LM-79-19 TEST REPORT

for

RAB LIGHTING INC

408 W 14th St New York, NY 10014 United States

LED Tube

Model: T5HO-25-48G-840-SD-BYP

Laboratory: Leading Testing Laboratories

NVLAP CODE: 200960-0

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Report No.: HZ22110029n

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. 20, 2022

Approved by: Jim Zhang

Manager: Jim Zhang
Dec. 20, 2022

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: **T5HO-25-48G-840-SD-BYP**

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)	Power Factor
150.4	3880.1	25.80	0.9865

CCT (K)	CRI	Stabilization Time (Light & Power)
4075	82.9	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 : Nov. 28, 2022

Date of Test : Dec. 15, 2022

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

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SAMPLE PHOTO

Figure 1- Overview of the sample

Equipment Under Test(EUT)	
Name	: LED Tube
Model	: T5HO-25-48G-840-SD-BYP
Electrical Ratings	: 120-277V, 50/60Hz, 25W
Product Description	: 4000K

TEST RESULTS

Test ambient temperature was 26.0 ℃.

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)	0.218	0.093
Power Factor	0.9865	0.9504
Test Power (W)	25.80	24.35
THD A%	13.89	19.64
Luminous Efficacy (lm/W)	150.4	159.5
Total Luminous Flux (lm)	3880.1	3884.2
Color Rendering Index (CRI)	82.9	
R9	7.2	
Correlated Color Temperature (CCT)(K)	4075	
Chromaticity Chroma x	0.3777	
Chromaticity Chroma y	0.3772	
Chromaticity Chroma u	0.2231	
Chromaticity Chroma v	0.3343	
Duv	0.0010	
Chromaticity Chroma u ’	0.2231	
Chromaticity Chroma v’	0.5014	

Special Color Rendering Indices	
R1	80.9
R2	88.2
R3	94.3
R4	82.8
R5	81.5
R6	84.2
R7	86.2
R8	64.8
R9	7.2
R10	72.6
R11	82.3
R12	65
R13	82.6
R14	96.9

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 ℃.

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)	0.218
Power Factor	0.9871
Power (W)	25.84
Luminous Efficacy (lm/W)	151.4
Total Luminous Flux (lm)	3912.0
Beam Angle (°)	109.3 (0^o-180^o) / 174.3 (90^o-270^o)
Center Beam Candle Power (cd)	787
Maximum Beam Candle Power (cd)	788.8 (At: C=200.0, Gamma=2.5)
Spacing Criteria	1.29 (0^o-180^o) / 1.39 (90^o-270^o)
Zonal Lumens in the 0 °-60 °Zone	49.62%
Zonal Lumens in the 60 °-90 °Zone	27.07%
Zonal Lumens in the 90 °-120 °Zone	14.83%
Zonal Lumens in the 120 °-180 °Zone	8.48%

