1	26.1	36.7	46.1	54.2	63.3	70.6	75.4	80.2	82.3	80.5	76.0	70.6	63.9	54.3	44.9	41.0	30.7	28.9
140	33.0	27.9	37.7	45.9	54.3	60.4	66.4	71.2	73.5	75.4	75.3	73.0	68.0	60.3	49.4	47.9	41.7	31.5	30.5
145	35.3	29.9	39.0	45.1	52.6	59.3	63.5	65.9	68.0	68.7	69.2	67.1	62.4	53.3	51.5	49.1	41.8	32.4	31.8
150	37.2	32.4	40.0	45.8	49.7	55.7	60.3	63.0	64.4	64.7	63.4	60.7	55.4	53.3	52.8	49.1	41.4	33.1	33.2
155	38.8	35.5	41.5	46.2	49.7	52.1	55.1	57.7	58.9	58.6	57.8	56.5	53.9	54.4	52.8	48.6	41.7	36.0	34.9
160	38.7	33.3	40.4	47.4	50.0	51.7	53.6	53.9	54.6	54.9	54.9	53.9	54.5	54.3	50.9	44.4	40.1	34.8	33.9
165	36.1	31.4	32.2	44.1	51.2	51.5	52.5	53.3	54.0	54.4	54.5	53.5	54.2	49.1	42.1	36.4	33.7	32.0	31.8
170	32.0	30.9	29.6	30.3	39.1	49.4	52.0	52.4	53.1	53.6	51.9	50.9	41.1	34.0	32.1	30.9	29.4	29.4	30.3
175	33.7	36.1	36.9	36.4	35.4	39.0	39.0	38.4	44.8	45.8	25.5	27.1	29.7	33.9	36.2	34.9	35.9	35.5	34.8
180	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1

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	277	277	277	277	277	277	277	277	277	277	277	277	277	277	277	277	277		
5	276	276	276	276	276	276	276	276	276	276	276	276	276	276	276	276	276		
10	272	272	272	272	273	273	273	274	274	274	273	273	273	273	272	272	272		
15	265	265	266	267	268	269	269	270	270	270	270	269	268	267	267	266	266		
20	256	257	258	260	261	263	264	265	266	266	265	264	262	260	259	258	257		
25	245	246	248	251	254	256	259	260	261	260	259	257	255	252	249	247	246		
30	231	233	236	240	245	249	252	254	255	255	253	250	246	242	238	235	232		
35	216	219	223	229	235	240	245	248	249	248	246	242	236	231	225	220	217		
40	199	203	209	217	224	232	237	241	242	242	238	233	226	219	211	205	200		
45	180	185	194	204	214	222	229	234	235	234	230	224	216	206	196	188	182		
50	161	167	178	190	202	213	221	226	228	227	222	215	205	193	181	170	163		
55	140	149	163	177	191	203	213	218	220	219	214	205	194	180	166	153	143		
60	117	130	147	165	180	194	204	210	212	211	205	196	183	168	151	134	121		
65	95.2	111	131	152	170	184	195	202	204	203	197	186	172	156	136	116	99.9		
70	73.1	92.9	117	140	160	175	187	194	196	194	188	177	163	144	122	98.6	78.7		
75	52.5	76.6	104	129	150	166	178	185	188	186	179	168	153	133	109	82.6	58.8		
80	34.7	62.6	92.2	119	141	158	169	176	179	177	170	160	143	122	97.1	68.7	41.3		
85	21.6	51.8	82.4	109	131	149	161	168	170	168	162	151	134	113	86.9	57.7	27.9		
90	14.9	44.1	74.1	101	123	140	152	159	162	160	153	142	125	104	78.4	49.3	20.0		
95	12.4	38.9	67.4	93.1	115	131	143	151	153	151	144	133	117	96.3	71.3	43.4	16.3		
100	13.2	35.3	61.4	85.8	106	123	134	141	144	142	135	124	109	88.7	64.8	38.9	15.4		
105	15.6	33.8	56.6	79.1	98.4	114	125	132	134	132	126	115	101	81.6	59.4	36.1	16.9		
110	19.3	33.9	53.0	73.3	91.1	105	116	122	125	123	117	107	92.9	75.3	55.2	35.5	19.9		
115	23.3	35.4	51.0	68.0	84.3	97.5	107	113	115	114	108	98.6	85.7	69.8	52.5	35.9	23.7		
120	27.1	37.3	50.3	64.2	78.3	90.0	98.9	104	106	105	99.5	90.9	79.3	65.6	51.0	37.0	27.5		
125	30.9	39.5	50.1	61.8	72.7	83.6	91.1	95.9	97.6	96.3	91.5	84.0	74.3	62.7	50.4	38.9	30.4		
130	34.7	41.5	50.6	60.1	69.3	78.4	84.7	88.7	90.0	88.9	84.9	78.6	70.4	60.6	50.2	40.8	34.0		
135	37.2	42.2	51.3	58.9	66.1	71.2	79.3	82.5	83.6	82.6	79.3	74.0	67.1	59.0	50.1	42.9	37.5		
140	39.6	44.4	52.0	58.1	63.8	69.3	74.4	77.1	78.0	77.1	74.4	70.0	64.4	57.3	51.0	44.1	40.6		
145	42.3	45.8	50.9	57.5	61.9	65.6	69.0	72.3	73.0	72.3	70.1	66.1	61.5	56.7	51.6	46.2	42.9		
150	45.7	48.9	50.7	56.6	60.3	62.6	65.1	68.1	68.7	68.2	66.2	63.2	59.9	56.4	51.9	48.5	45.1		
155	48.6	50.7	51.5	52.4	58.3	61.2	61.7	61.9	64.7	64.7	63.2	61.0	58.8	55.7	52.9	49.5	47.7		
160	43.2	50.5	52.6	51.4	53.5	58.4	59.7	60.2	61.8	61.8	60.6	58.9	57.0	54.0	52.9	50.7	47.9		
165	36.3	42.1	43.5	46.5	49.9	53.2	55.3	55.9	55.8	57.1	56.8	55.8	55.1	54.4	53.0	50.5	43.9		
170	31.3	33.6	34.8	35.1	37.3	40.0	45.1	52.5	55.4	55.0	55.2	54.8	53.8	52.8	51.6	45.9	37.0		
175	33.7	32.4	34.9	32.9	32.0	29.0	26.4	27.7	30.7	41.1	49.7	52.3	49.2	43.5	38.4	36.5	34.5		
180	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1		

