LM-79-19 TEST REPORT

for

P.Q.L., Inc.

2285 Ward Avenue / Simi Valley, CA 93065

LED Tube

Model: 90455

Laboratory: Leading Testing Laboratories

NVLAP CODE: 200960-0

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Report No.: HZ24050039b

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

Review by: Wei Fei

Engineer: Wei Fei

Jun. 20, 2024

Approve by:

Manager: April Zou

Jun. 20, 2024

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: **90455**

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)/2	Power Factor
124.4	1597.2	12.84	0.9933

CCT (K)	CRI	Stabilization Time (Light & Power)
3076	82.3	50

Table 1: Executive Data Summary

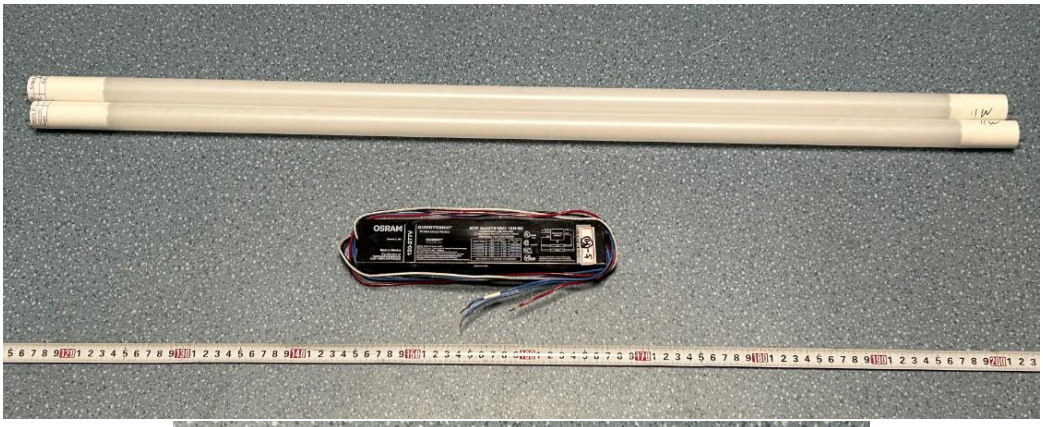
Note: The above results are recorded/ derived from measurements made using an Integrating Sphere.

Test specifications:

Date of Receipt	: May 27, 2024
Date of Test	: May 28, 2024
Test item	: Total Luminous Flux, Luminous Distribution Intensity, Luminous Efficacy, Correlated Color Temperature, Color Rendering Index, Chromaticity Coordinate, Electrical parameters
Reference Standard	: IESNA LM-79-2019 Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products ANSI/IES TM-30-18 IES Method for Evaluating Light Source Color Rendition

TABLE OF CONTENT

SAMPLE PHOTO



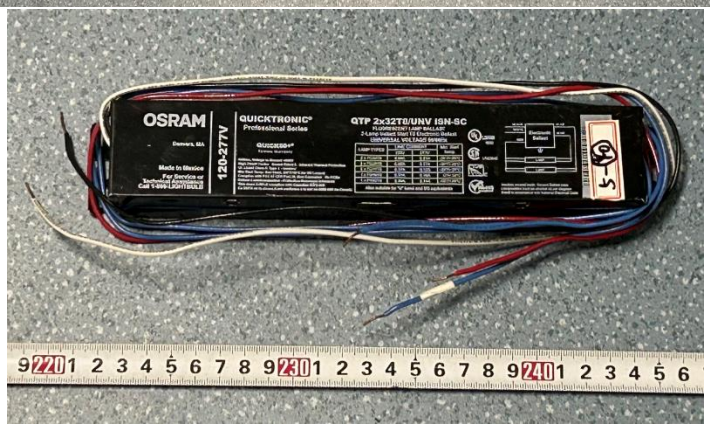


Figure 1- Overview of the sample

Equipment Under Test(EUT)	
Name	: LED Tube
Model	: 90455
Electrical Ratings	: 120-277V, 50/60Hz, 11W
Product Description	: Color- Tunable 3000K/3500K/4000K/5000K/6500K LED Tube 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 26.0°C.

Base orientation was base up. Test was conducted without a dimmer in the circuit.

The stabilization time of the sample was 50 minutes, and the total operating time including stabilization was 55 minutes.