Table 3: Test data per Goniophotometer Method

Spectral Power Distribution - Sphere Spectroradiometer Method

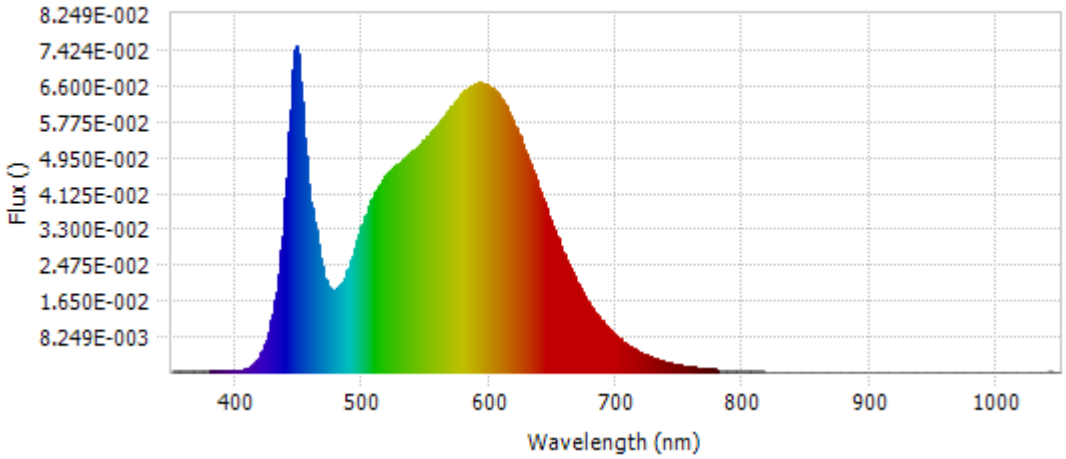
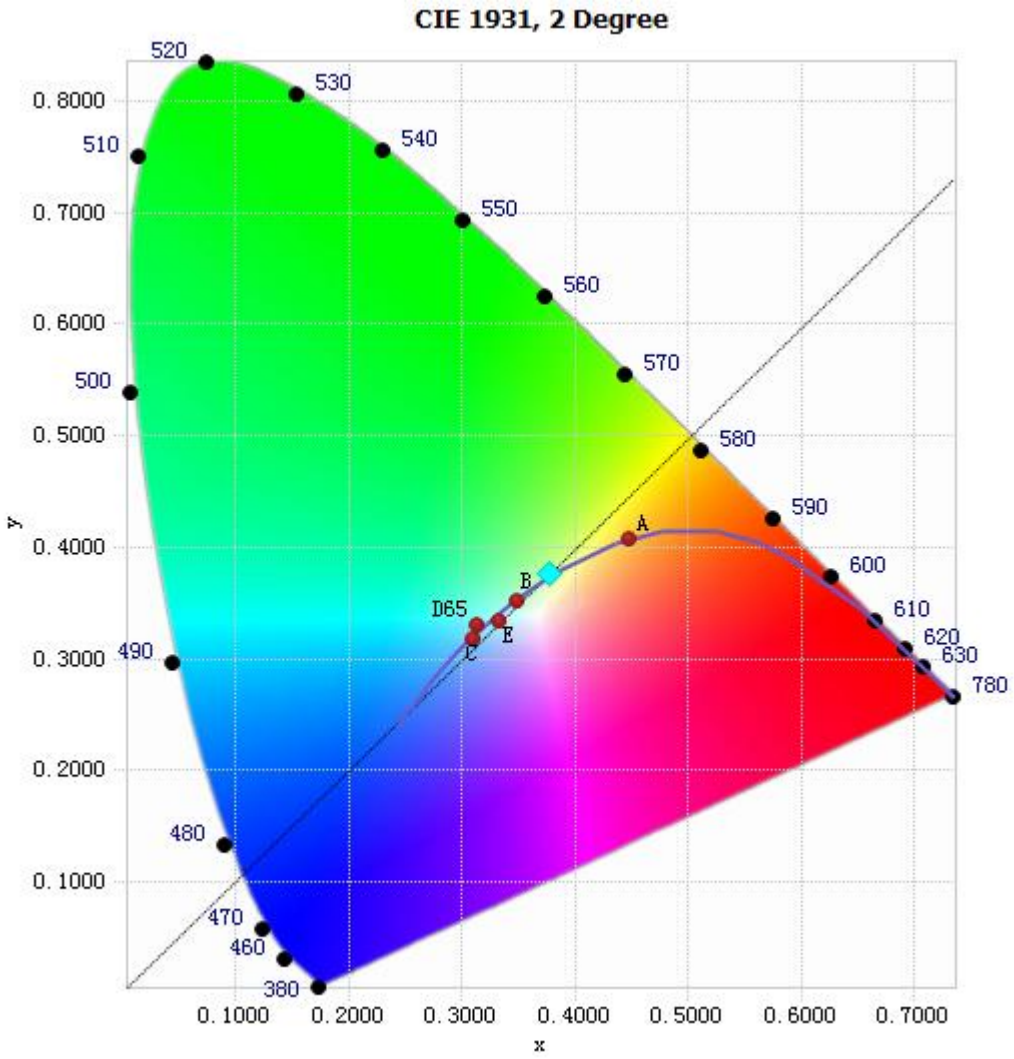


