



LM-79-08 TEST REPORT

for

RAB Lighting INC

170 Ludlow Avenue, Northvale, New Jersey 07647 USA

LED TUBE

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

Laboratory: Leading Testing Laboratories

NVLAP CODE: 200960-0

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Report No.: HZ20090061m

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

Review by:

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Sep. 29, 2020

Approved by:



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Sep. 29, 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: **T5HO-25-48G-840-SE-BYP**

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)	Power Factor
140.8	3363.0	23.88	0.9935
CCT (K)	CRI	Stabilization Time (Light & Power)	
3964	83.8	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 : Oct. 29, 2019

Date of Test : Oct. 30, 2019

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)

Name	: LED TUBE
Model	: T5HO-25-48G-840-SE-BYP
Electrical Ratings	: 120-277V, 50/60Hz, 25W
Product Description	: 4000K

TEST RESULTS

Test ambient temperature was 26.0 °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)	0.200	0.094
Power Factor	0.9935	0.9188
Test Power (W)	23.88	23.95
THD A%	7.21	12.50
Luminous Efficacy (lm/W)	140.8	142.0
Total Luminous Flux (lm)	3363.0	3402.0
Color Rendering Index (CRI)	83.8	
R9	9	
Correlated Color Temperature (CCT)(K)	3964	
Chromaticity Chroma x	0.3833	
Chromaticity Chroma y	0.3825	
Chromaticity Chroma u	0.2247	
Chromaticity Chroma v	0.3364	
Duv	0.0019	
Chromaticity Chroma u'	0.2247	
Chromaticity Chroma v'	0.5045	

Special Color Rendering Indices	
R1	82.3
R2	92
R3	96
R4	81
R5	82.3
R6	88.7
R7	84.9
R8	63.4
R9	9
R10	80.8
R11	80.5
R12	63.8
R13	85.1
R14	98.4

Table 2: Test data per Sphere-Spectroradiometer Method

Note: According to CIE 1976 (u',v') diagram, $u' = u / (-2x + 12y + 3)$, $v' = 3v / 2 = 9y / (-2x + 12y + 3)$.

Goniophotometer Method

Test ambient temperature was 25.2 °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)	0.202
Power Factor	0.9934
Power (W)	24.03
Luminous Efficacy (lm/W)	138.3
Total Luminous Flux (lm)	3324.4
Beam Angle (°)	104.2 (0°-180°) / 143.3 (90°-270°)
Center Beam Candle Power (cd)	808
Maximum Beam Candle Power (cd)	808.2 (At: C=80.0, Gamma=1.5)
Spacing Criteria	1.22 (0°-180°) / 1.30 (90°-270°)
Zonal Lumens in the 0°-60° Zone	56.29%
Zonal Lumens in the 60°-90° Zone	26.13%
Zonal Lumens in the 90°-120° Zone	11.66%
Zonal Lumens in the 120°-180° Zone	5.93%