Sphere-Spectroradiometer Method

Parameter	Result	
Test Voltage (V)	120.0	277.0
Voltage frequency (Hz)	60	60
Test Current (A)	0.215	0.098
Power Factor	0.9933	0.9502
Test Power (W)/2	12.84	12.92
THD A%	9.90	14.20
Luminous Efficacy (lm/W)	124.4	123.6
Total Luminous Flux (lm)	1597.2	1596.8
Color Rendering Index (CRI)	82.3	
R9	6.2	
Correlated Color Temperature (CCT)(K)	3076	
Chromaticity Chroma x	0.4323	
Chromaticity Chroma y	0.4039	
Chromaticity Chroma u	0.2476	
Chromaticity Chroma v	0.3471	
Duv	0.0006	
Chromaticity Chroma u ’	0.2476	
Chromaticity Chroma v’	0.5206	

Special Color Rendering Indices	
R1	80.3
R2	89.6
R3	96.8
R4	80.9
R5	80.5
R6	87.3
R7	83.6
R8	59.6
R9	6.2
R10	76.6
R11	80.4
R12	70.8
R13	82.3
R14	98.6

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 24.8°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)	0.216
Power Factor	0.9954
Power (W)/2	12.89
Luminous Efficacy (lm/W)	125.0
Total Luminous Flux (lm)	1611.5
Beam Angle (°)	106.4 (0^o-180^o) / 181.7 (90^o-270^o)
Center Beam Candle Power (cd)	319
Maximum Beam Candle Power (cd)	319.0 (At: C=60.0, Gamma=4.0)
Spacing Criteria	1.20 (0^o-180^o) / 1.37 (90^o-270^o)
Zonal Lumens in the 0°-60°Zone	47.99%
Zonal Lumens in the 60°-90°Zone	26.51%
Zonal Lumens in the 90°-120°Zone	15.83%
Zonal Lumens in the 120°-180°Zone	9.67%

Table 3: Test data per Goniophotometer Method

Spectral Power Distribution - Sphere Spectroradiometer Method

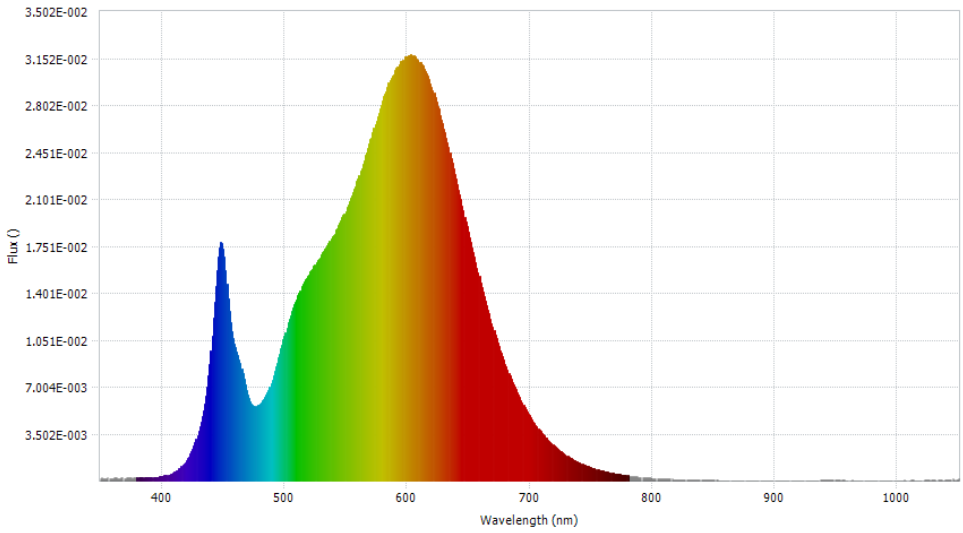
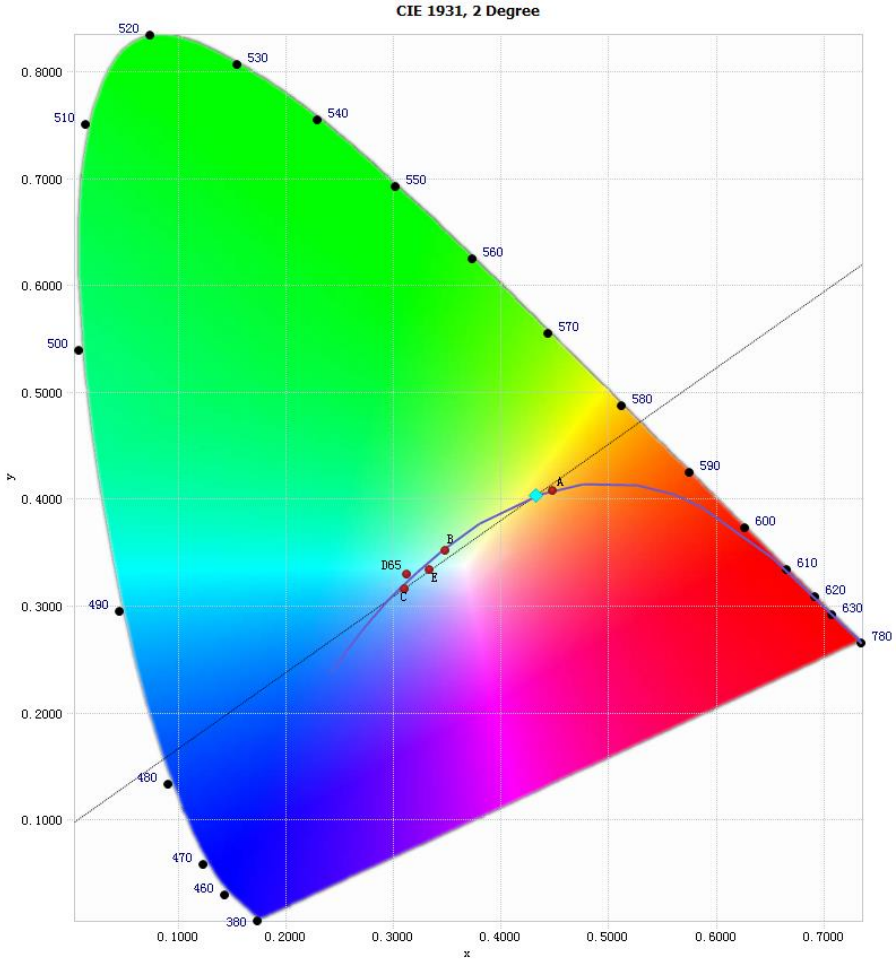