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	3.41E-04	485	2.14E-02	590	6.63E-02	695	9.78E-03
385	3.31E-04	490	2.50E-02	595	6.65E-02	700	8.38E-03
390	3.29E-04	495	2.97E-02	600	6.59E-02	705	7.15E-03
395	2.97E-04	500	3.43E-02	605	6.47E-02	710	6.12E-03
400	3.26E-04	505	3.83E-02	610	6.28E-02	715	5.23E-03
405	5.37E-04	510	4.14E-02	615	6.01E-02	720	4.51E-03
410	1.10E-03	515	4.41E-02	620	5.68E-02	725	3.82E-03
415	2.25E-03	520	4.59E-02	625	5.34E-02	730	3.27E-03
420	4.42E-03	525	4.73E-02	630	4.97E-02	735	2.78E-03
425	8.24E-03	530	4.85E-02	635	4.58E-02	740	2.35E-03
430	1.48E-02	535	4.97E-02	640	4.16E-02	745	2.00E-03
435	2.56E-02	540	5.11E-02	645	3.77E-02	750	1.71E-03
440	4.48E-02	545	5.25E-02	650	3.37E-02	755	1.48E-03
445	6.96E-02	550	5.41E-02	655	3.00E-02	760	1.26E-03
450	7.03E-02	555	5.55E-02	660	2.64E-02	765	1.08E-03
455	4.98E-02	560	5.73E-02	665	2.32E-02	770	9.18E-04
460	3.76E-02	565	5.92E-02	670	2.03E-02	775	7.83E-04
465	2.95E-02	570	6.12E-02	675	1.76E-02	780	6.79E-04
470	2.19E-02	575	6.28E-02	680	1.53E-02		
475	1.90E-02	580	6.46E-02	685	1.32E-02		
480	1.94E-02	585	6.59E-02	690	1.14E-02		

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

Chromaticity Diagram - Sphere Spectroradiometer Method



Tristimulus values(x, y): (0.3777, 0.3772)