Table 3: Test data per Goniophotometer Method

Spectral Power Distribution - Sphere Spectroradiometer Method

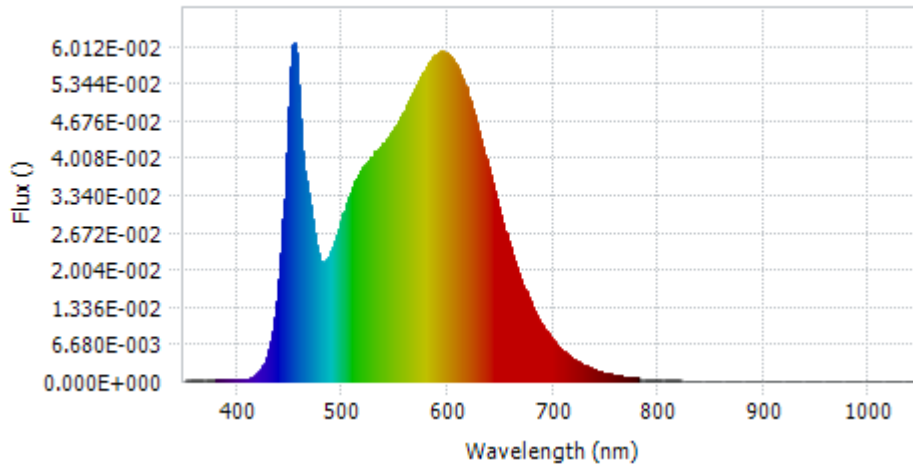
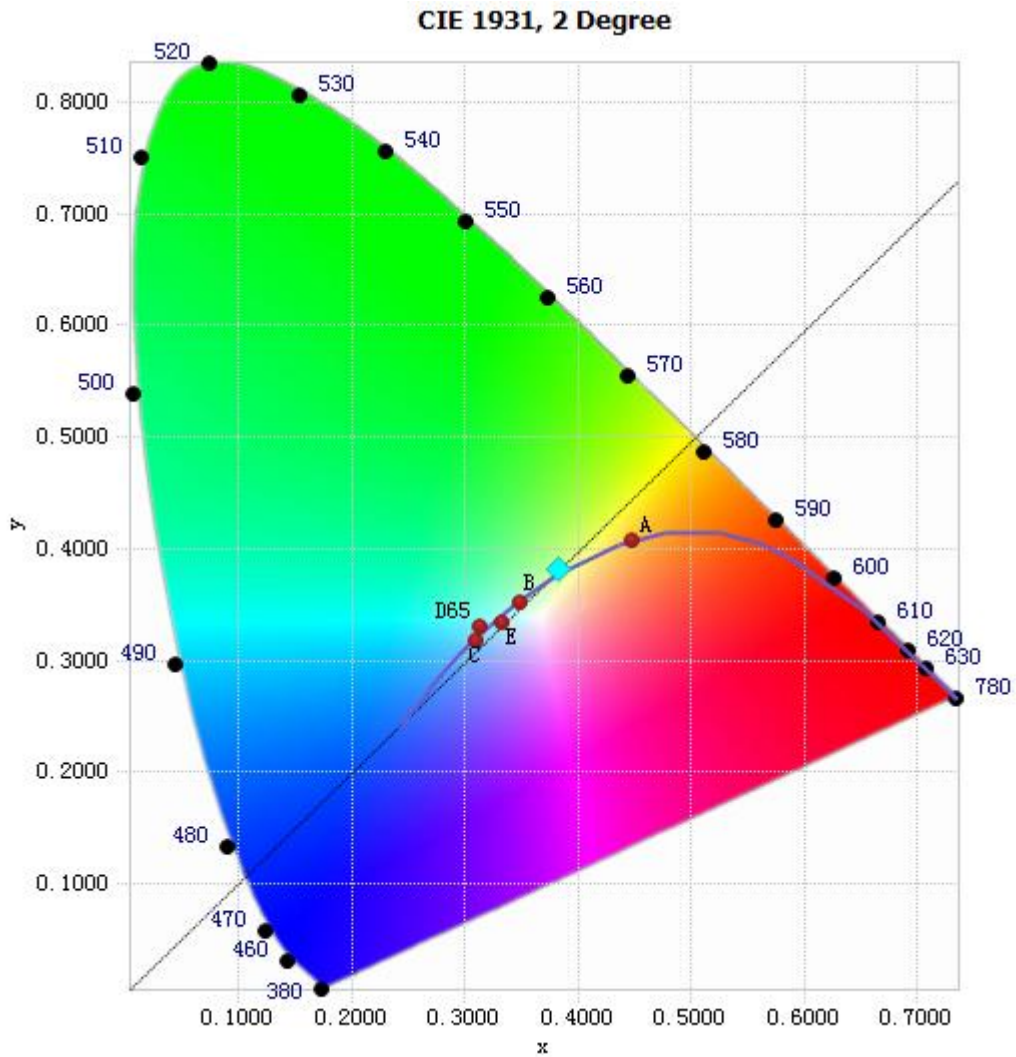


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	3.23E-04	485	2.18E-02	590	5.87E-02	695	8.54E-03
385	2.84E-04	490	2.37E-02	595	5.89E-02	700	7.30E-03
390	2.76E-04	495	2.63E-02	600	5.86E-02	705	6.24E-03
395	2.54E-04	500	2.94E-02	605	5.75E-02	710	5.29E-03
400	2.21E-04	505	3.24E-02	610	5.60E-02	715	4.51E-03
405	2.66E-04	510	3.49E-02	615	5.36E-02	720	3.86E-03
410	4.04E-04	515	3.71E-02	620	5.06E-02	725	3.29E-03
415	7.38E-04	520	3.81E-02	625	4.76E-02	730	2.79E-03
420	1.46E-03	525	3.96E-02	630	4.42E-02	735	2.36E-03
425	2.90E-03	530	4.05E-02	635	4.05E-02	740	2.00E-03
430	5.61E-03	535	4.16E-02	640	3.69E-02	745	1.72E-03
435	1.02E-02	540	4.28E-02	645	3.33E-02	750	1.46E-03
440	1.83E-02	545	4.40E-02	650	2.98E-02	755	1.23E-03
445	3.26E-02	550	4.56E-02	655	2.64E-02	760	1.06E-03
450	5.29E-02	555	4.73E-02	660	2.33E-02	765	8.96E-04
455	6.02E-02	560	4.88E-02	665	2.05E-02	770	7.68E-04
460	4.70E-02	565	5.09E-02	670	1.79E-02	775	6.50E-04
465	3.60E-02	570	5.29E-02	675	1.56E-02	780	5.61E-04
470	3.02E-02	575	5.47E-02	680	1.34E-02		
475	2.46E-02	580	5.65E-02	685	1.16E-02		
480	2.14E-02	585	5.79E-02	690	9.97E-03		

