

LM-79-08 TEST REPORT

for

ESPEN TECHNOLOGY, INC.

12257 FLORENCE AVE SANTA FE SPRINGS, CA. 90670-3805. LOS ANGELES US

LED Tube

Model: L24T8/8T/9G-AB

Laboratory: Leading Testing Laboratories

NVLAP CODE: 200960-0

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Report No.: HZ24030021a

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

Review by:

Wei Fei



Approved by:

April Zou

Engineer: Wei Fei
Mar. 18, 2024

Manager: April Zou
Mar. 18, 2024

Note: This report does not imply product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

TEST SUMMARY

Tested Model	L24T8/8T/9G-AB 3500K Setting	L24T8/8T/9G-AB 4000K Setting	L24T8/8T/9G-AB 5000K Setting
Luminous Efficacy (Lumens /Watt)	122.9	130.4	124.9
Total Luminous Flux (Lumens)	1491.7	1564.8	1518.1
Power (Watts)/2	12.14	12.00	12.15
Power Factor	0.9967	0.9966	0.9966
CCT (K)	3454	4276	5221
CRI	83.7	85.5	85.2
Stabilization Time (Light & Power)	60 mins	60 mins	60 mins
Note	3500K	4000K	5000K

Table 1: Executive Data Summary

Test specifications:

Date of Receipt	: Apr. 12, 2021
Date of Test	: Apr. 14, 2021
Test item	: Total Luminous Flux, Luminous Distribution Intensity, Luminous Efficacy, Correlated Color Temperature, Color Rendering Index, Chromaticity Coordinate, Electrical parameters In-Situ Maximum Temperature
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 ANSI/UL 8750-2011 Light Emitting Diode (LED) Equipment for Use in Lighting Products UL 1993 Self-Ballasted Lamps and Lamp Adapters

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SAMPLE PHOTO

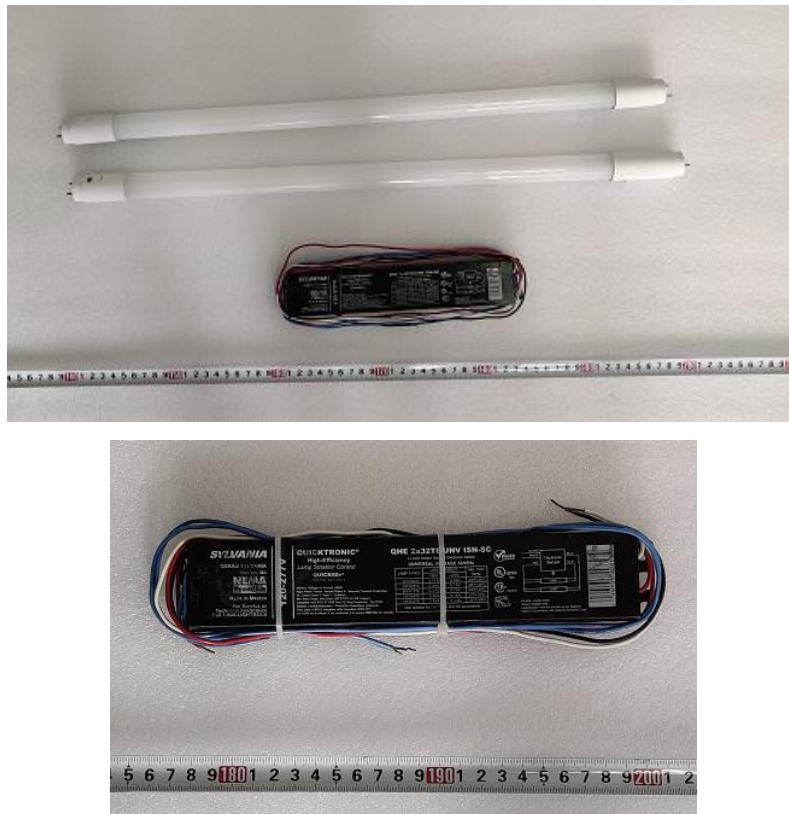


Figure 1- Overview of the sample

Equipment Under Test(EUT)

Name	: LED Tube
Model	: L24T8/8T/9G-AB
Electrical Ratings	: 120-277V, 50/60Hz, 9W
Product Description	: Color- Tunable 3500K/4000K/5000K LED Tubes supplied by a high frequency fluorescent lamp ballast: QHE 2x32T8/UNV ISN-SC

TEST RESULTS (3500K Setting)

Test ambient temperature was 26.0 °C.

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

The sample was adjusted and tested at 3500K and 100% dimming setting.

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)	0.202	0.094
Power Factor	0.9967	0.9474
Test Power (W)/2	12.14	12.35
THD A%	6.18	12.03
Luminous Efficacy (lm/W)	122.9	120.9
Total Luminous Flux (lm)	1491.7	1492.3
Color Rendering Index (CRI)	83.7	
R9	9.8	
Correlated Color Temperature (CCT)(K)	3454	
Chromaticity Chroma x	0.4079	
Chromaticity Chroma y	0.3922	
Chromaticity Chroma u	0.2368	
Chromaticity Chroma v	0.3415	
Duv	0.0001	
Chromaticity Chroma u'	0.2368	
Chromaticity Chroma v'	0.5123	

Special Color Rendering Indices	
R1	82
R2	90.3
R3	96.5
R4	82.8
R5	82.4
R6	87.7
R7	84.9
R8	62.7
R9	9.8
R10	77.8
R11	82.6
R12	69.4
R13	84
R14	98.4

Table 2: Test data per Sphere-Spectroradiometer Method

Note: According to CIE 1976 (u', v') diagram, $u' = u = 4x/(-2x+12y+3)$, $v' = 3v/2 = 9y/(-2x+12y+3)$.

Spectral Power Distribution - Sphere Spectroradiometer Method (3500K Setting)

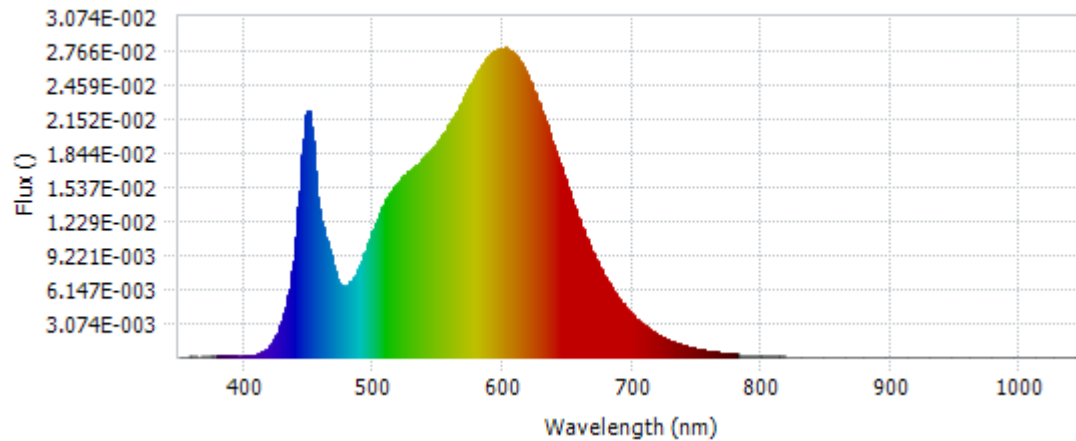
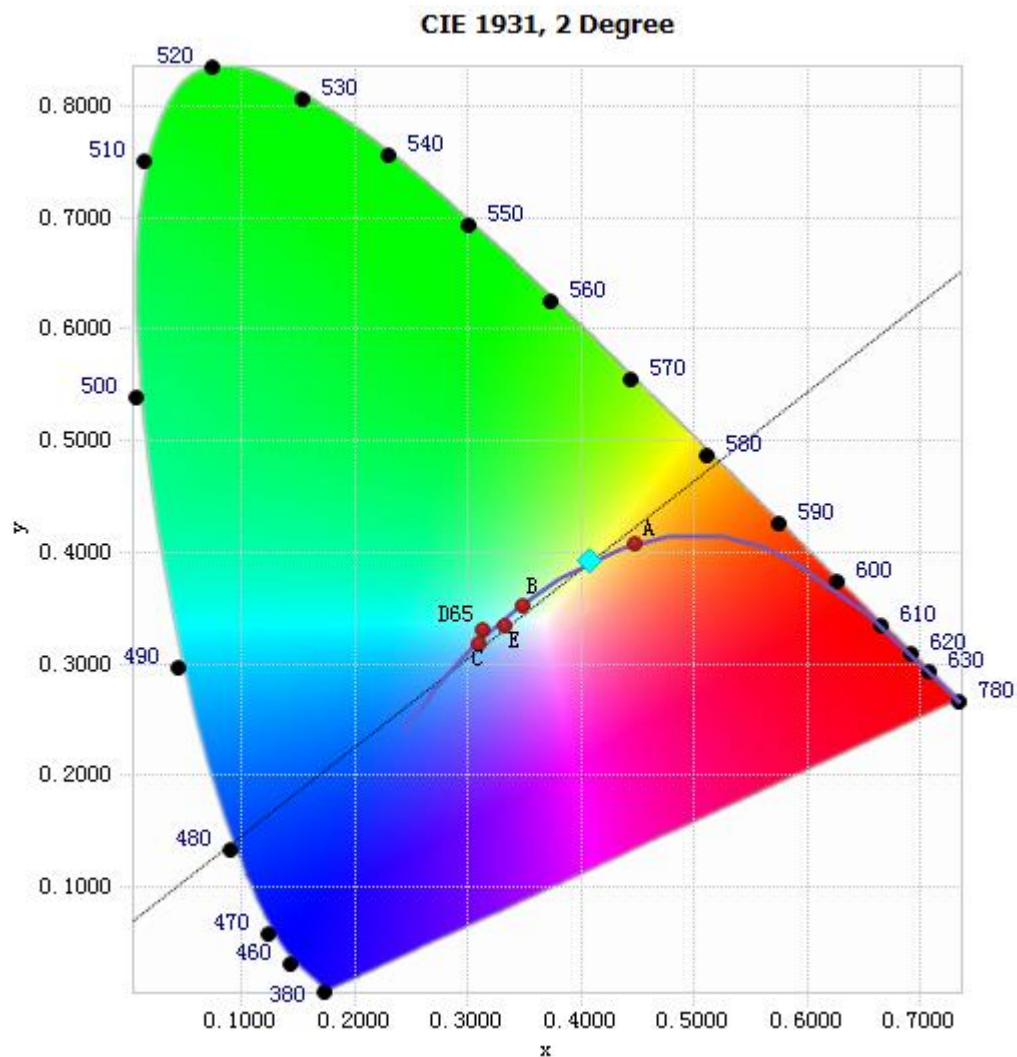


