

LM-79-08 TEST REPORT

for

ESPEN TECHNOLOGY, INC.

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

LED Tube

Model: L36T8/8T/11G-AB

Laboratory: Leading Testing Laboratories

NVLAP CODE: 200960-0

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Report No.: HZ24030021b

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	L36T8/8T/11G-AB 3500K Setting	L36T8/8T/11G-AB 4000K Setting	L36T8/8T/11G-AB 5000K Setting
Luminous Efficacy (Lumens /Watt)	128.3	135.4	129.4
Total Luminous Flux (Lumens)	1896.1	1959.2	1914.5
Power (Watts)/2	14.78	14.48	14.79
Power Factor	0.9971	0.9970	0.9971
CCT (K)	3463	4184	5067
CRI	83.9	85.2	84.2
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

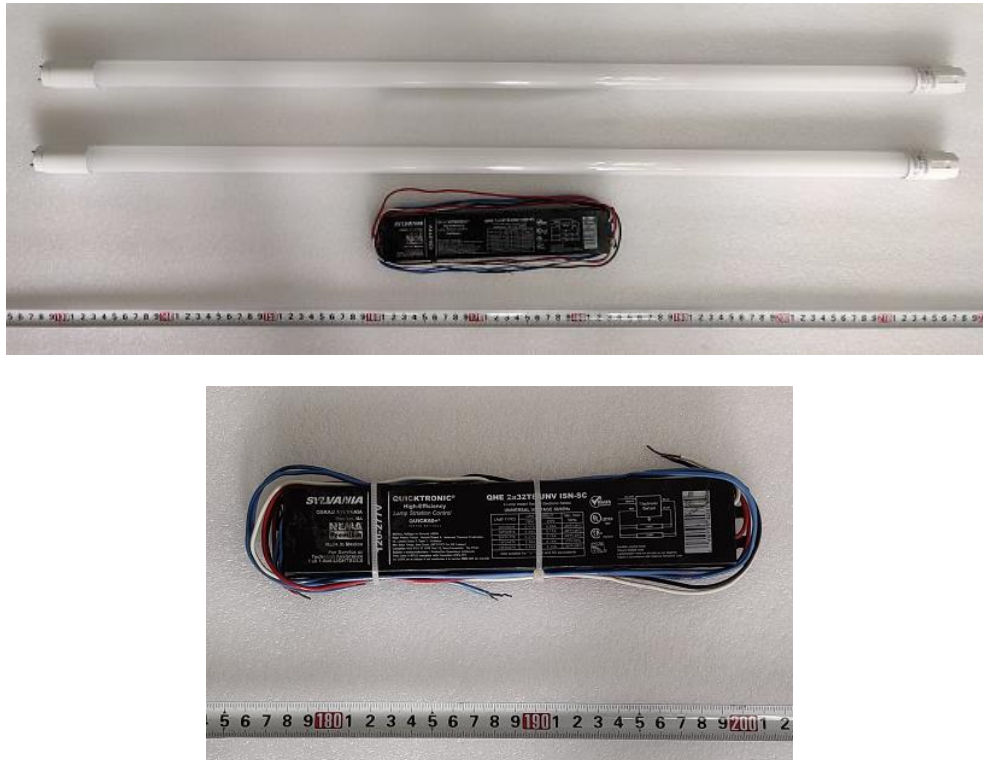


Figure 1- Overview of the sample

Equipment Under Test(EUT)

Name	: LED Tube
Model	: L36T8/8T/11G-AB
Electrical Ratings	: 120-277V, 50/60Hz, 11W
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)	0.247	0.112
Power Factor	0.9971	0.9622
Test Power (W)/2	14.78	14.91
THD A%	5.46	9.83
Luminous Efficacy (lm/W)	128.3	127.2
Total Luminous Flux (lm)	1896.1	1896.2
Color Rendering Index (CRI)	83.9	
R9	11	
Correlated Color Temperature (CCT)(K)	3463	
Chromaticity Chroma x	0.4068	
Chromaticity Chroma y	0.3906	
Chromaticity Chroma u	0.2368	
Chromaticity Chroma v	0.3410	
Duv	-0.0004	
Chromaticity Chroma u'	0.2368	
Chromaticity Chroma v'	0.5114	