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

Chromaticity Diagram - Sphere Spectroradiometer Method



Tristimulus values(x, y): (0.3833, 0.3825)

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

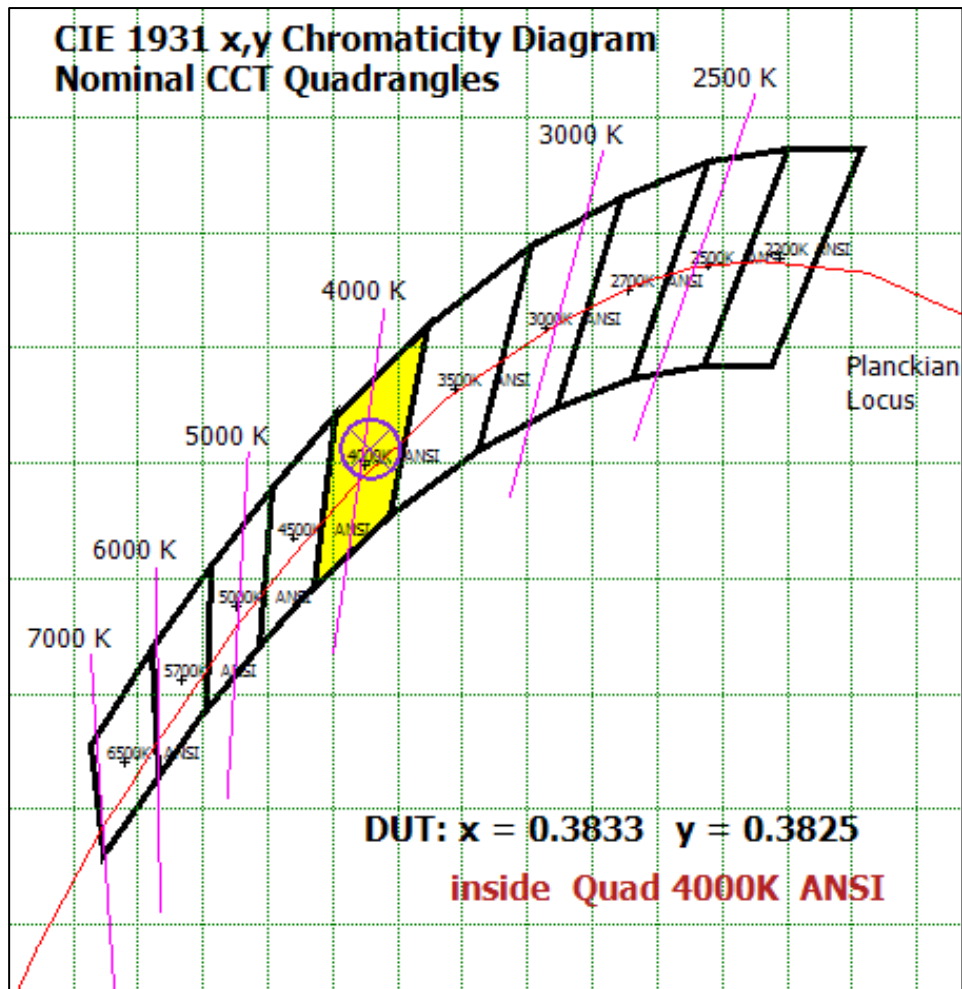
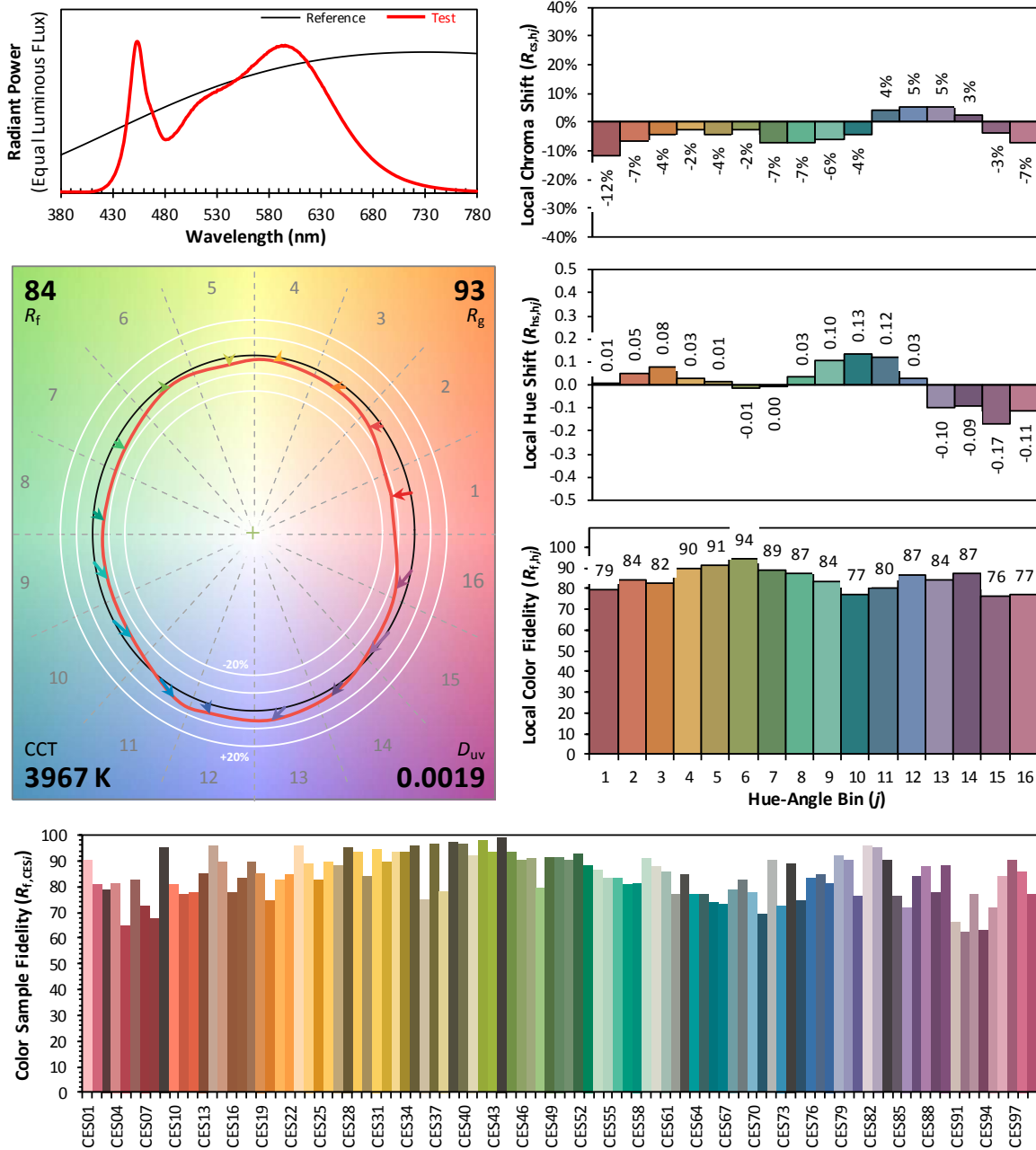