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	1.10E-04	485	7.24E-03	590	2.73E-02	695	4.50E-03
385	1.08E-04	490	8.40E-03	595	2.77E-02	700	3.86E-03
390	1.01E-04	495	9.98E-03	600	2.79E-02	705	3.31E-03
395	9.40E-05	500	1.16E-02	605	2.77E-02	710	2.81E-03
400	1.01E-04	505	1.31E-02	610	2.72E-02	715	2.40E-03
405	1.42E-04	510	1.42E-02	615	2.64E-02	720	2.05E-03
410	2.77E-04	515	1.53E-02	620	2.52E-02	725	1.75E-03
415	5.40E-04	520	1.59E-02	625	2.39E-02	730	1.49E-03
420	1.03E-03	525	1.65E-02	630	2.23E-02	735	1.26E-03
425	1.96E-03	530	1.70E-02	635	2.06E-02	740	1.07E-03
430	3.57E-03	535	1.75E-02	640	1.89E-02	745	9.14E-04
435	6.20E-03	540	1.81E-02	645	1.71E-02	750	7.80E-04
440	1.08E-02	545	1.88E-02	650	1.54E-02	755	6.62E-04
445	1.82E-02	550	1.95E-02	655	1.37E-02	760	5.64E-04
450	2.22E-02	555	2.03E-02	660	1.21E-02	765	4.82E-04
455	1.68E-02	560	2.13E-02	665	1.07E-02	770	4.10E-04
460	1.22E-02	565	2.23E-02	670	9.34E-03	775	3.49E-04
465	1.02E-02	570	2.34E-02	675	8.16E-03	780	3.01E-04
470	7.82E-03	575	2.46E-02	680	7.08E-03		
475	6.44E-03	580	2.57E-02	685	6.10E-03		
480	6.55E-03	585	2.66E-02	690	5.26E-03		

Table 3: Spectral Power Distribution Numerical Data per Sphere - Spectroradiometer Method

Chromaticity Diagram - Sphere Spectroradiometer Method (3500K Setting)



Tristimulus values(x, y): (0.4079, 0.3922)

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 (3500K Setting)

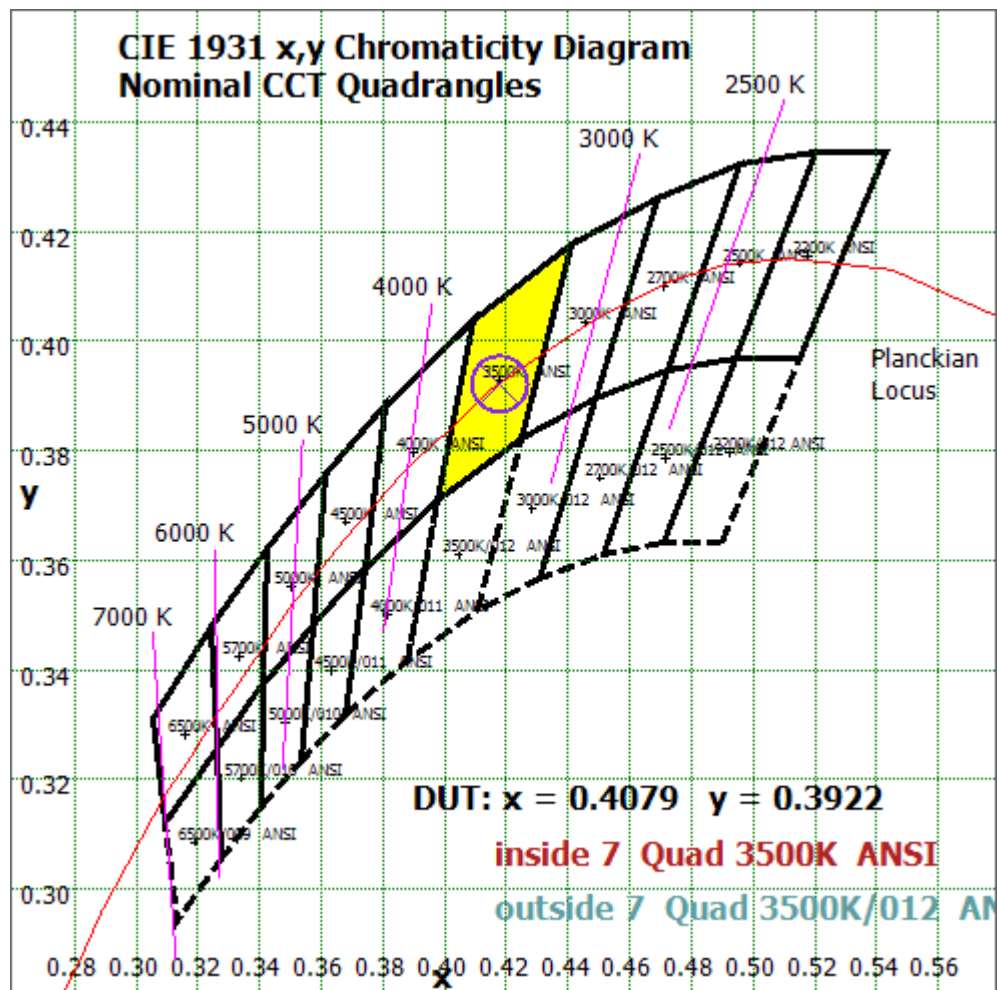


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

Color Rendition Report – Sphere Spectroradiometer Method (3500K Setting)

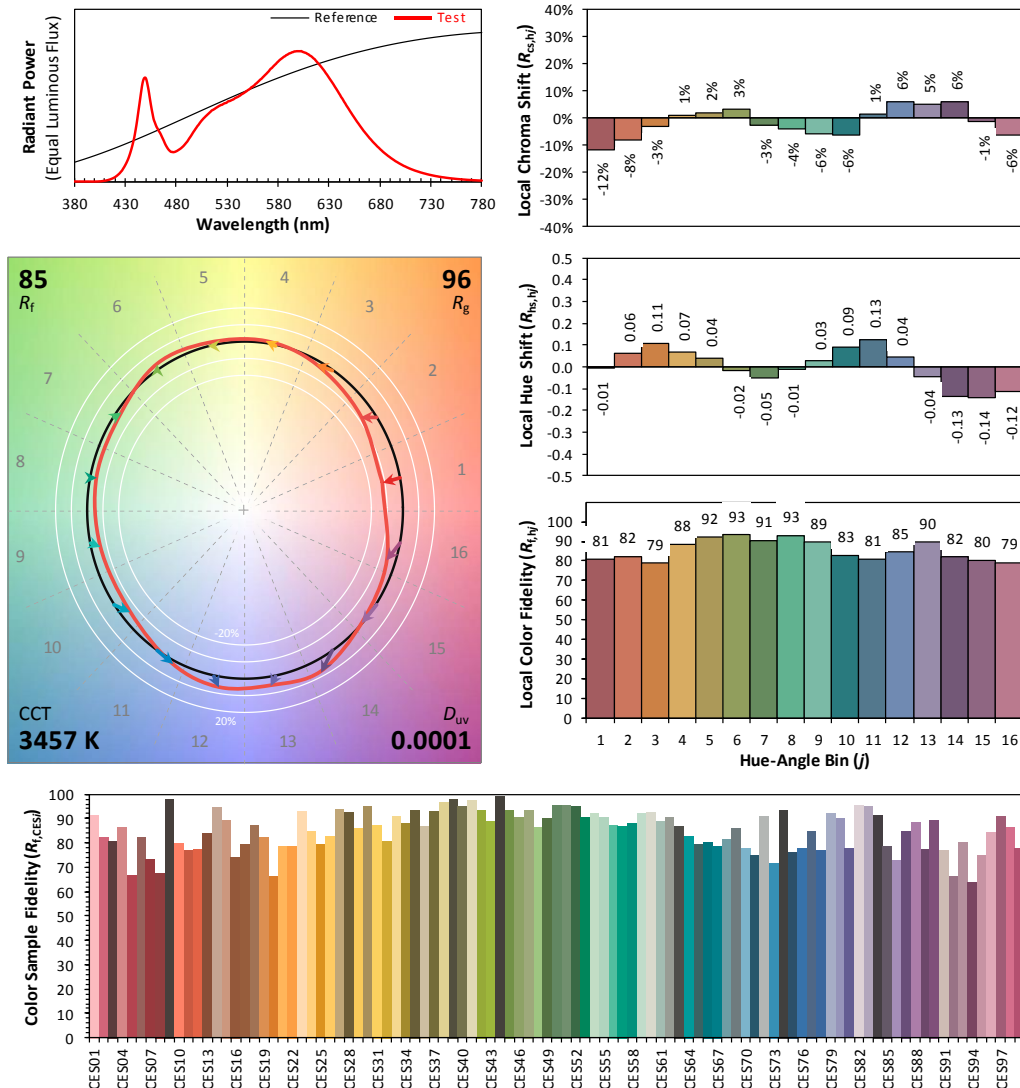
ANSI/IES TM-30-18 Color Rendition Report

Source: LED

Manufacturer: ESPEN TECHNOLOGY, INC.