Special Color Rendering Indices	
R1	82.4
R2	90.4
R3	96.4
R4	83.1
R5	82.7
R6	87.7
R7	85
R8	63.2
R9	11
R10	78
R11	83
R12	68.8
R13	84.3
R14	98.3

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)

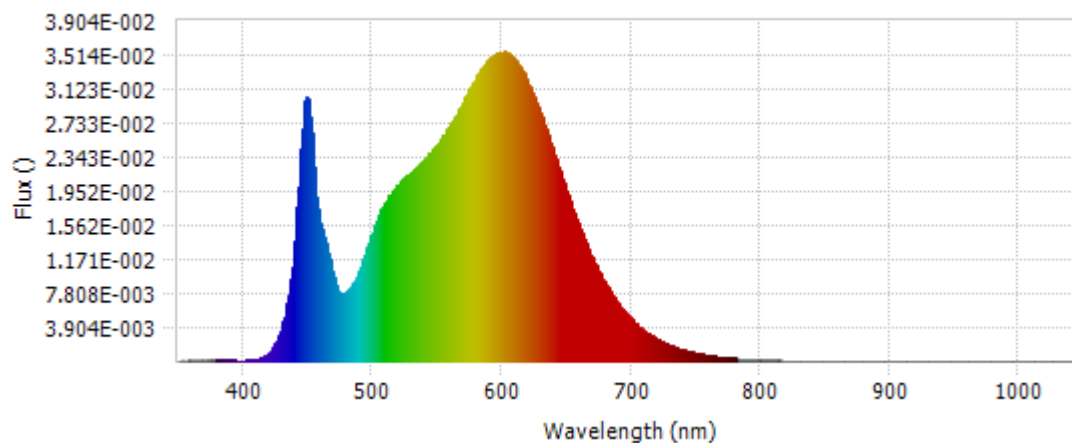
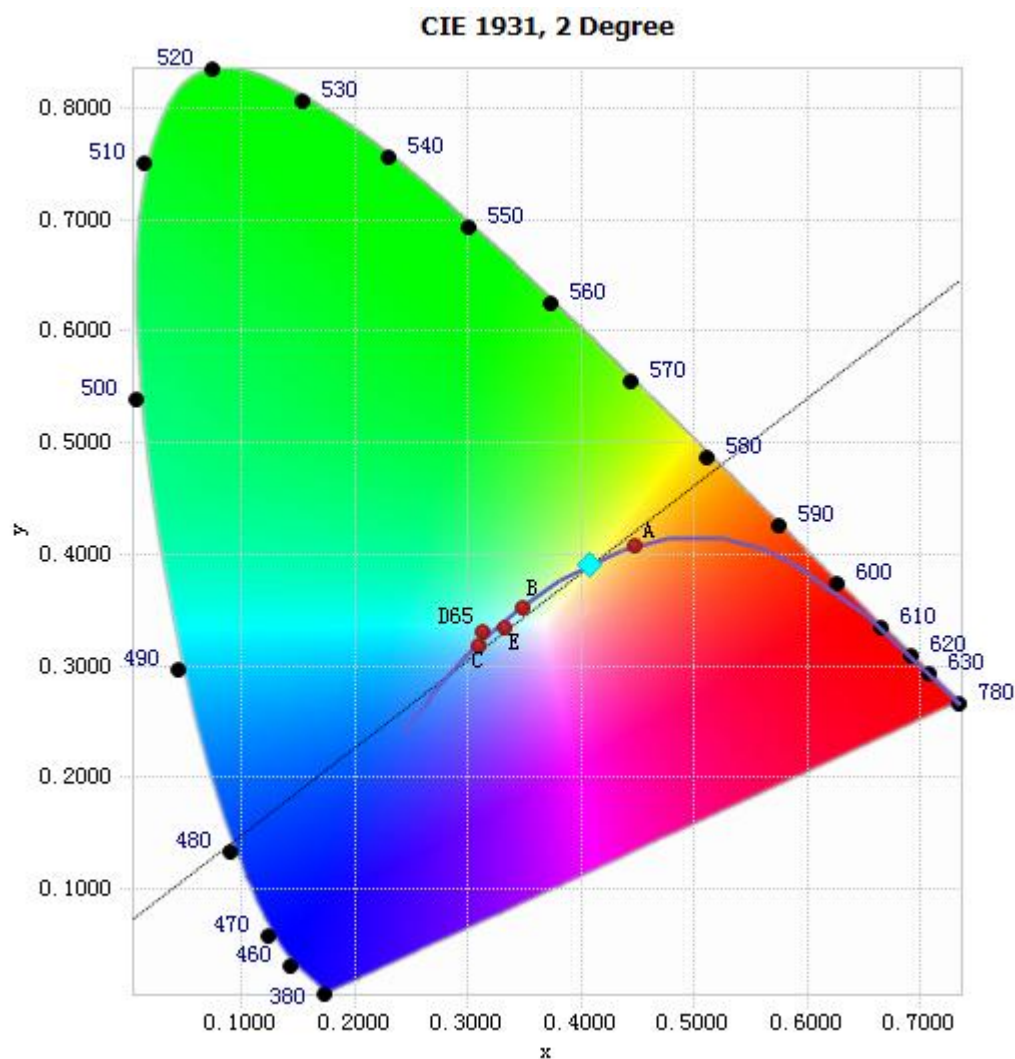