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

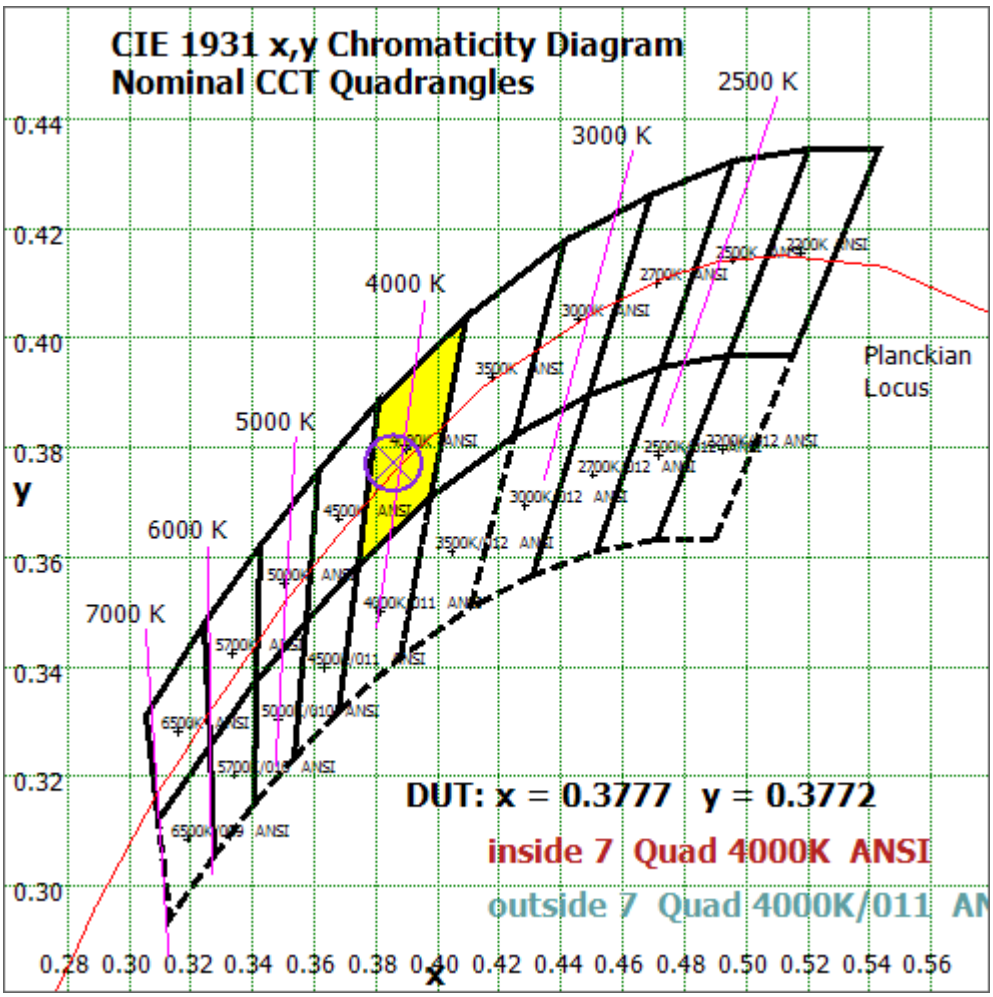


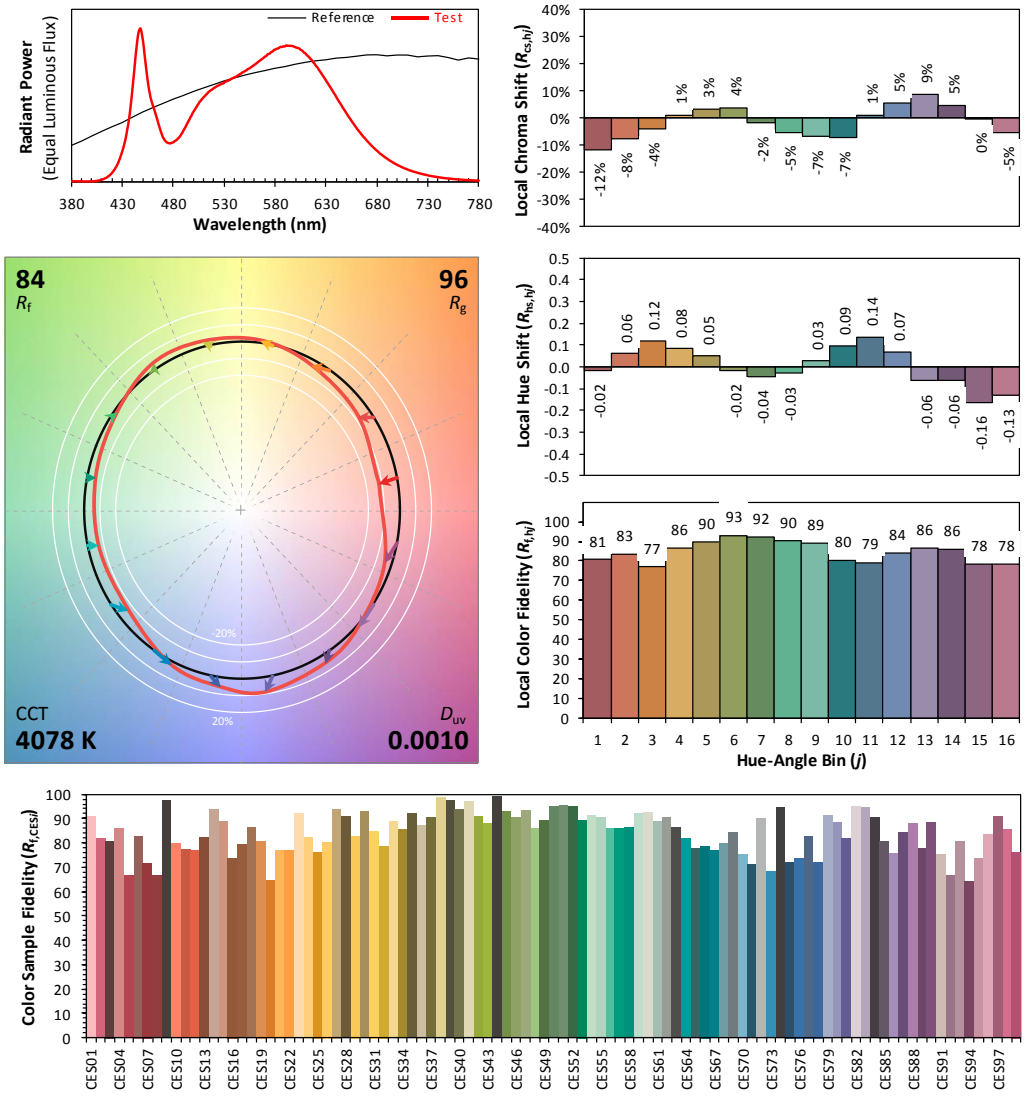
Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

Color Rendition Report – Sphere Spectroradiometer Method

ANSI/IES TM-30-18 Color Rendition Report

Source: LED **Manufacturer:** RAB LIGHTING INC

Date: 2022/12/15 **Model:** T5HO-25-48G-840-SD-BYP



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

x	0.3777
y	0.3772
u'	0.2231
v'	0.5014

CIE 13.3-1995 (CRI)