Date: 2021/04/14

Model: L24T8/8T/9G-AB



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

x 0.4079
 y 0.3922
 u' 0.2368
 v' 0.5123

CIE 13.3-1995
(CRI)
 R_a 84
 R_9 10

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.

TEST RESULTS (4000K Setting)

Test ambient temperature was 26.0 °C.

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

The sample was adjusted and tested at 4000K and 100% dimming setting.

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	0.093
Power Factor	0.9966	0.9461
Test Power (W)/2	12.00	12.23
THD A%	6.21	12.14
Luminous Efficacy (lm/W)	130.4	128.0
Total Luminous Flux (lm)	1564.8	1565.3
Color Rendering Index (CRI)	85.5	
R9	18.2	
Correlated Color Temperature (CCT)(K)	4276	
Chromaticity Chroma x	0.3684	
Chromaticity Chroma y	0.3669	
Chromaticity Chroma u	0.2211	
Chromaticity Chroma v	0.3302	
Duv	-0.0010	
Chromaticity Chroma u'	0.2211	
Chromaticity Chroma v'	0.4954	

Special Color Rendering Indices	
R1	84.8
R2	93.4
R3	95.8
R4	83
R5	84.6
R6	89.3
R7	85.8
R8	67.4
R9	18.2
R10	83.4
R11	82.7
R12	64.2
R13	87.6
R14	98.5

Table 4: Test data per Sphere-Spectroradiometer Method

Note: According to CIE 1976 (u', v') diagram, $u' = u = 4x/(-2x+12y+3)$, $v' = 3v/2 = 9y/(-2x+12y+3)$.

Spectral Power Distribution - Sphere Spectroradiometer Method (4000K Setting)

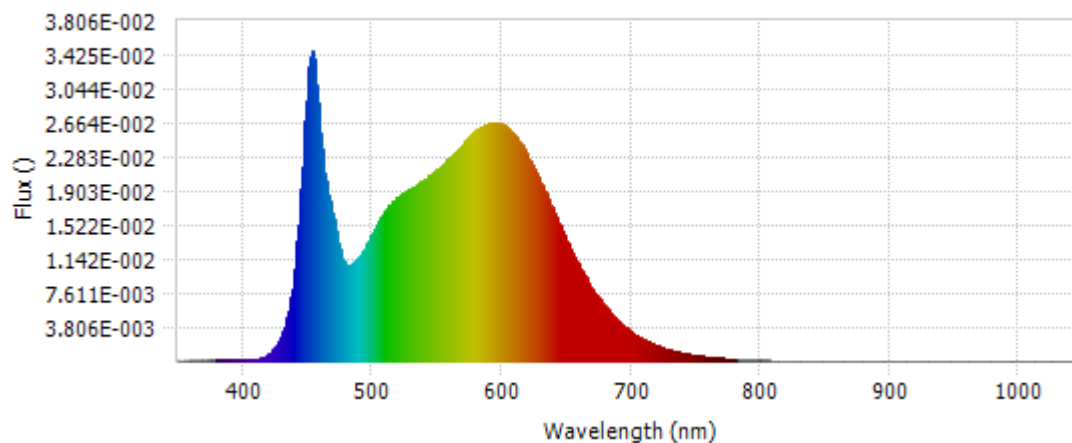
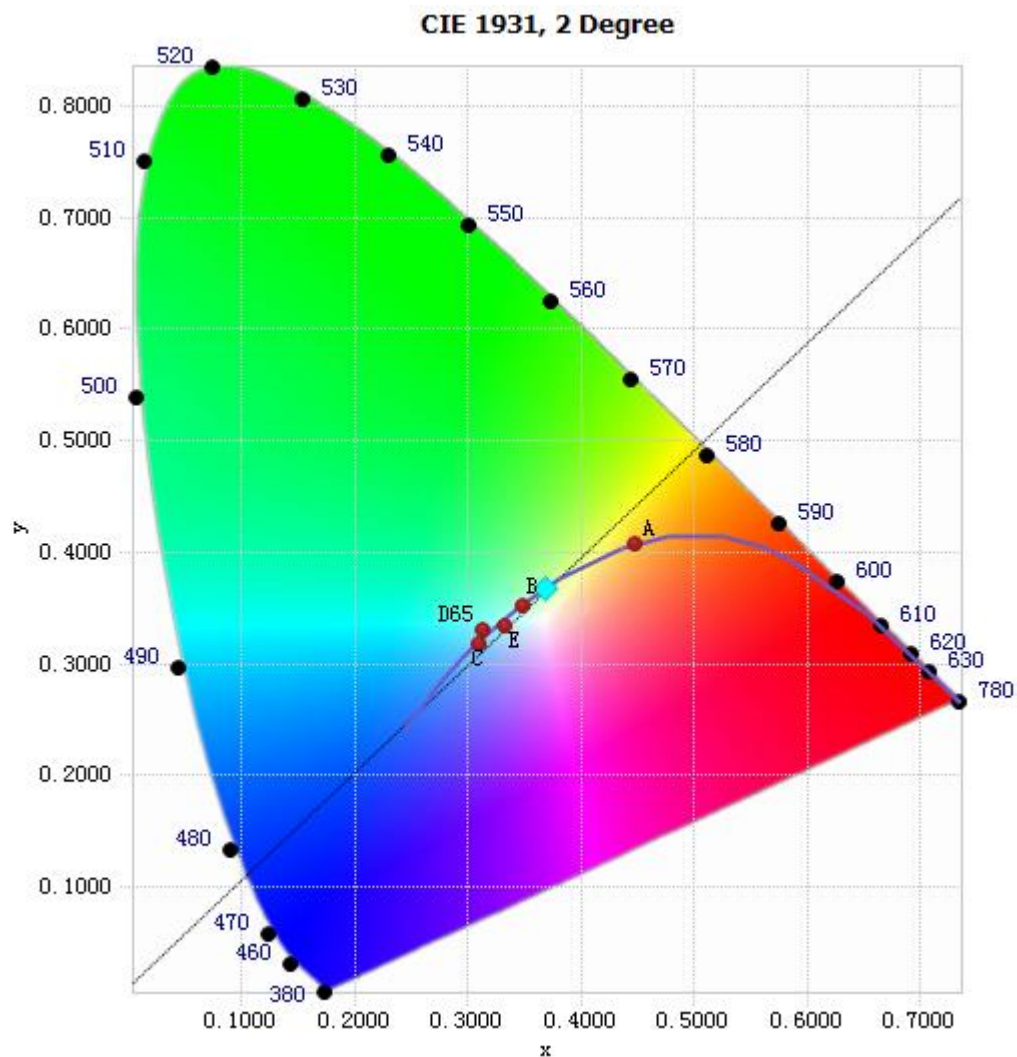


Chart 5: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	1.58E-04	485	1.10E-02	590	2.66E-02	695	3.89E-03
385	1.44E-04	490	1.17E-02	595	2.67E-02	700	3.33E-03
390	1.55E-04	495	1.28E-02	600	2.65E-02	705	2.84E-03
395	1.49E-04	500	1.43E-02	605	2.60E-02	710	2.42E-03
400	1.46E-04	505	1.58E-02	610	2.53E-02	715	2.06E-03
405	1.62E-04	510	1.68E-02	615	2.42E-02	720	1.76E-03
410	2.40E-04	515	1.78E-02	620	2.30E-02	725	1.50E-03
415	4.30E-04	520	1.84E-02	625	2.16E-02	730	1.27E-03
420	8.07E-04	525	1.89E-02	630	2.00E-02	735	1.08E-03
425	1.57E-03	530	1.93E-02	635	1.84E-02	740	9.20E-04
430	3.01E-03	535	1.98E-02	640	1.68E-02	745	7.88E-04
435	5.64E-03	540	2.02E-02	645	1.51E-02	750	6.70E-04
440	1.04E-02	545	2.08E-02	650	1.35E-02	755	5.70E-04
445	1.93E-02	550	2.14E-02	655	1.20E-02	760	4.86E-04
450	3.12E-02	555	2.20E-02	660	1.06E-02	765	4.15E-04
455	3.38E-02	560	2.27E-02	665	9.33E-03	770	3.55E-04
460	2.54E-02	565	2.35E-02	670	8.11E-03	775	3.02E-04
465	1.93E-02	570	2.43E-02	675	7.07E-03	780	2.61E-04
470	1.60E-02	575	2.51E-02	680	6.13E-03		
475	1.25E-02	580	2.58E-02	685	5.29E-03		
480	1.08E-02	585	2.63E-02	690	4.53E-03		