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

Color Rendition Report – Sphere Spectroradiometer Method



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

x	0.3833
y	0.3825
u'	0.2247
v'	0.5045

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	76.485	2.30%
10- 20	219.33	6.60%
20- 30	333.345	10.03%
30- 40	404.599	12.17%
40- 50	428.303	12.88%
50- 60	409.281	12.31%
60- 70	358.289	10.78%
70- 80	289.714	8.71%
80- 90	220.58	6.64%
90-100	165.477	4.98%
100-110	125.855	3.79%
110-120	96.174	2.89%
120-130	72.12	2.17%
130-140	52.098	1.57%
140-150	35.464	1.07%
150-160	21.726	0.65%
160-170	11.596	0.35%
170-180	3.971	0.12%
Total	3324.4	100%

$\gamma(^{\circ})$	Lumens	% Total
0- 60	1871.343	56.29%
60- 90	868.583	26.13%
0-90	2739.926	82.42%
90- 180	584.481	17.58%
0- 180	3324.4	100%

Table 5: Zonal Lumen

Illuminance Plots- Goniophotometer Method

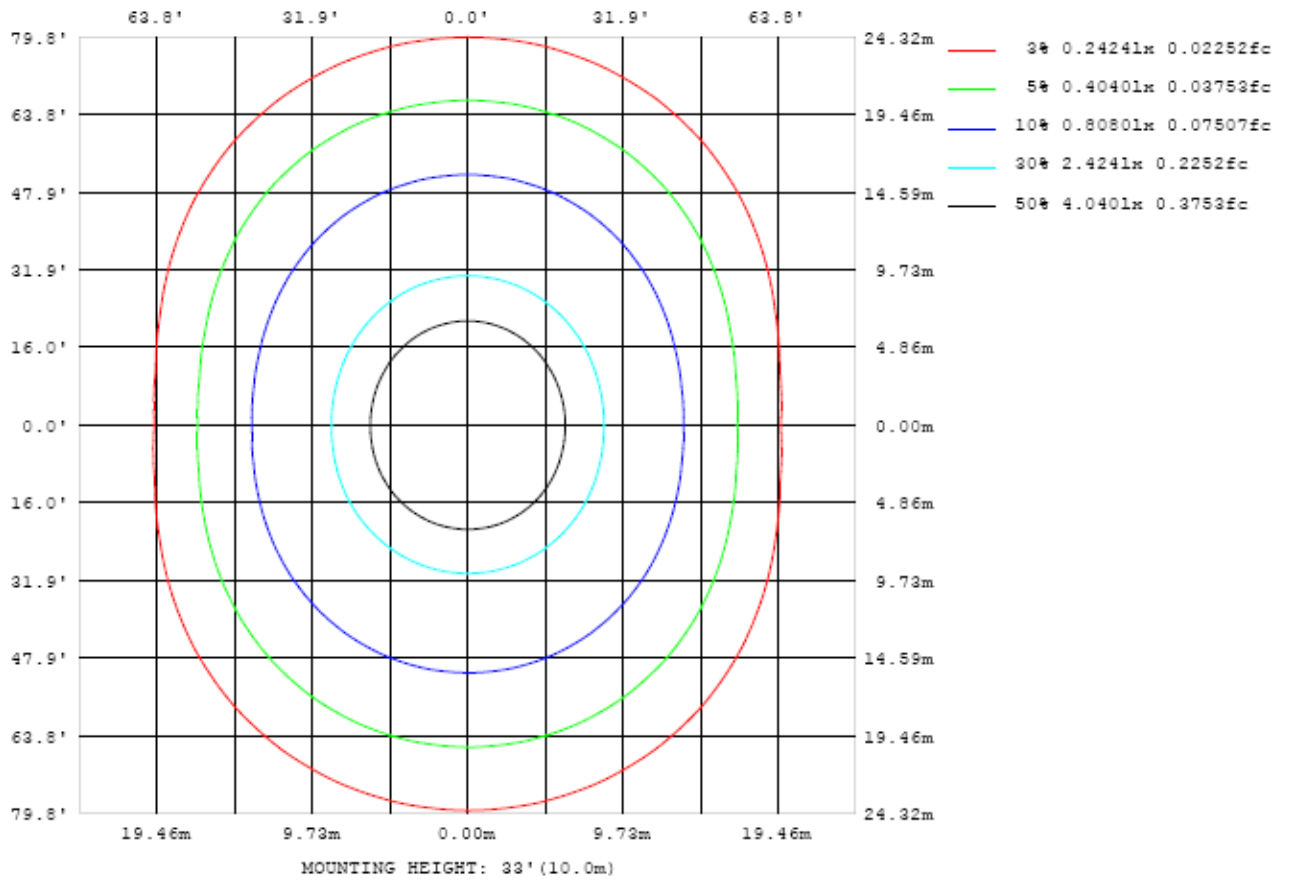


Chart 5: Illuminance Plot (Footcandles)