Table 7: Luminous Intensity Data

EQUIPMENT LIST

Test Equipment	Model	Equipment No.	Calibration Date	Calibration Due date
Goniophotometer system	GO-R5000	HZTE011-01	Aug. 14, 2018	Aug. 13, 2019
Digital Power Meter	PF2010A	HZTE028-01	Sep. 12, 2018	Sep. 11, 2019
AC Power Supply	DPS1060	HZTE001-06	Aug. 09, 2018	Aug. 08, 2019
DC Power Supply	WY12010	HZTE004-03	Aug. 09, 2018	Aug. 08, 2019
Temperature recorder	JM624U	HZTE018-08	Aug. 09, 2018	Aug. 08, 2019
Temperature and humidity recorder	JR900	HZTE018-01	Aug. 09, 2018	Aug. 08, 2019
Standard source	D908	HZTE012-01	Aug. 14, 2018	Aug. 13, 2019
Integrate Sphere system	3M	HZTE015-04	Aug. 16, 2018	Aug. 15, 2019
Digital Power Meter	WT210	HZTE008-01	Aug. 02, 2018	Aug. 01, 2019
AC Power Supply	PCR 500L	HZTE001-07	Aug. 09, 2018	Aug. 08, 2019
DC Power Supply	IT6154	HZTE004-04	Aug. 09, 2018	Aug. 08, 2019
Standard source	SCL-1400	HZTE012-02	Aug. 16, 2018	Aug. 15, 2019
Temperature and humidity recorder	JR900	HZTE018-02	Aug. 09, 2018	Aug. 08, 2019
Temperature Meter	TES1310	HZTE017-01	Aug. 09, 2018	Aug. 08, 2019

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 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 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 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 expended uncertainty is 2.3% with a coverage factor k=2.

Color Characteristics Measurements

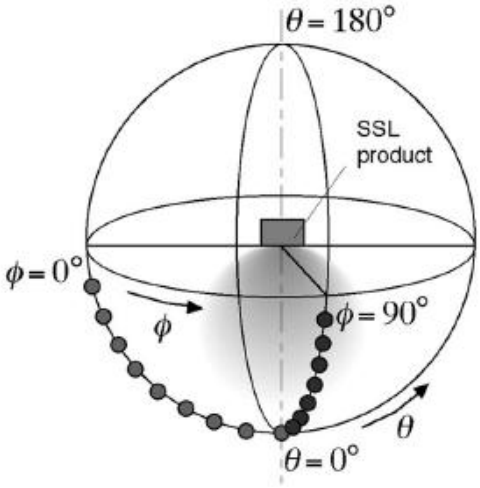
The color characteristics of SSL products include chromaticity coordinates, correlated color temperature, and color rendering index. These characteristics of SSL products may be spatially non-uniform, and thus, in order that they can be specified accurately, the color quantities shall be measured as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