R_a	83
R_9	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

γ(°)	Lumens	% Total
0- 10	74.533	1.91%
10- 20	215.241	5.50%
20- 30	332.206	8.49%
30- 40	413.669	10.57%
40- 50	453.535	11.59%
50- 60	451.848	11.55%
60- 70	414.941	10.61%
70- 80	354.828	9.07%
80- 90	289.092	7.39%
90-100	234.824	6.00%
100-110	191.002	4.88%
110-120	154.414	3.95%
120-130	121.679	3.11%
130-140	90.662	2.32%
140-150	62.648	1.60%
150-160	35.237	0.90%
160-170	16.482	0.42%
170-180	5.126	0.13%
Total	3912.0	100%

γ(°)	Lumens	% Total
0- 60	1941.03	49.62%
60- 90	1058.86	27.07%
0-90	2999.89	76.69%
90- 180	912.074	23.31%
0- 180	3912.0	100%

Table 5: Zonal Lumen

Illuminance Plots- Goniophotometer Method

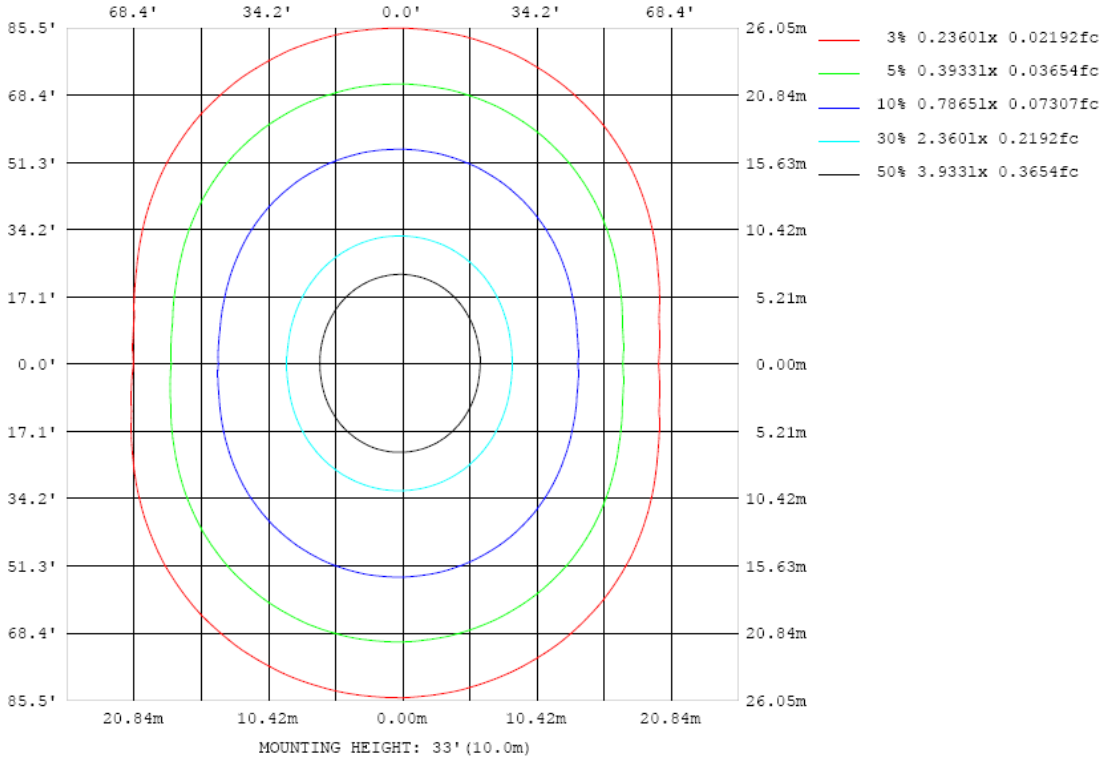


Chart 5: Illuminance Plot (Footcandles)