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	2.63E-04	485	6.43E-03	590	3.07E-02	695	5.67E-03
385	2.35E-04	490	7.56E-03	595	3.13E-02	700	4.88E-03
390	2.72E-04	495	9.21E-03	600	3.17E-02	705	4.20E-03
395	3.05E-04	500	1.08E-02	605	3.17E-02	710	3.58E-03
400	3.54E-04	505	1.23E-02	610	3.13E-02	715	3.05E-03
405	4.64E-04	510	1.36E-02	615	3.05E-02	720	2.64E-03
410	6.57E-04	515	1.47E-02	620	2.94E-02	725	2.25E-03
415	9.85E-04	520	1.54E-02	625	2.80E-02	730	1.92E-03
420	1.52E-03	525	1.62E-02	630	2.63E-02	735	1.63E-03
425	2.41E-03	530	1.69E-02	635	2.45E-02	740	1.39E-03
430	3.70E-03	535	1.75E-02	640	2.26E-02	745	1.18E-03
435	5.76E-03	540	1.83E-02	645	2.06E-02	750	1.02E-03
440	9.73E-03	545	1.92E-02	650	1.86E-02	755	8.64E-04
445	1.57E-02	550	2.01E-02	655	1.67E-02	760	7.51E-04
450	1.73E-02	555	2.13E-02	660	1.48E-02	765	6.38E-04
455	1.27E-02	560	2.26E-02	665	1.31E-02	770	5.55E-04
460	9.95E-03	565	2.39E-02	670	1.15E-02	775	4.70E-04
465	8.39E-03	570	2.55E-02	675	1.01E-02	780	4.05E-04
470	6.45E-03	575	2.68E-02	680	8.75E-03		
475	5.56E-03	580	2.83E-02	685	7.63E-03		
480	5.75E-03	585	2.97E-02	690	6.60E-03		

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

Chromaticity Diagram - Sphere Spectroradiometer Method



Tristimulus values(x, y): (0.4323, 0.4039)