Luminous Intensity Distribution Plots- Goniophotometer Method

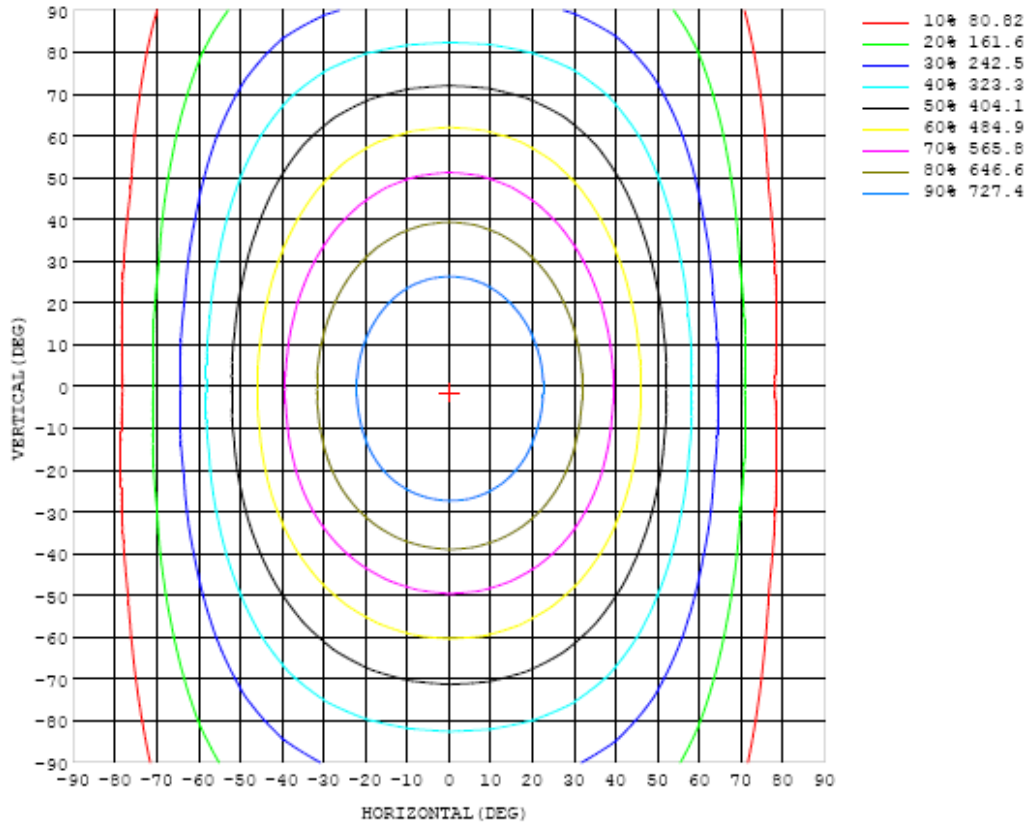


Chart 6: Isocandela Plot

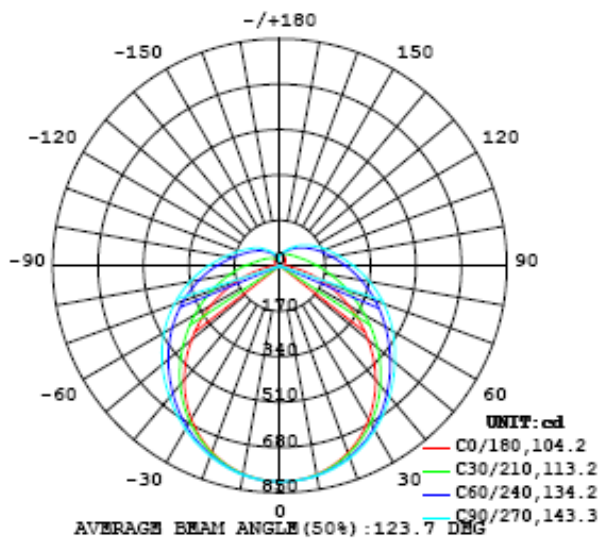


Chart 7: Polar Candela Distribution

Luminous Intensity Data- Goniophotometer Method

Table--1 UNIT: cd

C (DEG) y (DEG)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
0	808	808	808	808	808	808	808	808	808	808	808	808	808	808	808	808	808	808	808
5	805	805	805	805	805	806	806	806	806	806	806	806	805	805	805	804	804	804	804
10	793	793	794	795	795	796	797	798	798	798	798	797	796	795	794	792	792	791	791
15	773	773	774	776	778	781	782	784	785	785	785	783	782	779	777	775	772	771	770
20	745	746	748	751	755	759	762	765	766	766	766	764	761	757	753	749	745	743	742
25	709	710	713	718	725	730	735	739	741	741	740	738	734	729	723	717	711	707	706
30	665	667	672	680	688	696	703	707	710	711	709	706	701	695	687	679	671	665	663
35	614	617	625	636	646	657	665	671	675	676	674	670	663	655	645	634	624	615	613
40	558	562	572	586	600	613	625	633	638	639	637	631	623	612	599	585	572	561	556
45	497	502	515	533	551	568	582	593	599	601	598	591	580	566	550	532	515	501	496
50	432	438	456	478	501	522	540	553	561	563	559	551	537	520	499	477	456	438	431
55	365	374	395	422	450	476	498	513	523	525	521	511	495	474	449	422	396	374	365
60	298	309	336	369	402	433	457	475	485	488	484	473	455	430	401	368	336	310	299
65	233	247	279	318	357	391	418	437	448	451	447	435	415	388	355	318	280	248	234
70	171	188	227	272	315	351	380	400	411	414	410	397	377	349	313	271	228	190	172
75	113	135	181	231	276	314	343	363	374	377	373	360	341	312	275	230	182	138	114
80	62.1	90.1	142	195	242	280	309	328	338	341	337	325	306	278	240	195	143	93.2	63.6
85	21.8	56.3	112	165	212	249	276	295	305	307	303	292	274	246	210	165	113	58.6	22.5