Table 5: Spectral Power Distribution Numerical Data per Sphere - Spectroradiometer Method

Chromaticity Diagram - Sphere Spectroradiometer Method (4000K Setting)



Tristimulus values(x, y): (0.3684, 0.3669)

Chart 6: 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 (4000K Setting)

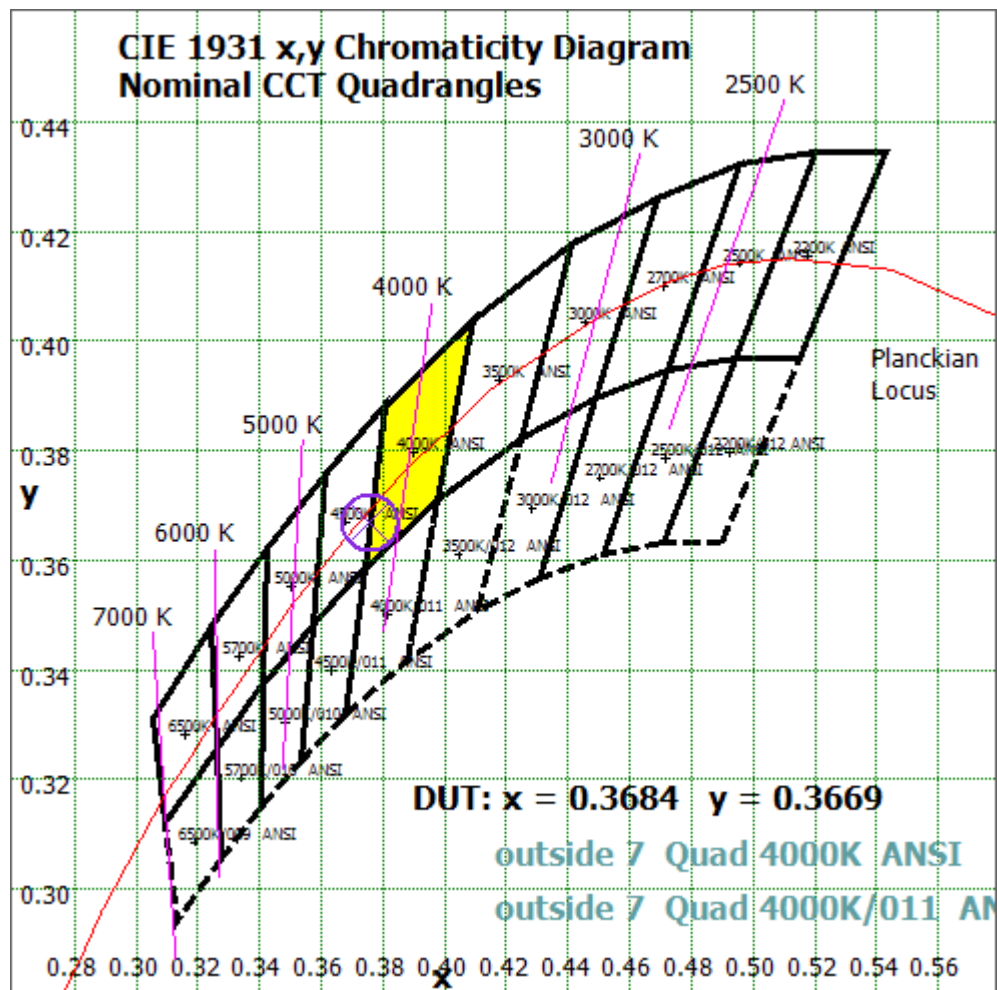


Chart 7: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

Color Rendition Report – Sphere Spectroradiometer Method (4000K Setting)

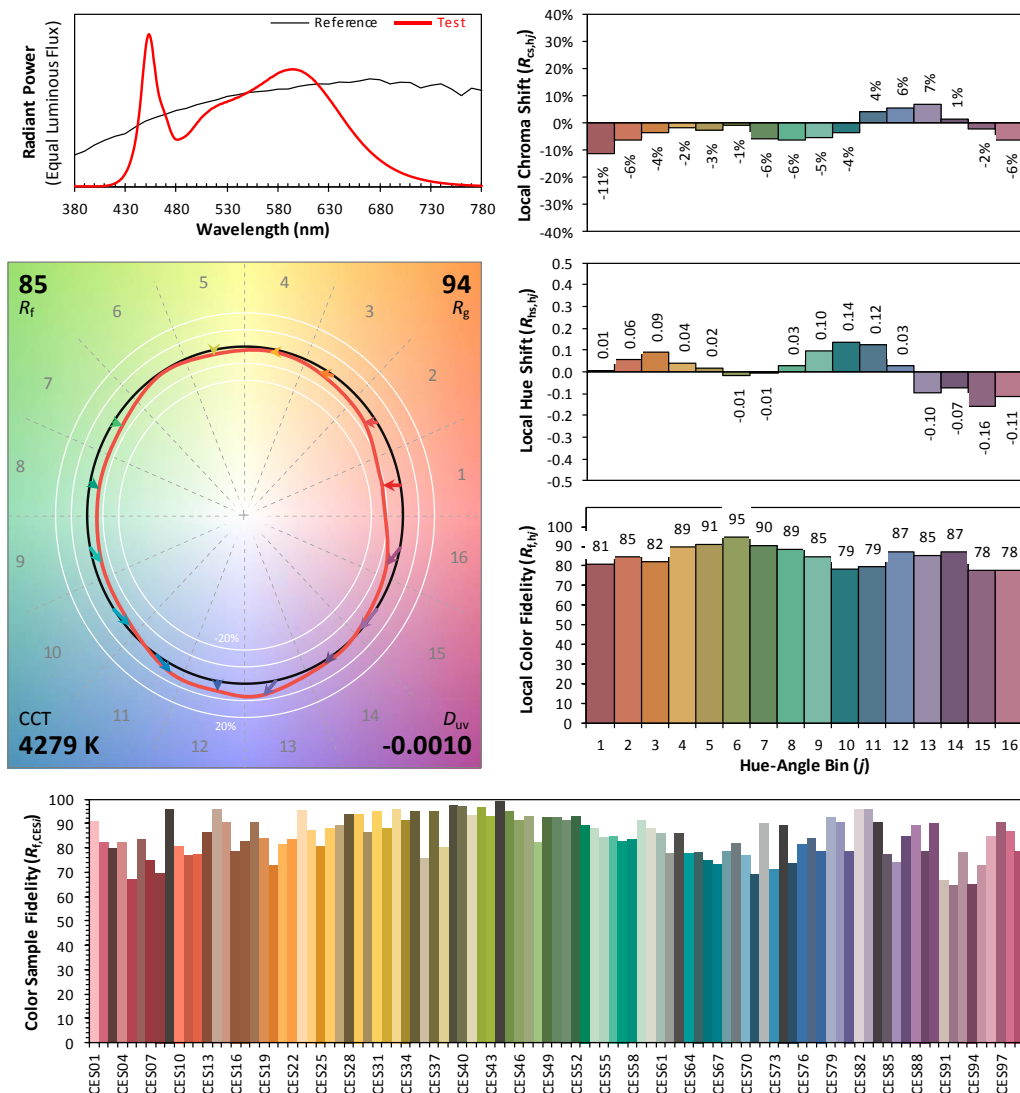
ANSI/IES TM-30-18 Color Rendition Report

Source: LED

Manufacturer: ESPEN TECHNOLOGY, INC.

Date: 2021/04/14

Model: L24T8/8T/9G-AB



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

x 0.3684
 y 0.3669
 u' 0.2211
 v' 0.4954

CIE 13.3-1995
(CRI)
 R_a 86
 R_g 18

Colors are for visual orientation purposes only. Created with the ANSI/IES TM-30-18 Calculator Version 2.00.

Chart 8: 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 4 due to rounding.

TEST RESULTS (5000K Setting)

Test ambient temperature was 26.0 °C.

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

The sample was adjusted and tested at 5000K and 100% dimming setting.

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)	0.203	0.094
Power Factor	0.9966	0.9472
Test Power (W)/2	12.15	12.36
THD A%	6.52	12.13
Luminous Efficacy (lm/W)	124.9	122.9
Total Luminous Flux (lm)	1518.1	1519.5
Color Rendering Index (CRI)	85.2	
R9	14.3	
Correlated Color Temperature (CCT)(K)	5221	
Chromaticity Chroma x	0.3392	
Chromaticity Chroma y	0.3490	
Chromaticity Chroma u	0.2084	
Chromaticity Chroma v	0.3217	
Duv	0.0011	
Chromaticity Chroma u'	0.2084	
Chromaticity Chroma v'	0.4825	

Special Color Rendering Indices	
R1	84.4
R2	93
R3	95.1
R4	82.8
R5	84.5
R6	88.2
R7	86
R8	67.9
R9	14.2
R10	82.4
R11	82.5
R12	64.5
R13	87.4
R14	98

Table 6: Test data per Sphere-Spectroradiometer Method

Note: According to CIE 1976 (u', v') diagram, $u' = u = 4x/(-2x+12y+3)$, $v' = 3v/2 = 9y/(-2x+12y+3)$.