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

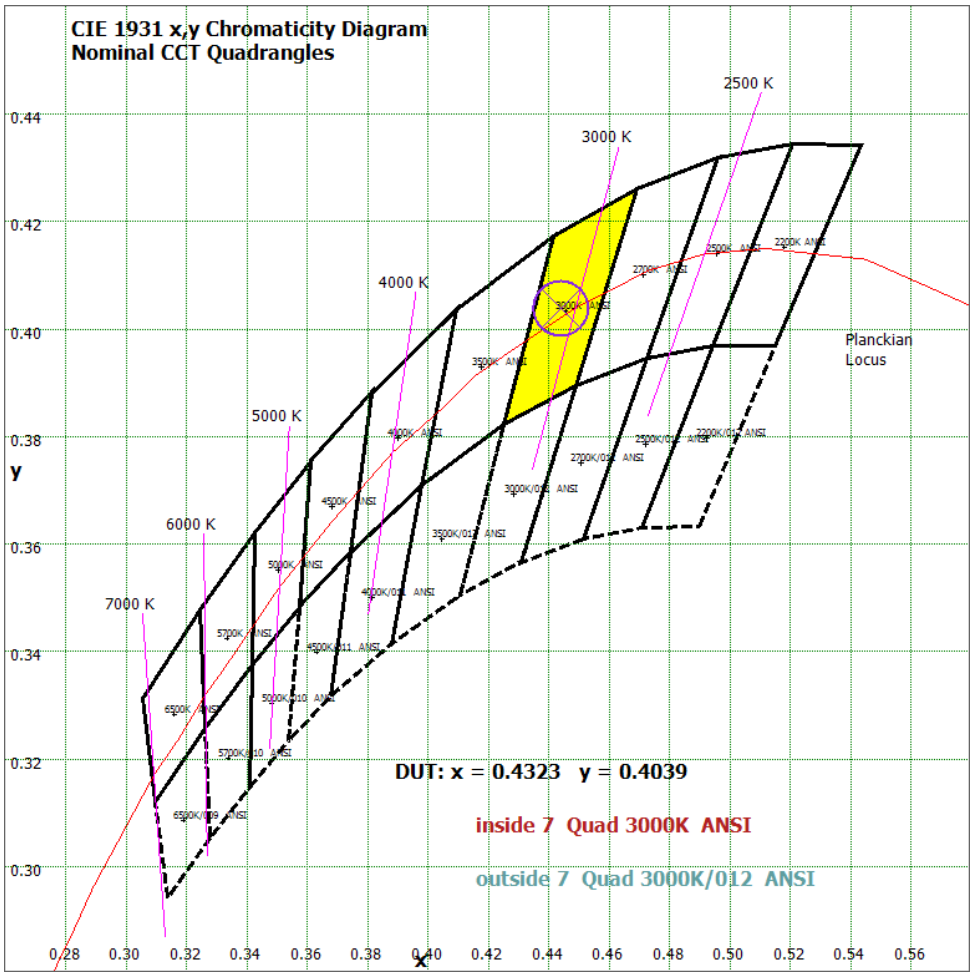


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

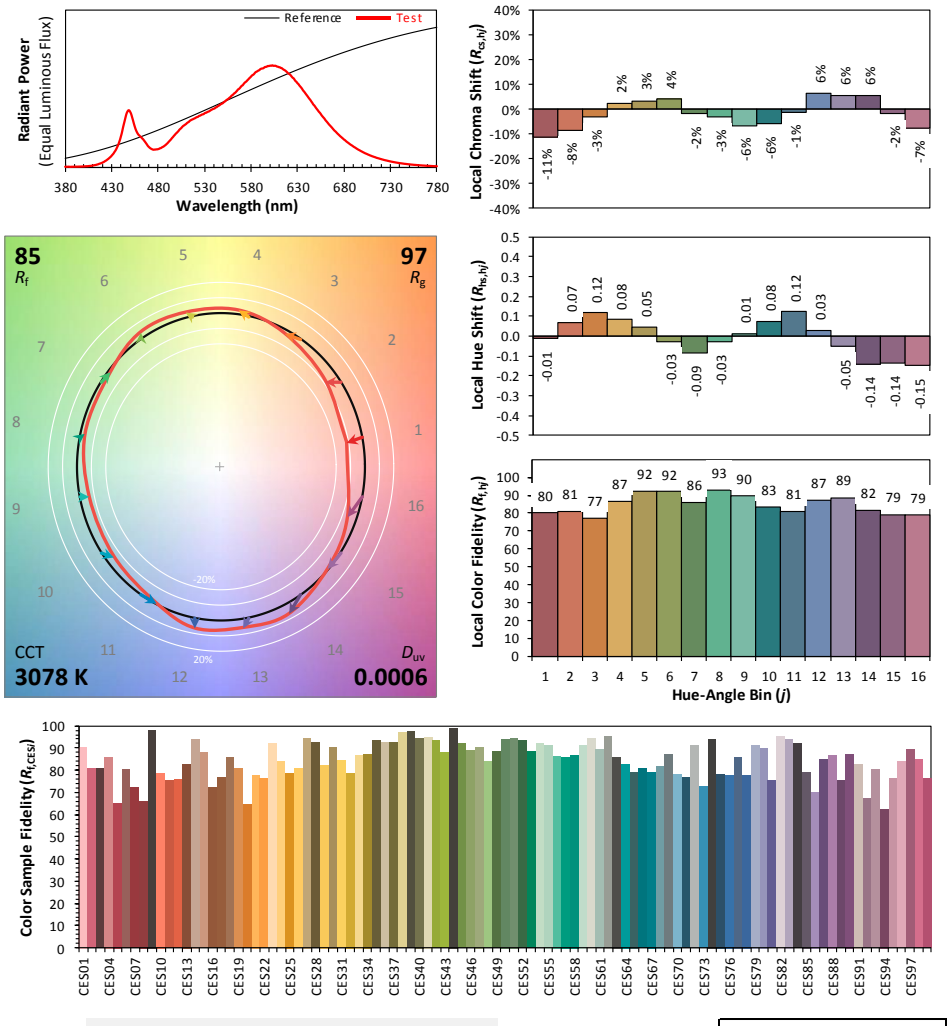
Quality Assured

Color Rendition Report – Sphere Spectroradiometer Method

ANSI/IES TM-30-18 Color Rendition Report

Source: LED **Manufacturer:** P.Q.L., Inc.