90	0.71	35.9	89.5	142	185	221	247	264	274	276	272	262	245	219	184	141	89.5	36.7	0.56
95	2.88	26.7	74.1	122	163	197	221	237	246	248	245	235	219	194	161	121	73.5	26.4	2.21
100	5.02	23.2	63.5	107	145	175	198	213	221	223	220	211	196	173	144	106	62.7	22.3	4.53
105	8.47	22.9	55.7	94.5	130	158	178	192	199	201	198	190	177	156	128	93.0	54.3	22.1	7.98
110	12.6	24.8	51.1	83.6	116	142	161	174	181	183	180	172	159	140	114	82.0	49.7	24.0	12.2
115	16.8	27.2	48.4	75.9	103	127	145	157	164	166	163	156	144	125	101	74.1	47.0	26.0	16.2
120	21.0	29.9	46.9	70.0	93.3	114	130	141	148	149	147	140	129	112	91.2	68.4	45.7	28.4	20.1
125	25.1	32.4	46.3	65.1	85.2	103	116	127	133	134	132	126	115	101	83.5	63.9	44.8	31.1	23.9
130	28.3	34.6	46.1	61.2	77.9	93.2	105	114	119	120	118	113	104	91.9	76.9	60.2	44.5	33.6	27.2
135	31.0	36.5	46.0	58.1	71.6	84.4	95.1	103	107	108	106	102	94.2	83.8	71.0	57.1	44.6	35.8	30.4
140	33.7	38.2	45.9	55.4	66.1	76.5	85.3	91.9	95.8	96.9	95.4	91.4	84.9	76.2	65.7	54.6	44.8	37.8	33.4
145	36.3	39.7	45.8	53.2	61.4	69.5	76.6	82.0	85.2	86.1	84.8	81.6	76.4	69.4	61.1	52.5	44.9	39.4	36.2
150	37.5	39.3	45.4	51.3	57.4	63.5	68.9	73.0	75.6	76.2	75.4	72.8	68.7	63.4	57.0	50.6	44.9	40.7	38.0
155	38.9	40.9	45.4	49.5	53.9	58.1	62.1	65.2	67.0	67.5	66.9	65.1	62.1	58.1	53.6	49.0	44.9	41.8	39.9
160	39.4	41.2	44.1	47.8	50.8	53.8	56.3	58.4	59.6	60.0	59.7	58.5	56.4	53.7	50.7	47.6	44.9	42.7	41.2
165	39.4	40.5	43.7	46.2	48.1	49.9	51.6	52.9	53.7	53.9	53.8	53.1	51.8	50.2	48.3	46.5	44.8	43.5	42.5
170	39.2	41.2	42.8	44.9	45.9	46.8	47.7	48.4	48.9	49.1	49.0	48.6	48.0	47.3	46.3	45.4	44.6	43.9	43.3
175	40.6	42.2	42.6	43.7	44.4	44.7	45.0	45.2	45.4	45.5	45.5	45.4	45.2	45.0	44.7	44.4	44.0	43.7	43.5
180	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3