Spectral Power Distribution - Sphere Spectroradiometer Method (5000K Setting)

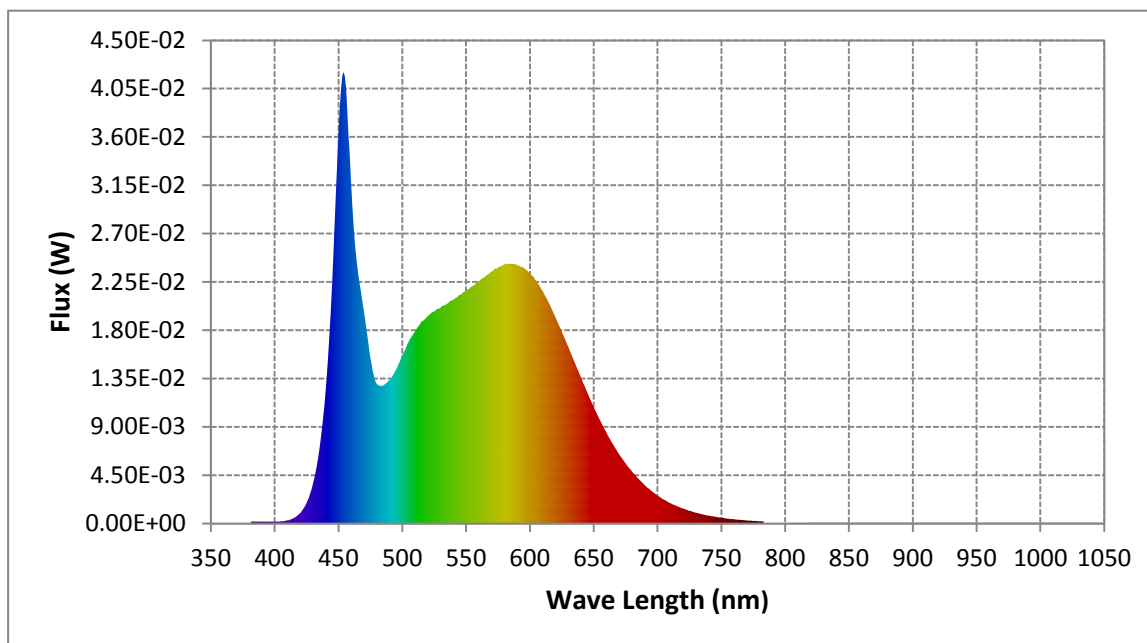
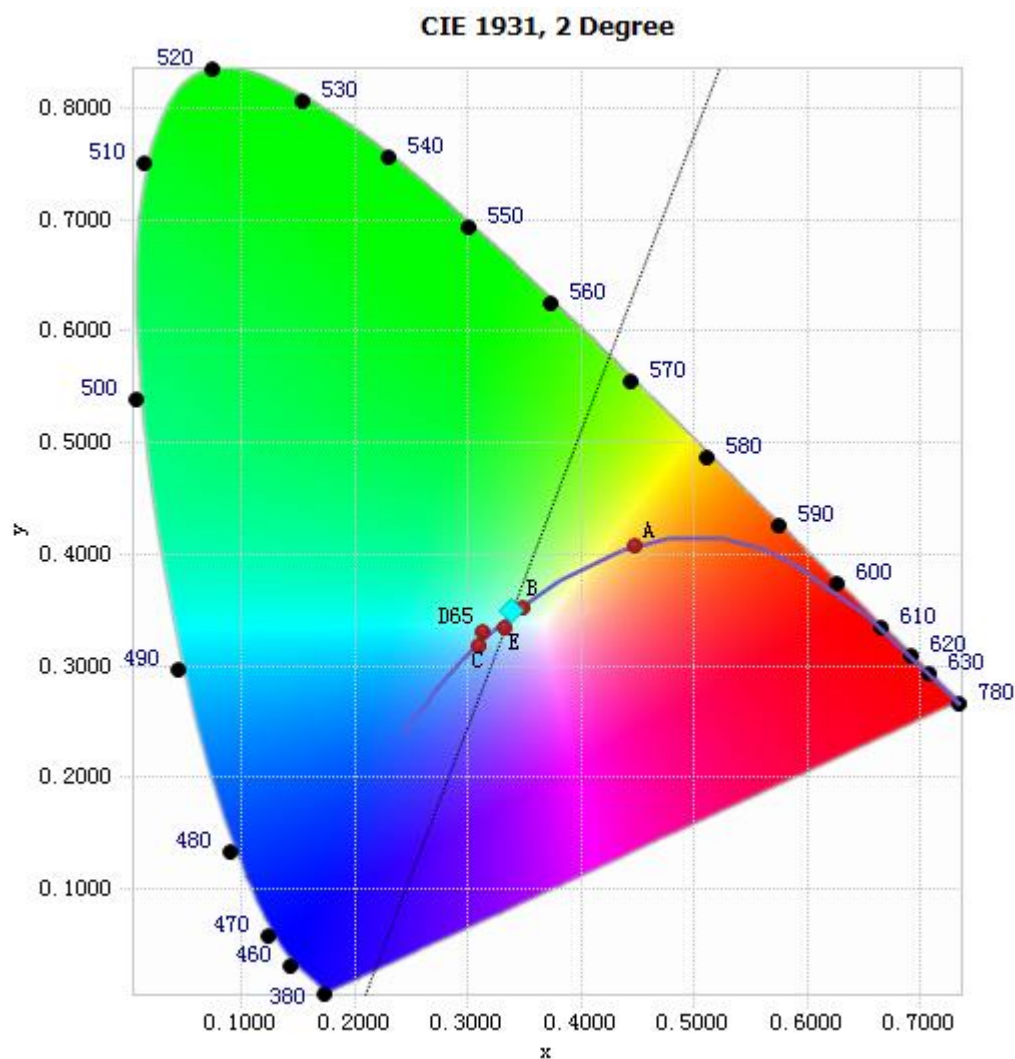


Chart 9: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	1.76E-04	485	1.29E-02	590	2.41E-02	695	3.06E-03
385	1.67E-04	490	1.34E-02	595	2.38E-02	700	2.62E-03
390	1.79E-04	495	1.43E-02	600	2.33E-02	705	2.24E-03
395	1.81E-04	500	1.56E-02	605	2.26E-02	710	1.90E-03
400	1.62E-04	505	1.69E-02	610	2.16E-02	715	1.63E-03
405	1.89E-04	510	1.79E-02	615	2.05E-02	720	1.40E-03
410	2.79E-04	515	1.88E-02	620	1.93E-02	725	1.18E-03
415	4.98E-04	520	1.93E-02	625	1.79E-02	730	1.01E-03
420	9.56E-04	525	1.97E-02	630	1.65E-02	735	8.62E-04
425	1.89E-03	530	2.01E-02	635	1.51E-02	740	7.33E-04
430	3.65E-03	535	2.05E-02	640	1.36E-02	745	6.21E-04
435	6.83E-03	540	2.08E-02	645	1.22E-02	750	5.32E-04
440	1.24E-02	545	2.13E-02	650	1.09E-02	755	4.57E-04
445	2.22E-02	550	2.17E-02	655	9.62E-03	760	3.91E-04
450	3.64E-02	555	2.21E-02	660	8.46E-03	765	3.35E-04
455	4.16E-02	560	2.26E-02	665	7.40E-03	770	2.87E-04
460	3.20E-02	565	2.30E-02	670	6.43E-03	775	2.45E-04
465	2.39E-02	570	2.35E-02	675	5.59E-03	780	2.11E-04
470	1.99E-02	575	2.38E-02	680	4.84E-03		
475	1.55E-02	580	2.41E-02	685	4.17E-03		
480	1.30E-02	585	2.42E-02	690	3.58E-03		

Table 7: Spectral Power Distribution Numerical Data per Sphere - Spectroradiometer Method

Chromaticity Diagram - Sphere Spectroradiometer Method (5000K Setting)



Tristimulus values(x, y): (0.3392, 0.3490)

Chart 10: 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 (5000K Setting)