Date: 2024/05/28 **Model:** 90455



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

x	0.4323
y	0.4039
u'	0.2476
v'	0.5206

CIE 13.3-1995 (CRI)

R_a	82
R_9	6

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.

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Zonal Lumen Tabulation- Goniophotometer Method

γ(°)	Lumens	% Total
0- 10	30.223	1.88%
10- 20	86.983	5.40%
20- 30	133.453	8.28%
30- 40	164.96	10.24%
40- 50	179.53	11.14%
50- 60	178.227	11.06%
60- 70	164.414	10.20%
70- 80	142.986	8.87%
80- 90	119.774	7.43%
90-100	100.304	6.22%
100-110	84.408	5.24%
110-120	70.381	4.37%
120-130	57.055	3.54%
130-140	44.262	2.75%
140-150	30.842	1.91%
150-160	17.156	1.06%
160-170	5.722	0.36%
170-180	0.83	0.05%
Total	1611.5	100%

γ(°)	Lumens	% Total
0- 60	773.376	47.99%
60- 90	427.174	26.51%
0-90	1200.55	74.50%
90- 180	410.96	25.50%
0- 180	1611.5	100%

Table 5: Zonal Lumen

Illuminance Plots- Goniophotometer Method

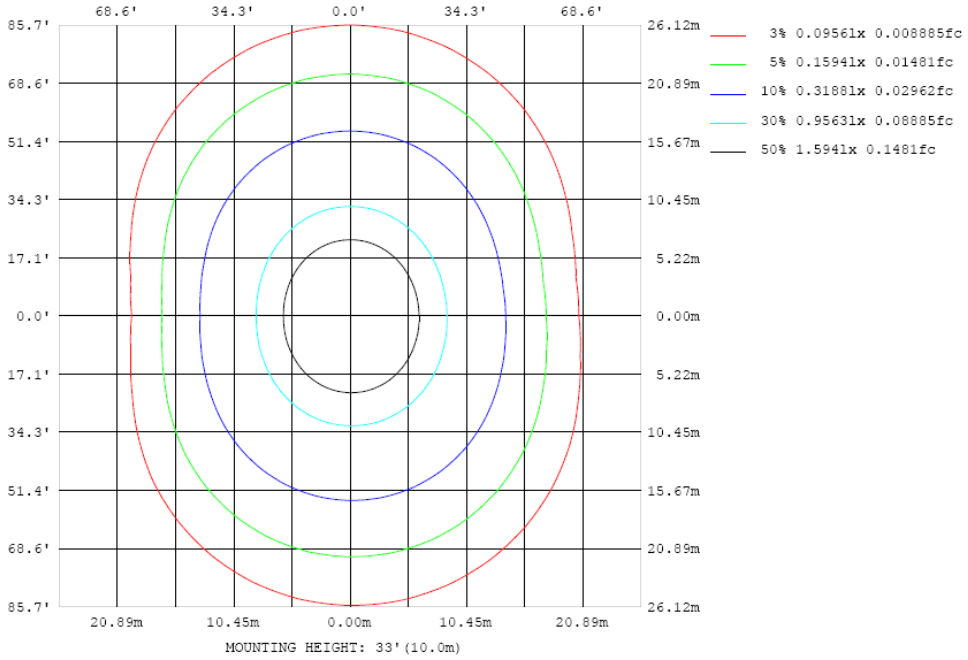

Chart 5: Illuminance Plot (Footcandles)