Luminous Intensity Distribution Plots- Goniophotometer Method

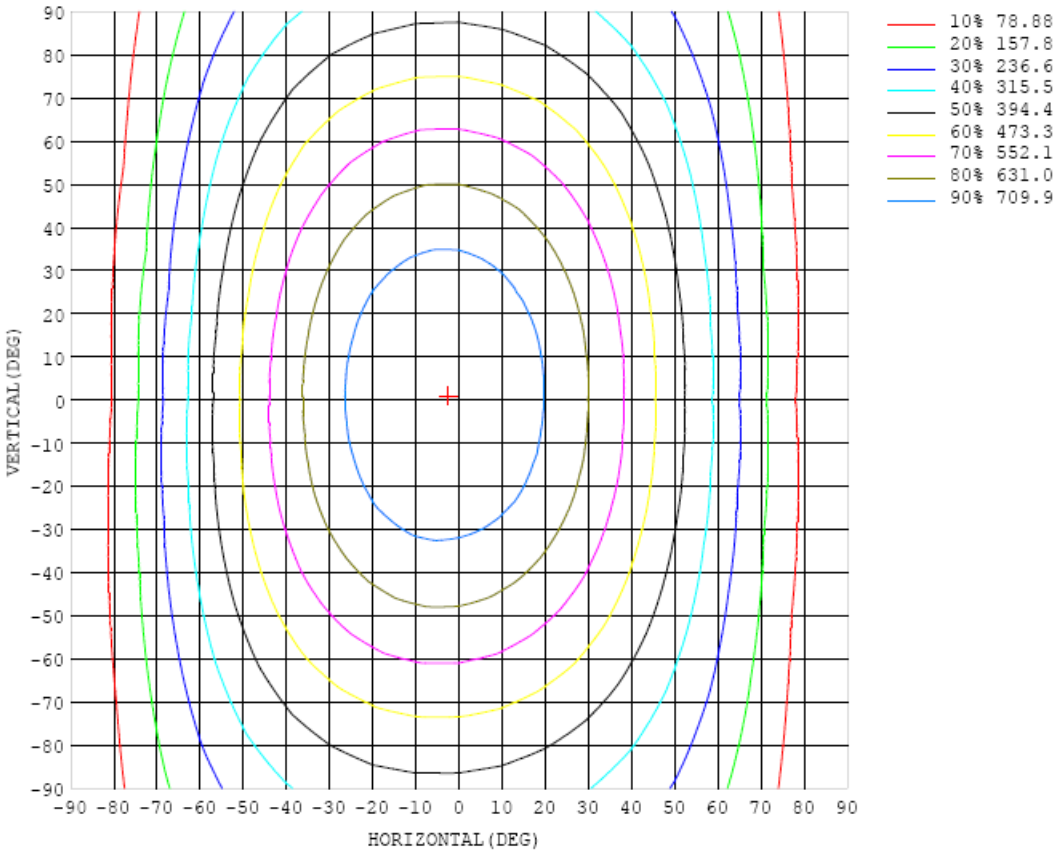


Chart 6: Isocandela Plot

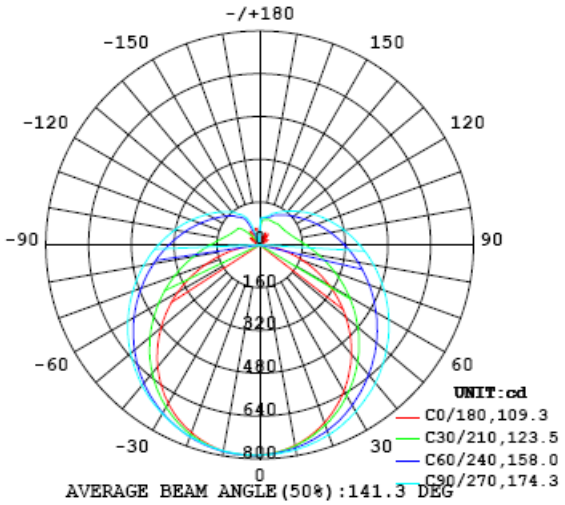


Chart 7: Polar Candela Distribution

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	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787
5	778	777	777	778	779	780	781	782	783	784	785	786	786	786	786	786	787	787	787
10	761	761	762	763	764	767	771	774	776	777	779	781	782	782	782	782	781	781	782
15	737	738	739	742	747	751	756	760	765	768	770	771	772	771	770	770	768	768	768
20	707	708	711	717	724	731	739	746	751	756	757	758	758	756	754	750	749	747	746
25	672	673	678	687	695	707	718	726	733	739	742	744	741	737	733	727	722	720	719
30	630	632	640	651	665	679	692	703	712	719	723	722	718	714	706	698	690	685	684
35	584	587	598	612	630	647	664	678	690	696	701	700	694	687	676	664	652	644	642
40	533	539	553	570	592	614	634	650	664	674	677	674	668	656	641	626	610	598	594
45	479	486	503	526	552	578	602	622	637	647	650	647	638	623	604	583	564	547	541
50	421	430	451	480	511	542	570	592	608	618	622	617	606	588	565	538	513	492	482
55	362	372	399	433	470	506	536	561	578	589	592	586	573	551	525	492	460	432	420
60	300	313	345	387	430	469	502	528	548	558	560	554	539	515	483	445	406	371	354
65	236	253	293	342	390	433	469	497	516	527	529	522	504	478	441	398	351	309	286
70	174	195	243	300	352	398	436	465	485	495	497	489	470	441	402	353	298	247	217
75	113	141	198	261	318	366	404	433	453	464	465	456	436	406	363	310	248	187	149
80	58.5	92.9	159	226	285	335	374	403	423	433	434	424	404	372	328	271	203	134	84.7
85	17.1	57.4	129	197	257	306	345	373	394	403	403	394	372	340	295	236	165	89.2	32.3