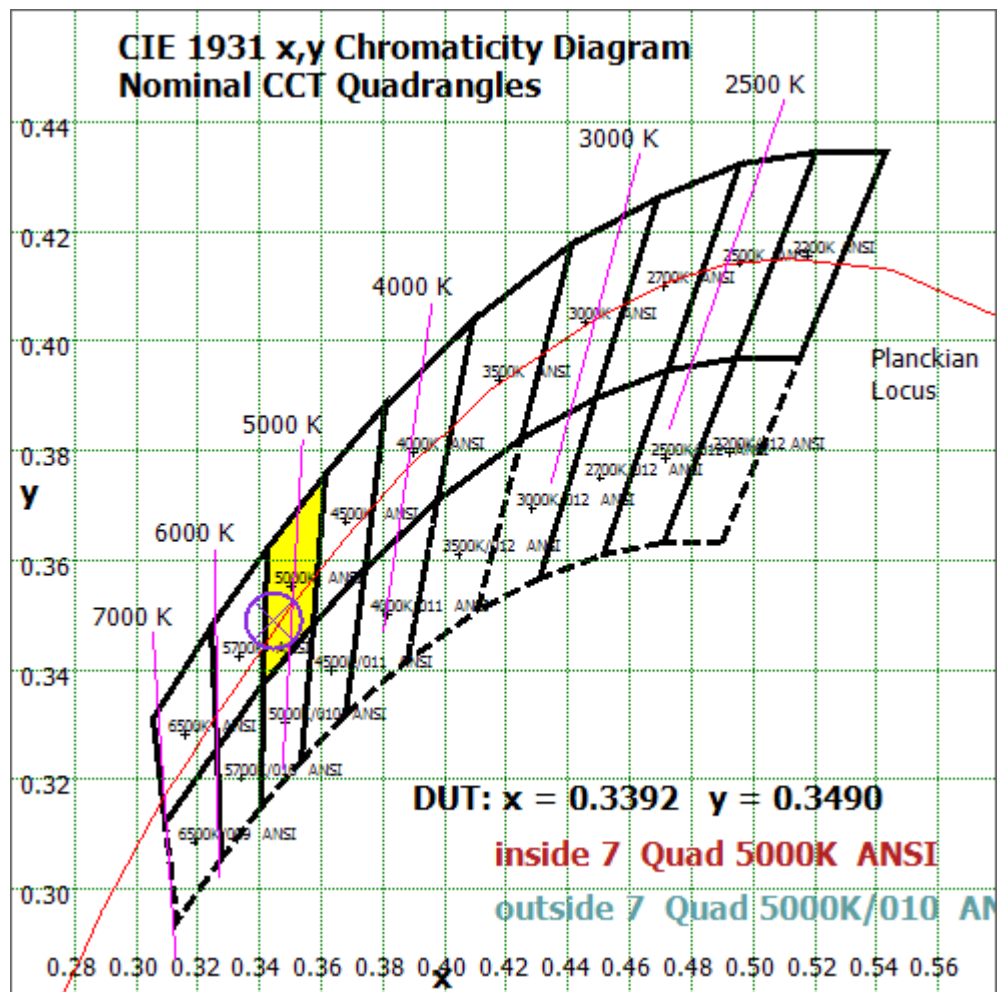


Chart 11: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

Color Rendition Report – Sphere Spectroradiometer Method (5000K Setting)

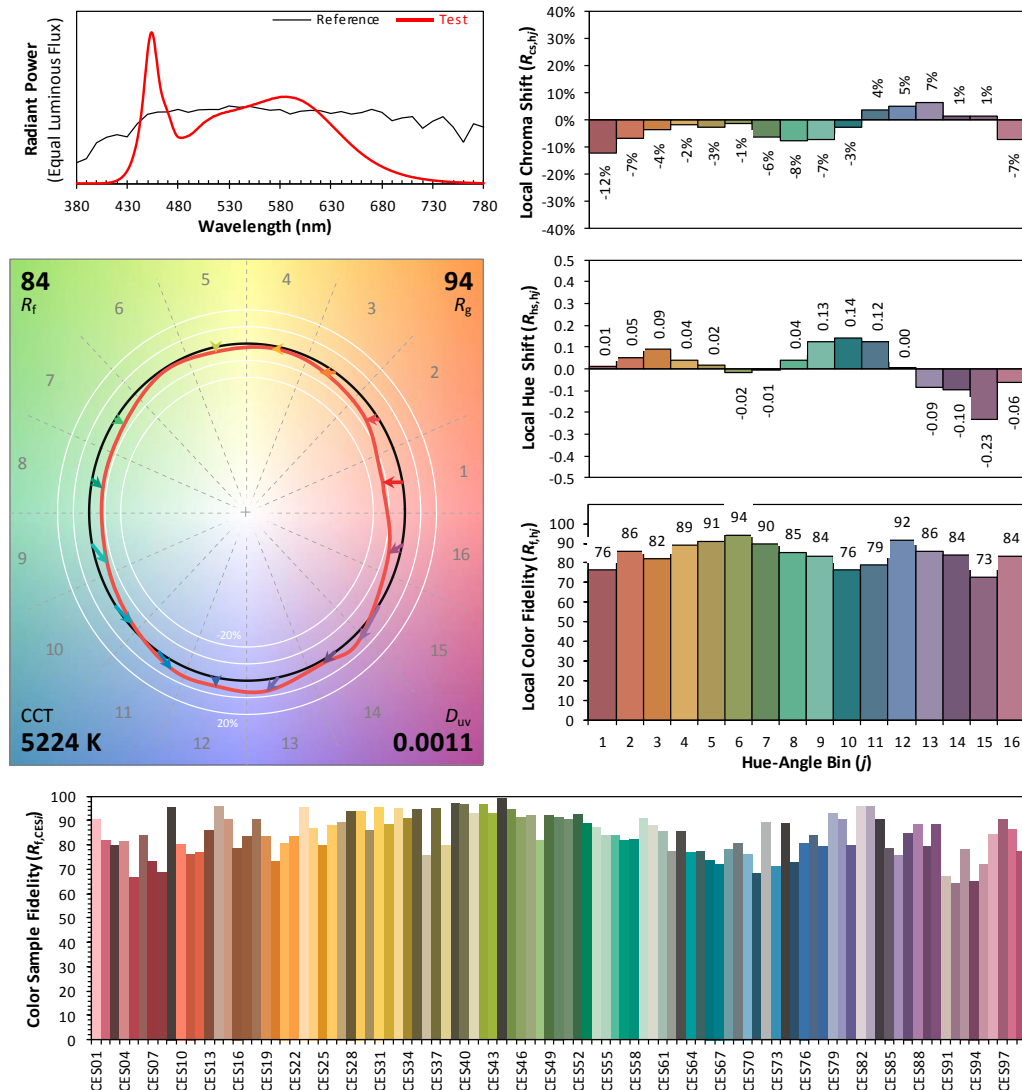
ANSI/IES TM-30-18 Color Rendition Report

Source: LED

Manufacturer: ESPEN TECHNOLOGY, INC.

Date: 2021/04/14

Model: L24T8/8T/9G-AB



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

x 0.3392
 y 0.3490
 u' 0.2084
 v' 0.4825

CIE 13.3-1995
(CRI)
 R_a 85
 R_9 14

Colors are for visual orientation purposes only. Created with the ANSI/IES TM-30-18 Calculator Version 2.00.

Chart 12: 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 6 due to rounding.

TEST RESULTS (3500K Setting)

Test ambient temperature was 25.2 °C.

The photometric distance is 30 m.

The sample was adjusted and tested at 3500K and 100% dimming setting.

Luminous data was taken at 0.5 ° vertical intervals and 10 ° horizontal intervals.

Goniophotometer Method

Parameter	Result
Test Voltage (V)	120.0
Voltage frequency (Hz)	60
Test Current (A)	0.203
Power Factor	0.9969
Power (W)/2	12.17
Luminous Efficacy (lm/W)	121.8
Total Luminous Flux (lm)	1482.0
Beam Angle (°)	109.8 (0°-180°) / 212.5 (90°-270°)
Center Beam Candle Power (cd)	263
Maximum Beam Candle Power (cd)	263.5 (At: C=30.0, Gamma=0.5)
Spacing Criteria	1.23 (0°-180°) / 1.43 (90°-270°)
Zonal Lumens in the 0 °-60 °Zone	45.24%
Zonal Lumens in the 60 °-90 °Zone	27.60%
Zonal Lumens in the 90 °-120 °Zone	16.79%
Zonal Lumens in the 120 °-180 °Zone	10.37%

Table 8: Test data per Goniophotometer Method

Zonal Lumen Tabulation- Goniophotometer Method (3500K Setting)

$\gamma(^{\circ})$	Lumens	% Total
0- 10	24.993	1.69%
10- 20	72.391	4.88%
20- 30	112.45	7.59%
30- 40	141.567	9.55%
40- 50	157.833	10.65%
50- 60	161.248	10.88%
60- 70	153.335	10.35%
70- 80	137.377	9.27%
80- 90	118.267	7.98%
90-100	100.633	6.79%
100-110	82.684	5.58%
110-120	65.551	4.42%
120-130	50.88	3.43%
130-140	39.262	2.65%
140-150	29.416	1.98%
150-160	20.141	1.36%
160-170	11.062	0.75%
170-180	2.945	0.20%
Total	1482.0	100%

$\gamma(^{\circ})$	Lumens	% Total
0- 60	670.482	45.24%
60- 90	408.979	27.60%
0-90	1079.46	72.84%
90- 180	402.574	27.16%
0- 180	1482.0	100%

Table 9: Zonal Lumen

Illuminance Plots- Goniophotometer Method (3500K Setting)