Luminous Intensity Distribution Plots- Goniophotometer Method

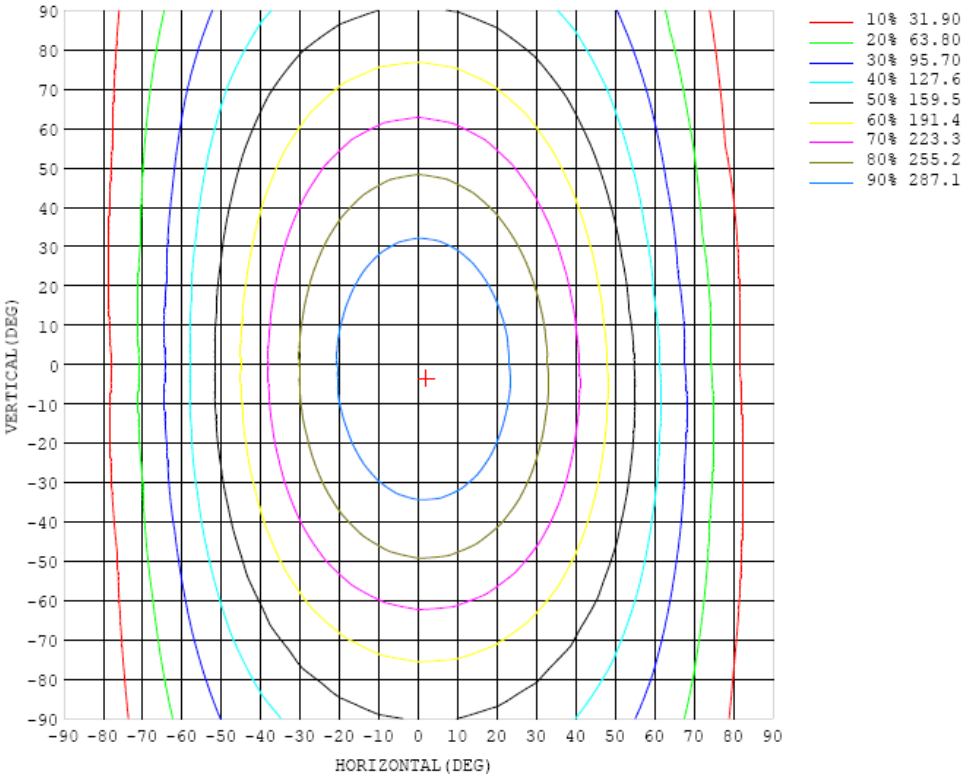

Chart 6: Isocandela Plot

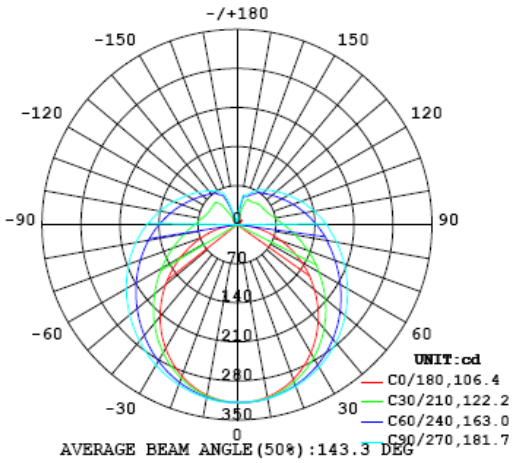

Chart 7: Polar Candela Distribution

Luminous Intensity Data- Goniophotometer Method

Table--1 UNIT: cd

γ (DEG) \ C (DEG)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
0	319	319	319	319	319	319	319	319	319	319	319	319	319	319	319	319	319	319	319
5	318	318	318	318	318	319	319	319	319	319	319	318	318	318	317	317	316	316	316
10	313	314	314	315	316	316	316	317	317	316	316	315	315	314	313	312	311	310	310
15	306	307	308	309	310	311	312	313	313	313	312	311	309	308	306	305	303	301	301
20	295	296	298	300	302	304	306	308	308	308	307	305	303	300	296	294	292	289	289
25	281	284	286	289	292	296	299	301	302	302	301	298	294	290	285	281	278	275	274
30	265	268	271	275	280	285	290	293	295	295	293	289	284	278	272	266	261	257	256
35	247	250	254	260	267	274	279	284	286	286	284	279	273	265	257	249	243	238	236
40	227	230	235	243	252	260	268	273	276	276	273	268	260	251	241	231	223	217	215
45	205	209	216	225	236	246	255	261	265	265	262	256	247	236	224	212	202	194	192
50	182	186	195	207	219	232	242	249	253	253	250	243	233	221	206	192	180	171	167
55	158	164	174	188	203	216	228	236	241	241	238	230	219	205	189	172	158	147	142
60	134	141	154	170	186	202	214	223	228	229	225	218	206	190	172	154	136	123	117
65	109	118	133	153	170	187	201	210	216	217	213	205	192	176	157	136	115	98.8	91.7
70	84.4	94.9	114	136	156	173	188	198	204	205	201	192	179	163	142	118	94.6	75.5	67.8
75	60.7	73.6	95.8	120	142	161	175	186	192	193	189	181	167	151	128	103	76.4	53.7	44.5
80	38.4	54.7	80.1	106	129	149	164	174	180	181	178	169	157	139	116	90.0	61.3	34.8	23.1
85	19.0	39.2	67.1	94.1	118	138	153	164	169	170	167	160	146	128	106	79.2	49.8	20.9	6.43