90	0.42	38.2	106	173	231	280	318	346	365	374	374	364	343	311	265	207	137	59.6	3.79
95	1.04	31.7	91.4	154	209	256	292	319	338	347	346	336	315	283	239	183	116	44.6	1.81
100	2.47	32.3	82.4	139	190	234	269	295	312	320	320	310	290	259	216	164	101	36.5	2.83
105	5.58	36.5	77.6	127	174	215	248	272	288	296	295	285	266	236	196	147	90.1	37.4	6.04
110	10.7	42.1	75.9	119	161	198	228	251	266	273	272	262	244	216	179	134	84.6	41.6	12.4
115	20.1	48.9	76.3	113	150	182	210	231	245	251	250	241	224	198	165	125	82.6	47.1	20.5
120	32.7	55.7	78.0	109	141	169	194	213	225	231	230	221	205	182	152	118	83.0	53.6	31.1
125	30.5	60.7	80.5	106	133	158	179	196	207	212	211	203	189	168	143	114	85.0	60.3	42.1
130	15.3	66.3	83.6	104	127	149	167	181	191	195	194	187	174	156	135	111	87.5	67.2	33.0
135	29.4	72.1	83.5	104	122	140	155	167	176	179	178	171	161	147	129	109	90.4	77.0	22.5
140	47.3	78.8	87.2	104	118	133	146	156	162	164	163	159	151	138	123	108	92.6	82.4	46.8
145	38.5	75.1	87.8	100	115	127	137	145	151	153	152	148	141	131	119	105	91.6	85.5	63.1
150	19.1	83.0	92.6	99.9	110	121	129	135	140	141	141	138	132	124	114	103	95.5	88.7	44.3
155	42.5	86.3	90.9	99.9	106	113	122	127	130	131	131	129	124	117	107	102	96.9	96.9	61.1
160	16.4	78.8	91.9	101	104	108	112	115	119	121	120	117	113	109	106	102	98.9	92.7	56.2
165	15.4	66.6	88.0	98.4	103	105	107	109	110	111	110	109	108	106	104	102	99.2	95.1	59.2
170	10.4	51.5	86.4	94.8	100	103	104	105	105	106	106	105	105	104	103	101	99.7	91.2	61.9
175	28.6	48.5	65.7	85.6	96.4	98.7	100	101	102	102	102	102	102	101	100	99.9	92.6	71.5	54.1
180	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5