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	808	808	808	808	808	808	808	808	808	808	808	808	808	808	808	808	808		
5	804	804	804	804	804	804	804	805	805	805	805	805	805	805	805	805	805		
10	791	791	792	793	793	794	795	795	795	795	795	795	795	794	794	793	793		
15	770	771	772	774	776	777	778	779	779	780	779	778	777	776	775	774	773		
20	742	743	746	749	752	755	757	759	759	759	758	756	753	751	748	746	745		
25	707	709	713	717	723	728	731	734	734	734	732	728	724	719	715	711	709		
30	664	667	673	681	689	696	702	705	706	705	702	696	690	682	675	670	666		
35	614	620	629	640	651	661	669	673	675	673	669	661	651	641	630	622	616		
40	559	568	580	596	610	623	634	640	642	640	634	623	610	595	581	569	561		
45	500	511	529	548	568	585	598	606	609	606	598	585	568	548	529	512	501		
50	437	453	475	500	524	545	561	571	574	571	561	546	524	500	475	453	437		
55	372	393	421	452	481	505	524	535	539	535	524	506	482	452	421	393	372		
60	308	333	368	404	438	465	485	497	501	497	486	466	439	405	369	334	308		
65	245	277	318	358	395	424	445	457	461	458	446	425	396	360	319	278	246		
70	186	224	271	315	353	383	404	416	421	417	405	385	355	317	273	226	187		
75	132	178	228	274	313	343	364	376	380	377	365	345	316	277	231	180	133		
80	86.2	138	190	237	276	306	326	337	341	338	327	308	279	240	194	141	88.5		
85	52.3	105	158	204	242	270	289	299	303	300	290	272	245	208	162	109	55.7		
90	31.0	80.7	131	175	210	236	254	263	267	264	255	238	213	178	135	84.8	34.2		
95	20.7	62.1	108	148	181	206	222	231	234	232	224	208	185	153	112	66.6	23.9		
100	18.0	51.4	90.4	127	157	180	195	203	206	204	196	182	160	131	94.8	55.5	20.6		
105	17.3	44.8	78.6	110	137	157	171	179	182	180	173	160	140	114	82.9	48.9	19.5		
110	17.0	40.0	69.4	97.5	121	139	152	159	161	160	153	142	124	101	73.5	44.9	20.0		
115	18.3	36.7	62.0	86.6	108	124	136	142	144	143	137	126	111	90.0	66.1	41.9	21.1		
120	19.2	32.0	54.9	77.2	96.2	111	121	127	130	128	123	113	98.9	80.7	59.9	39.8	22.0		
125	20.3	31.5	49.6	68.4	85.8	99.2	109	114	116	115	110	101	88.4	72.1	55.2	38.2	22.5		
130	22.3	31.0	45.7	60.5	75.6	88.3	96.9	102	104	103	98.0	89.9	78.3	64.3	51.2	35.9	24.1		
135	25.4	29.6	40.7	53.9	66.1	76.7	85.1	90.0	91.8	90.7	86.2	78.6	69.1	58.4	46.3	32.6	26.2		
140	29.3	26.3	37.9	48.7	58.6	67.0	73.1	77.3	79.0	78.0	74.6	69.2	61.7	53.3	40.5	28.8	29.7		
145	33.1	24.5	35.3	44.1	51.2	59.0	64.4	67.4	68.6	68.3	65.9	60.7	52.7	45.2	36.5	27.1	34.6		
150	36.4	31.0	29.6	39.4	46.8	51.9	55.5	57.5	58.7	58.1	55.6	49.5	46.8	40.2	30.8	30.9	37.0		
155	38.2	33.7	24.7	28.0	38.0	45.9	48.5	50.7	51.0	50.0	40.8	36.2	34.0	31.4	26.8	34.0	38.2		
160	40.4	39.6	29.2	23.0	25.4	27.1	35.5	41.1	45.2	27.4	31.6	29.7	27.3	25.7	28.6	33.4	37.6		
165	41.5	40.9	40.5	34.3	24.8	26.7	33.0	37.1	18.3	36.8	32.8	28.8	25.2	26.1	28.6	32.3	35.5		
170	42.7	42.4	41.9	41.1	40.1	38.4	35.0	35.8	22.4	29.6	29.8	29.7	26.3	29.2	29.8	32.5	36.5		
175	43.2	43.0	42.9	42.8	42.7	42.7	42.2	40.9	40.1	39.4	38.7	37.2	36.7	37.2	38.5	39.9	40.4		
180	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3		