90	4.88	28.7	57.1	84.0	108	127	143	153	159	161	157	149	136	118	96.4	70.5	42.0	14.1	0.69
95	2.42	23.1	49.8	75.8	98.8	118	133	143	149	151	147	139	127	110	88.6	64.0	37.3	12.3	0.63
100	3.61	21.2	45.1	69.2	91.0	109	124	134	139	141	138	130	118	102	82.1	59.2	35.0	13.1	1.36
105	4.57	21.7	42.1	64.1	84.3	102	115	125	130	131	128	121	110	95.1	76.7	55.8	34.5	15.5	2.79
110	5.14	23.8	40.8	60.3	78.7	94.6	107	116	121	122	120	113	103	89.0	72.3	53.7	35.3	18.8	3.34
115	4.26	26.0	40.7	57.5	74.0	88.4	99.8	108	113	114	112	106	96.2	83.7	68.8	52.6	36.9	21.8	3.59
120	5.91	28.1	41.6	55.8	70.1	82.9	93.3	101	105	106	104	98.6	90.2	79.2	66.1	52.1	39.7	16.7	0.46
125	8.84	31.7	42.8	54.8	67.1	78.3	87.4	94.1	98.0	99.0	97.2	92.4	85.0	75.3	64.1	52.2	43.0	14.2	0.00
130	12.0	33.8	43.0	54.5	64.7	74.3	82.3	88.1	91.5	92.5	90.9	86.7	80.4	72.1	62.7	52.7	45.4	19.0	1.22
135	10.8	29.6	41.5	52.8	63.1	71.0	77.7	82.7	85.7	86.6	85.2	81.7	76.4	69.5	61.6	53.0	47.0	23.3	0.00
140	2.62	24.8	43.3	50.8	60.5	68.3	73.8	78.0	80.5	81.3	80.2	77.3	72.8	67.0	59.9	52.9	41.4	18.0	0.49
145	0.94	27.9	44.1	49.5	57.1	64.6	70.4	73.7	75.8	76.5	75.6	73.3	69.5	62.5	56.4	53.1	35.1	3.45	3.77
150	8.41	23.8	42.4	48.5	54.0	59.9	64.2	68.9	71.3	71.8	70.9	67.2	63.3	60.0	56.1	51.5	31.6	3.28	14.1
155	3.33	8.48	37.3	49.4	51.3	55.1	59.5	62.1	63.5	64.0	63.7	62.2	60.0	57.0	54.7	48.9	23.3	14.8	11.1
160	7.91	10.4	20.0	42.4	51.7	52.9	54.3	56.0	57.5	58.2	58.0	57.2	56.3	55.6	52.7	36.3	12.7	7.13	7.96
165	2.00	7.46	6.50	19.2	37.2	51.7	54.0	54.4	55.1	55.6	55.7	55.6	55.9	53.2	38.7	19.3	11.1	10.9	2.94
170	3.75	5.19	10.0	4.48	8.62	19.9	32.6	36.7	38.8	40.0	39.3	37.7	35.0	27.1	16.2	9.00	11.7	8.07	7.42
175	4.70	2.85	4.69	7.76	8.45	5.64	3.92	4.48	7.28	10.0	10.6	10.3	9.31	8.31	8.64	8.68	7.49	4.12	5.00
180	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13