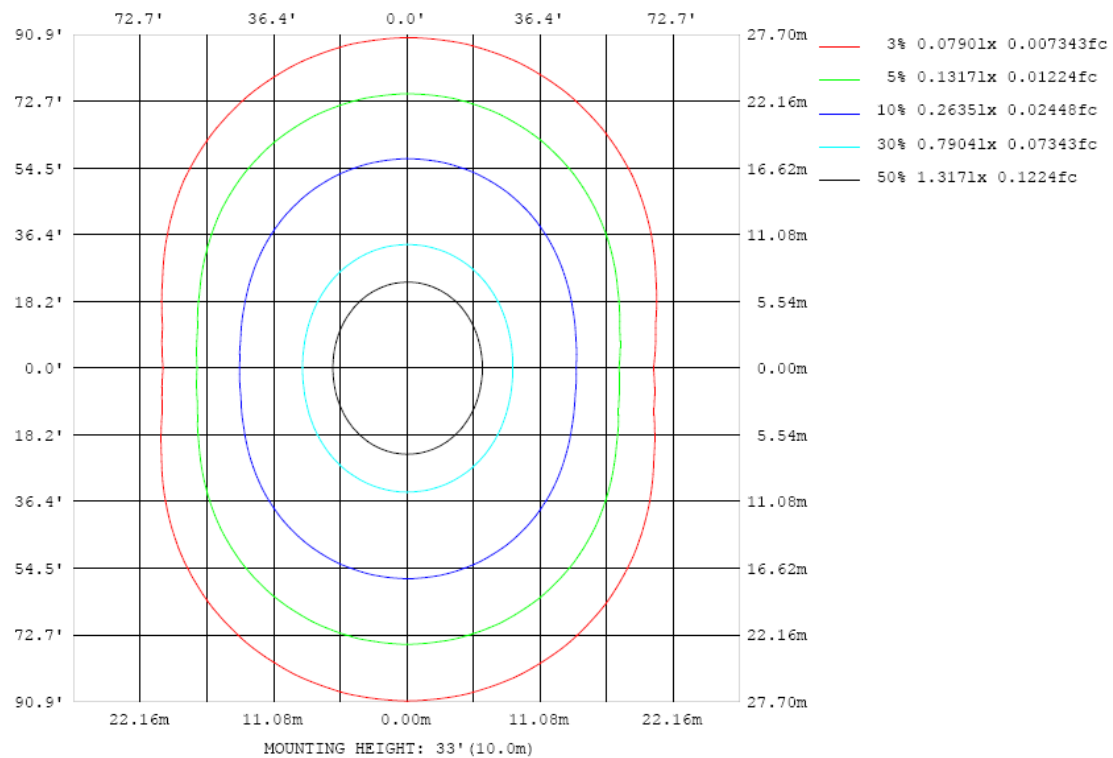


Chart 13: Illuminance Plot (Footcandles)

Luminous Intensity Distribution Plots- Goniophotometer Method (3500K Setting)

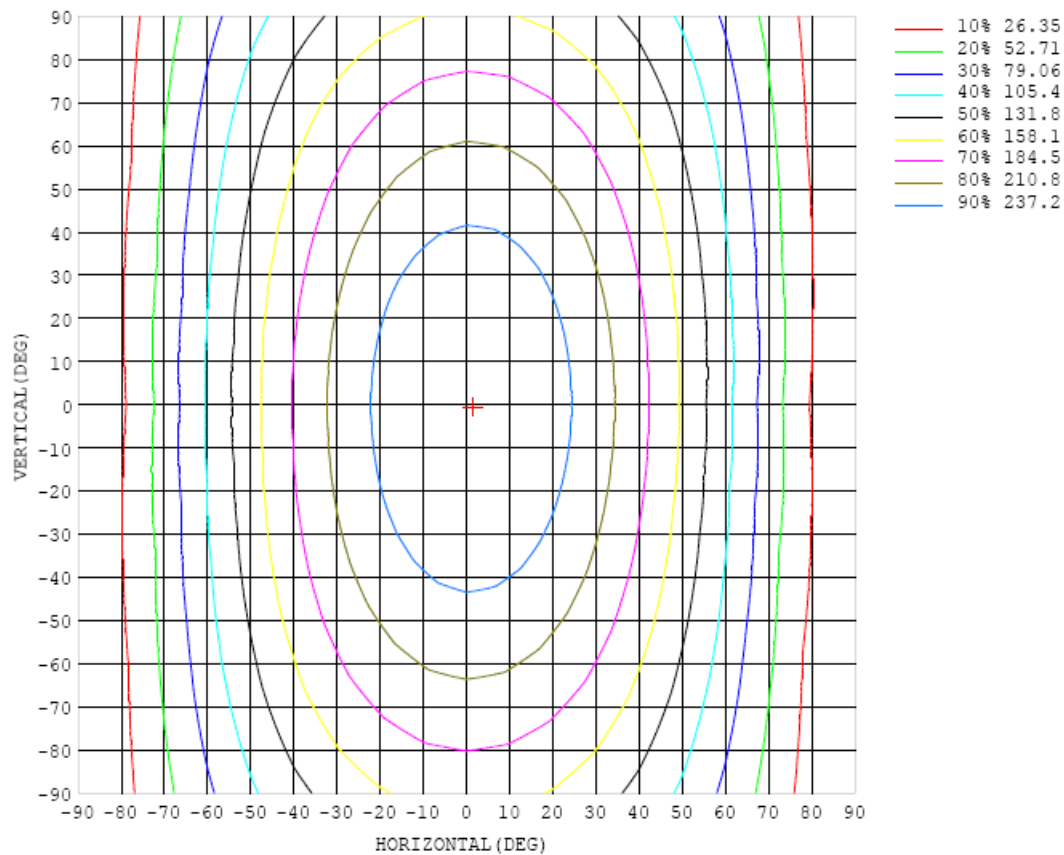


Chart 14: Isocandela Plot

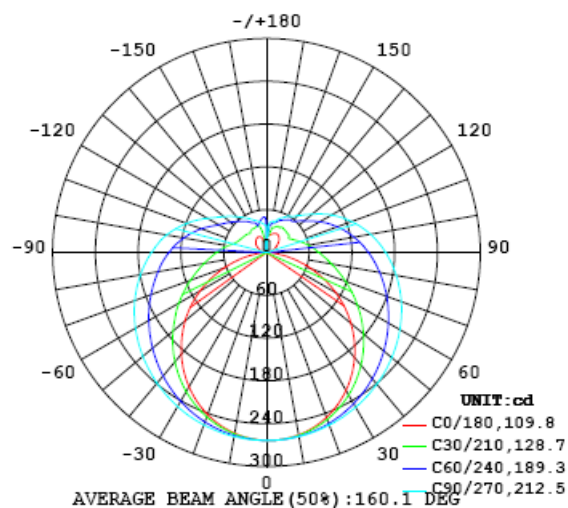


Chart 15: Polar Candela Distribution

Luminous Intensity Data- Goniophotometer Method (3500K Setting)

Table--1

UNIT: cd

C (DEG) γ (DEG)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
0	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263
5	263	263	263	263	263	263	263	263	263	263	263	263	263	262	262	262	262	262	262
10	260	260	260	260	261	261	262	262	262	262	262	261	261	260	259	258	258	257	257
15	254	254	255	256	257	258	259	260	260	260	260	259	257	256	254	253	252	251	251
20	246	246	247	249	251	253	255	257	257	257	257	255	253	251	248	245	243	242	242
25	236	236	238	241	244	247	250	253	254	254	253	251	248	244	240	236	233	231	231
30	223	224	227	231	235	240	245	248	250	250	249	246	242	237	231	226	221	218	217
35	209	210	213	219	226	232	238	243	245	246	244	241	235	229	221	214	208	204	203
40	192	194	199	206	215	223	231	237	240	241	239	235	228	220	210	201	193	188	186
45	174	176	183	192	203	214	223	230	234	235	233	228	220	210	199	187	177	170	168
50	155	157	166	178	191	204	215	223	228	229	227	221	212	200	187	173	160	151	149
55	134	137	148	163	178	194	206	216	221	223	220	214	204	190	175	158	143	132	129
60	112	117	130	147	166	183	197	208	214	216	213	206	195	180	163	144	126	112	108
65	89.6	95.3	112	132	154	173	189	200	207	209	206	198	186	170	151	130	109	91.6	85.5
70	66.8	74.0	93.9	118	142	163	180	192	199	201	198	190	178	160	140	116	92.3	71.6	63.3
75	44.9	54.3	77.6	105	130	153	170	183	191	193	190	182	169	151	129	104	77.2	53.4	41.7
80	24.4	36.3	63.8	92.8	120	143	161	175	182	185	182	173	160	142	119	92.8	64.6	37.0	22.2
85	8.44	22.4	52.2	82.4	110	133	152	166	174	176	173	165	151	133	110	83.1	54.0	24.6	7.15
90	0.67	14.6	43.8	73.6	101	125	143	157	165	167	164	156	142	124	101	74.9	46.2	17.6	0.44
95	1.41	10.9	37.7	66.8	93.0	116	134	148	155	158	155	147	134	116	93.5	68.1	40.3	13.7	1.42
100	3.31	9.24	32.5	59.8	84.9	107	125	138	145	148	145	137	125	107	85.7	61.7	35.5	12.5	3.19
105	5.89	10.7	28.1	53.5	77.1	98.2	115	128	135	138	135	128	115	98.6	78.2	55.7	31.9	13.8	5.68
110	8.78	13.2	25.2	47.4	69.6	89.5	106	117	125	127	125	117	106	90.2	71.1	50.5	30.2	15.8	8.62
115	12.0	16.4	25.2	42.5	62.7	81.0	96.1	107	114	116	114	107	96.4	81.9	64.8	46.6	28.6	18.7	11.7
120	15.4	19.8	27.7	38.5	56.2	72.2	86.4	96.8	103	105	103	97.1	87.0	73.6	59.1	43.7	31.5	21.4	14.6
125	18.4	23.2	29.3	37.5	50.9	65.2	76.8	86.2	92.1	94.2	92.3	86.7	77.8	67.4	54.9	41.3	32.6	24.2	17.6
130	21.9	26.4	31.4	39.9	46.6	59.0	68.8	76.9	81.7	83.5	82.1	77.6	70.6	61.9	51.0	42.7	33.8	26.5	19.7
135	24.8	29.4	33.5	40.0	48.4	53.4	62.5	69.1	73.2	74.8	73.7	70.0	64.6	57.1	50.3	42.4	34.8	28.5	21.6
140	27.3	31.9	35.6	40.6	47.2	53.9	56.9	62.1	66.0	67.4	66.6	63.7	59.3	55.0	48.9	42.4	34.1	29.1	23.1
145	29.3	33.7	36.6	41.3	46.2	51.6	56.2	59.4	60.6	61.7	61.4	59.7	56.8	52.5	47.4	42.0	30.4	30.5	24.1
150	29.8	34.3	37.5	41.3	45.4	49.4	53.0	55.8	57.5	58.2	57.7	56.1	53.5	50.1	46.2	39.7	35.6	31.5	24.6
155	29.6	34.8	36.3	40.5	43.0	47.3	50.2	52.2	53.5	54.0	53.6	52.4	50.5	48.0	43.9	36.1	33.1	31.9	24.8
160	28.4	30.4	35.3	38.4	41.6	43.1	46.8	48.6	49.7	50.1	49.9	49.2	47.9	45.9	39.8	37.3	33.0	29.3	23.2
165	26.6	27.0	34.2	36.2	38.9	41.9	43.8	44.1	44.3	44.6	44.5	43.9	43.5	42.6	37.9	35.4	32.5	25.0	18.4
170	24.6	25.8	26.0	28.9	35.8	38.7	40.3	42.5	43.8	44.4	44.3	43.5	42.6	38.2	31.1	26.7	21.4	19.3	14.7
175	23.3	23.3	23.3	23.3	23.2	24.3	28.1	33.9	37.8	40.2	35.5	23.3	19.7	18.1	17.9	18.2	17.9	15.8	13.0
180	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02