Table 7: Luminous Intensity Data

EQUIPMENT LIST

Test Equipment	Model	Equipment No.	Calibration Date	Calibration Due date
Goniophotometer system	GO-R5000	HZTE011-01	Aug. 02, 2019	Aug. 01, 2020
Digital Power Meter	PF2010A	HZTE028-01	Aug. 02, 2019	Aug. 01, 2020
AC Power Supply	DPS1060	HZTE001-06	Aug. 02, 2019	Aug. 01, 2020
DC Power Supply	WY12010	HZTE004-03	Aug. 02, 2019	Aug. 01, 2020
Temperature recorder	JM624U	HZTE018-08	Aug. 02, 2019	Aug. 01, 2020
Temperature and humidity recorder	JR900	HZTE018-01	Aug. 02, 2019	Aug. 01, 2020
Standard source	D908	HZTE012-01	Aug. 02, 2019	Aug. 01, 2020
Integrate Sphere system	2M	HZTE015-01	Aug. 02, 2019	Aug. 01, 2020
Digital Power Meter	WT210	HZTE008-01	Aug. 02, 2019	Aug. 01, 2020
AC Power Supply	PCR 500L	HZTE001-07	Aug. 02, 2019	Aug. 01, 2020
DC Power Supply	IT6154	HZTE004-04	Aug. 02, 2019	Aug. 01, 2020
Standard source	SCL-1400	HZTE012-02	Aug. 02, 2019	Aug. 01, 2020
Temperature and humidity recorder	JR900	HZTE018-02	Aug. 02, 2019	Aug. 01, 2020
Temperature Meter	TES1310	HZTE017-01	Aug. 02, 2019	Aug. 01, 2020

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 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

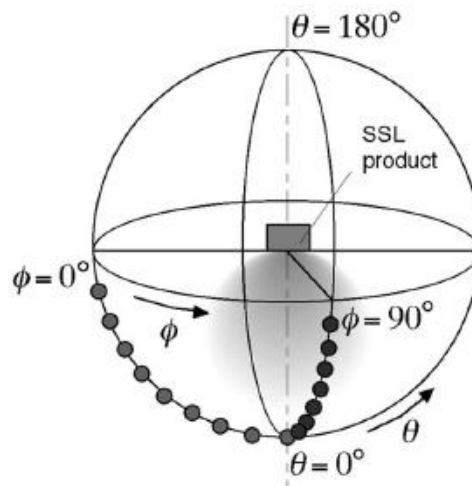
The color characteristics of SSL products include chromaticity coordinates, correlated color temperature, and color rendering index. These characteristics of SSL products may be spatially non-uniform, and thus, in order that they can be specified accurately, the color quantities shall be measured as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