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	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787		
5	786	787	787	787	787	787	787	786	786	785	783	782	781	780	779	778	778		
10	783	783	783	783	784	784	784	783	782	780	777	774	771	768	766	763	762		
15	769	770	772	773	774	776	777	776	774	771	766	761	756	751	746	742	739		
20	749	751	754	758	761	763	766	765	762	758	752	745	737	728	721	715	709		
25	720	724	730	737	742	746	750	750	748	741	734	725	713	702	691	681	675		
30	686	692	700	710	720	726	731	732	729	723	714	700	686	670	655	643	635		
35	645	654	666	680	692	702	708	711	709	701	690	674	656	636	617	601	589		
40	598	610	626	644	662	675	683	688	686	676	663	645	623	599	575	554	540		
45	546	560	583	606	627	644	656	661	659	650	635	613	587	559	531	505	486		
50	489	508	536	565	591	612	625	632	631	621	604	581	551	519	485	454	431		
55	428	453	487	522	553	577	594	603	601	591	573	547	514	477	438	401	373		
60	364	396	437	478	515	543	562	571	570	560	541	513	477	436	392	348	313		
65	298	337	387	435	477	507	528	539	538	527	508	478	441	396	346	295	253		
70	231	280	339	393	438	472	494	506	505	495	475	444	406	358	303	245	194		
75	166	226	293	353	401	437	460	473	473	462	442	411	372	322	264	200	139		
80	106	178	252	315	366	403	427	440	441	431	411	380	340	289	229	161	92.5		
85	61.0	139	216	281	333	371	395	408	410	400	381	350	310	259	199	129	58.9		
90	34.6	109	185	251	302	340	364	378	379	371	351	322	283	233	173	106	39.8		
95	25.4	90.4	161	224	274	311	335	349	350	342	324	296	258	210	153	90.6	29.4		
100	23.9	79.3	142	201	248	284	308	321	323	315	298	271	235	189	135	77.0	27.2		
105	24.6	74.2	129	181	226	260	282	295	297	290	274	248	212	169	121	75.9	25.3		
110	24.6	72.9	118	165	206	237	258	270	272	265	249	225	193	157	115	75.6	22.0		
115	20.4	73.8	111	152	188	216	236	247	249	243	230	209	181	146	109	76.6	17.9		
120	17.4	74.0	106	141	173	198	216	226	229	224	211	192	167	137	105	75.1	12.5		
125	7.98	65.7	103	132	160	182	198	207	209	205	194	177	155	130	97.8	70.6	5.38		
130	1.30	44.4	95.1	126	148	167	181	189	192	188	179	164	145	123	94.3	57.6	3.51		
135	0.55	5.11	67.5	117	137	155	166	173	176	172	165	152	136	112	91.9	46.8	2.42		
140	1.11	2.16	40.1	109	125	138	152	159	161	159	152	139	121	104	73.8	26.6	1.87		
145	11.7	12.0	25.0	81.6	118	127	134	139	141	139	133	125	104	82.3	35.5	8.94	11.9		
150	3.42	13.2	24.8	26.3	77.3	113	120	126	128	127	115	94.6	75.2	46.0	4.43	8.54	10.3		
155	20.8	12.1	20.2	11.0	17.5	47.1	90.0	99.9	106	96.8	70.7	62.0	31.6	11.2	9.27	23.3	16.9		
160	10.5	16.9	7.91	22.1	7.70	20.7	19.4	14.5	27.0	19.7	12.5	15.2	21.9	9.46	23.0	13.8	14.7		
165	27.3	20.7	11.4	13.1	21.3	19.0	12.8	7.85	8.12	13.3	11.3	15.7	15.0	9.63	16.8	7.48	16.7		
170	26.6	12.5	20.6	18.6	10.9	13.1	15.5	11.8	7.88	15.5	20.6	20.4	14.8	11.0	14.1	10.5	18.2		
175	40.6	15.9	9.50	22.7	24.8	20.7	19.6	16.6	12.1	13.1	15.7	14.0	12.1	8.81	17.3	10.2	5.22		
180	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5		

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, 2022	Aug. 04, 2023
Digital Power Meter	PF2010A	HZTE028-01	Aug. 05, 2022	Aug. 04, 2023
AC Power Supply	DPS1060	HZTE001-06	Aug. 05, 2022	Aug. 04, 2023
DC Power Supply	WY12010	HZTE004-03	Aug. 05, 2022	Aug. 04, 2023
Temperature recorder	JM624U	HZTE018-08	Aug. 05, 2022	Aug. 04, 2023
Temperature and humidity recorder	JR900	HZTE018-01	Aug. 05, 2022	Aug. 04, 2023
Standard source	D908	HZTE012-01	Aug. 05, 2022	Aug. 04, 2023
Integrate Sphere system	3M	HZTE015-04	Aug. 05, 2022	Aug. 04, 2023
Digital Power Meter	WT210	HZTE008-01	Aug. 05, 2022	Aug. 04, 2023
AC Power Supply	PCR 500L	HZTE001-07	Aug. 05, 2022	Aug. 04, 2023
DC Power Supply	IT6154	HZTE004-04	Aug. 05, 2022	Aug. 04, 2023
Standard source	SCL-1400	HZTE012-02	Aug. 05, 2022	Aug. 04, 2023
Temperature and humidity recorder	JR900	HZTE018-02	Aug. 05, 2022	Aug. 04, 2023
Temperature Meter	TES1310	HZTE017-01	Aug. 05, 2022	Aug. 04, 2023

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 ***