Table 10: 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	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263		
5	262	262	262	262	262	263	263	263	263	263	263	263	263	263	263	263	263		
10	257	258	258	259	260	260	261	262	262	262	262	262	261	261	260	260	260		
15	251	252	253	254	256	257	258	259	260	260	260	259	258	257	256	255	254		
20	242	243	245	248	250	253	255	256	257	257	256	255	253	251	249	247	246		
25	231	233	236	240	244	247	250	253	254	254	252	250	247	244	241	238	236		
30	218	221	225	230	236	241	245	248	249	249	247	244	240	235	231	227	224		
35	204	207	213	220	227	234	239	243	244	244	242	238	232	226	219	214	210		
40	188	193	200	209	218	226	232	237	239	238	235	230	223	215	206	199	194		
45	170	176	186	197	208	217	225	231	233	232	228	222	213	203	193	183	177		
50	152	160	171	184	197	209	218	224	227	225	221	213	203	191	178	167	158		
55	132	143	156	172	187	200	210	217	220	218	213	205	193	178	163	150	139		
60	112	125	142	159	176	191	202	209	212	211	205	196	182	166	149	132	119		
65	91.4	107	127	148	166	182	194	202	205	203	197	186	172	154	134	114	97.6		
70	70.9	90.1	113	136	156	173	185	193	197	195	189	177	161	143	120	96.8	76.8		
75	51.5	74.4	101	125	147	163	177	185	188	187	180	168	152	131	107	80.7	56.9		
80	34.6	60.9	89.0	115	137	154	168	176	180	178	171	159	142	121	95.2	66.7	39.4		
85	21.8	50.0	78.9	105	128	146	159	167	171	169	162	150	133	111	84.5	55.2	25.9		
90	14.5	41.8	70.3	96.3	119	137	150	158	161	159	153	141	123	101	75.3	46.3	17.6		
95	10.2	35.2	62.7	88.0	110	128	141	150	152	151	144	132	114	92.7	67.2	39.1	12.6		
100	9.71	29.6	55.1	79.4	101	118	131	139	142	140	133	121	105	83.6	59.0	32.6	10.9		
105	9.65	27.3	48.2	70.9	91.1	108	120	128	131	129	122	111	94.6	74.5	51.5	28.8	11.8		
110	11.7	26.6	44.1	62.9	81.7	97.3	109	117	119	118	111	100.0	84.7	66.4	46.0	27.2	13.9		
115	14.9	26.6	41.7	57.6	72.8	87.0	98.0	105	108	106	99.7	89.3	75.4	59.4	42.7	26.7	16.6		
120	18.0	26.6	40.3	53.8	66.9	78.0	87.2	93.5	95.9	94.2	88.5	79.8	68.4	55.0	40.5	28.0	20.1		
125	21.0	26.2	39.2	50.9	62.0	71.7	79.2	84.2	86.1	84.7	80.2	72.9	63.2	51.6	39.4	29.4	22.8		
130	24.0	27.5	38.2	48.6	58.0	66.1	72.6	76.8	78.4	77.1	73.3	67.1	58.9	49.0	39.3	29.8	25.4		
135	26.3	30.8	37.0	46.5	54.6	61.4	66.7	70.3	71.6	70.6	67.4	62.2	55.4	47.3	39.8	33.8	27.4		
140	28.3	32.6	35.4	44.4	51.4	57.1	61.6	64.6	65.7	64.8	62.1	58.0	52.5	46.1	39.3	35.3	29.5		
145	30.3	34.6	38.0	41.7	48.5	53.4	57.0	59.4	60.4	59.8	57.6	54.3	50.1	45.2	41.0	36.9	31.8		
150	32.0	36.3	38.6	41.9	45.0	49.7	52.9	54.9	55.7	55.3	53.7	51.2	48.1	44.7	41.5	38.5	33.9		
155	32.2	36.6	38.4	40.0	43.9	46.2	48.6	50.6	51.5	51.4	50.4	48.8	46.5	44.1	42.0	40.0	36.0		
160	28.3	36.9	39.1	40.2	40.8	43.0	46.1	47.3	48.1	48.0	47.6	46.5	44.9	43.5	42.5	41.6	38.1		
165	22.7	32.1	38.7	40.3	41.0	42.3	44.0	44.5	45.3	44.6	44.7	44.2	43.4	42.9	43.0	43.2	40.1		
170	14.9	18.9	24.9	28.5	32.5	46.5	42.1	41.6	42.5	41.2	41.9	42.0	41.8	42.3	43.5	44.9	42.0		
175	12.6	16.8	9.07	11.4	17.7	49.8	40.5	38.8	39.6	37.9	39.0	39.7	40.3	41.9	44.2	46.6	43.3		
180	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02		

Table 11: Luminous Intensity Data

EQUIPMENT LIST

Test Equipment	Model	Equipment No.	Calibration Date	Calibration Due date
Goniophotometer system	GO-R5000	HZTE011-01	Aug. 05, 2020	Aug. 04, 2021
Digital Power Meter	PF2010A	HZTE028-01	Aug. 05, 2020	Aug. 04, 2021
AC Power Supply	DPS1060	HZTE001-06	Aug. 05, 2020	Aug. 04, 2021
DC Power Supply	WY12010	HZTE004-03	Aug. 05, 2020	Aug. 04, 2021
Temperature recorder	JM624U	HZTE018-08	Aug. 05, 2020	Aug. 04, 2021
Temperature and humidity recorder	JR900	HZTE018-01	Aug. 05, 2020	Aug. 04, 2021
Standard source	D908	HZTE012-01	Aug. 05, 2020	Aug. 04, 2021
Integrate Sphere system	3M	HZTE015-04	Aug. 05, 2020	Aug. 04, 2021
Digital Power Meter	WT210	HZTE008-01	Aug. 05, 2020	Aug. 04, 2021
AC Power Supply	PCR 500L	HZTE001-07	Aug. 05, 2020	Aug. 04, 2021
DC Power Supply	IT6154	HZTE004-04	Aug. 05, 2020	Aug. 04, 2021
Standard source	SCL-1400	HZTE012-02	Aug. 05, 2020	Aug. 04, 2021
Temperature and humidity recorder	JR900	HZTE018-02	Aug. 05, 2020	Aug. 04, 2021
Temperature Meter	TES1310	HZTE017-01	Aug. 05, 2020	Aug. 04, 2021
Multi-Meter	FLUKE15B	HZTE020-01	Aug. 05, 2020	Aug. 04, 2021

Table 12: 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

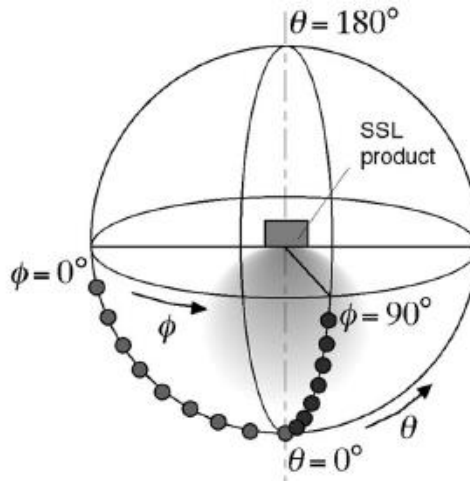
The color characteristics of SSL products include chromaticity coordinates, correlated color temperature, and color rendering index. These characteristics of SSL products may be spatially non-uniform, and thus, in order that they can be specified accurately, the color quantities shall be measured as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