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	319	319	319	319	319	319	319	319	319	319	319	319	319	319	319	319	319		
5	316	317	317	317	317	318	318	318	318	319	319	318	318	318	318	318	318		
10	311	311	312	313	313	314	315	315	316	316	316	316	315	315	314	314	314		
15	302	303	304	305	307	308	310	311	311	311	311	310	309	309	308	307	306		
20	290	291	293	296	298	301	303	305	306	306	305	303	302	300	298	297	295		
25	275	277	280	284	288	292	296	298	299	298	297	295	292	289	286	283	282		
30	257	260	265	271	277	282	287	290	291	290	288	285	280	276	271	268	266		
35	238	242	249	256	264	271	277	280	282	281	278	273	268	261	255	250	247		
40	217	222	231	241	250	259	266	271	272	271	267	261	254	245	237	231	227		
45	194	202	212	224	236	247	255	260	262	261	256	249	239	229	218	210	205		
50	171	180	193	208	222	234	244	250	252	250	244	235	224	211	199	188	182		
55	147	159	175	192	208	221	232	238	241	238	232	222	209	194	179	166	158		
60	123	138	156	176	194	209	220	227	230	227	220	209	194	177	160	144	134		
65	99.5	117	139	161	180	196	209	216	218	216	208	196	180	161	141	123	110		
70	77.2	98.2	123	146	167	184	197	205	207	204	196	183	166	146	123	102	86.1		
75	57.2	81.4	108	133	155	173	186	193	196	193	184	171	153	131	107	82.7	64.1		
80	39.9	68.0	95.7	122	144	161	174	182	184	181	173	159	141	118	92.8	66.7	43.4		
85	27.3	56.8	85.0	111	133	150	163	171	173	170	161	148	130	107	80.7	53.0	26.3		
90	20.5	48.8	76.1	101	123	140	152	160	162	159	151	137	119	96.7	71.4	42.8	15.2		
95	18.2	43.5	69.9	93.3	114	130	142	149	151	148	140	127	110	87.9	63.3	35.5	9.57		
100	18.5	40.4	64.5	86.2	106	121	132	139	140	138	130	118	101	80.5	56.9	30.6	7.65		
105	20.0	39.2	60.4	80.2	98.1	112	123	129	131	128	121	109	93.5	74.0	52.0	28.0	8.86		
110	21.9	39.3	57.5	75.2	91.4	105	114	120	121	119	112	101	86.8	69.5	48.8	28.0	10.3		
115	22.3	40.1	55.7	71.8	85.7	97.4	106	111	112	110	104	94.1	81.0	65.4	47.2	28.8	10.1		
120	23.5	41.4	54.8	68.6	80.6	91.0	98.7	103	104	102	96.7	87.9	76.1	62.4	47.0	27.8	5.43		
125	19.8	40.8	54.9	66.1	76.4	85.4	92.2	96.2	97.2	95.1	90.2	82.5	72.5	60.3	46.3	25.1	1.63		
130	5.59	32.3	55.3	64.3	73.9	80.7	86.3	89.8	90.6	88.8	84.5	77.9	69.4	58.5	45.7	21.0	0.37		
135	0.79	28.0	55.8	62.8	70.4	76.3	81.1	84.0	84.7	83.1	79.4	73.7	66.5	56.5	42.6	16.2	0.00		
140	0.45	18.1	48.8	61.1	67.8	73.2	76.3	78.5	79.0	77.6	74.5	70.3	63.3	54.6	29.8	8.21	0.92		
145	1.66	6.30	25.7	58.2	62.6	69.3	72.8	74.4	74.5	73.6	70.9	66.1	58.9	49.1	14.1	1.23	2.37		
150	4.10	6.14	6.18	43.4	58.7	61.6	66.0	68.8	69.4	68.0	64.1	59.8	54.4	26.0	3.23	1.71	2.47		
155	3.94	3.62	0.58	4.32	37.7	53.8	60.7	62.3	62.4	61.6	58.7	50.1	24.2	1.77	0.82	6.31	3.39		
160	5.04	7.69	8.57	1.99	0.52	7.90	24.1	36.5	38.9	35.1	21.1	5.53	0.59	1.32	6.33	6.54	5.61		
165	6.04	3.08	8.02	4.89	5.42	1.55	0.58	0.56	0.58	0.54	0.53	1.33	2.77	4.89	3.15	5.52	3.63		
170	12.8	6.11	1.68	3.64	7.30	8.96	6.13	4.51	4.13	2.37	3.46	5.75	6.35	2.68	5.77	5.28	6.18		
175	11.7	8.54	4.92	7.60	8.62	3.59	1.68	2.40	0.99	4.88	5.70	7.42	8.81	6.99	4.60	6.43	8.73		
180	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13		

Table 7: Luminous Intensity Data

EQUIPMENT LIST

Test Equipment	Model	Equipment No.	Calibration Date	Calibration Due date
Goniophotometer system	GO-R5000	HZTE011-01	Feb. 18, 2024	-
Digital Power Meter	PF2010A	HZTE028-01	Aug. 01, 2023	Jul. 31, 2024
AC Power Supply	DPS1060	HZTE001-06	Aug. 01, 2023	Jul. 31, 2024
DC Power Supply	WY12010	HZTE004-03	Aug. 01, 2023	Jul. 31, 2024
Temperature recorder	JM624U	HZTE018-08	Aug. 04, 2023	Aug. 03, 2024
Temperature and humidity recorder	JR900	HZTE018-01	Aug. 04, 2023	Aug. 03, 2024
Standard source	D908	HZTE012-01	Aug. 14, 2018	-
Integrate Sphere system	3M	HZTE015-04	Feb. 18, 2024	-
Digital Power Meter	WT210	HZTE008-01	Aug. 01, 2023	Jul. 31, 2024
AC Power Supply	PCR 500L	HZTE001-07	Aug. 01, 2023	Jul.31, 2024
DC Power Supply	IT6154	HZTE004-04	Aug. 01, 2023	Jul. 31, 2024
Standard source	SCL-1400	HZTE012-06	Nov. 04, 2021	-
Temperature and humidity recorder	JR900	HZTE018-02	Aug. 04, 2023	Aug. 03, 2024
Temperature Meter	TES1310	HZTE017-01	Aug. 04, 2023	Aug. 03, 2024

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 3 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 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 20 min, taken 10 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 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 20 min, taken 10 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.

*** End of Report ***