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	1.51E-04	485	8.88E-03	590	3.46E-02	695	5.70E-03
385	1.46E-04	490	1.04E-02	595	3.52E-02	700	4.87E-03
390	1.43E-04	495	1.26E-02	600	3.54E-02	705	4.15E-03
395	1.19E-04	500	1.48E-02	605	3.53E-02	710	3.53E-03
400	1.11E-04	505	1.67E-02	610	3.46E-02	715	3.01E-03
405	1.47E-04	510	1.81E-02	615	3.36E-02	720	2.57E-03
410	2.53E-04	515	1.95E-02	620	3.22E-02	725	2.19E-03
415	5.06E-04	520	2.03E-02	625	3.04E-02	730	1.86E-03
420	1.02E-03	525	2.10E-02	630	2.84E-02	735	1.58E-03
425	2.05E-03	530	2.17E-02	635	2.63E-02	740	1.34E-03
430	3.99E-03	535	2.24E-02	640	2.41E-02	745	1.14E-03
435	7.47E-03	540	2.31E-02	645	2.18E-02	750	9.67E-04
440	1.38E-02	545	2.39E-02	650	1.96E-02	755	8.21E-04
445	2.43E-02	550	2.48E-02	655	1.75E-02	760	6.98E-04
450	3.02E-02	555	2.59E-02	660	1.54E-02	765	5.98E-04
455	2.23E-02	560	2.70E-02	665	1.36E-02	770	5.07E-04
460	1.59E-02	565	2.83E-02	670	1.18E-02	775	4.38E-04
465	1.31E-02	570	2.97E-02	675	1.03E-02	780	3.70E-04
470	9.70E-03	575	3.11E-02	680	8.97E-03		
475	7.85E-03	580	3.25E-02	685	7.75E-03		
480	7.94E-03	585	3.37E-02	690	6.64E-03		

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

Chromaticity Diagram - Sphere Spectroradiometer Method (3500K Setting)



Tristimulus values(x, y): (0.4068, 0.3906)

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)

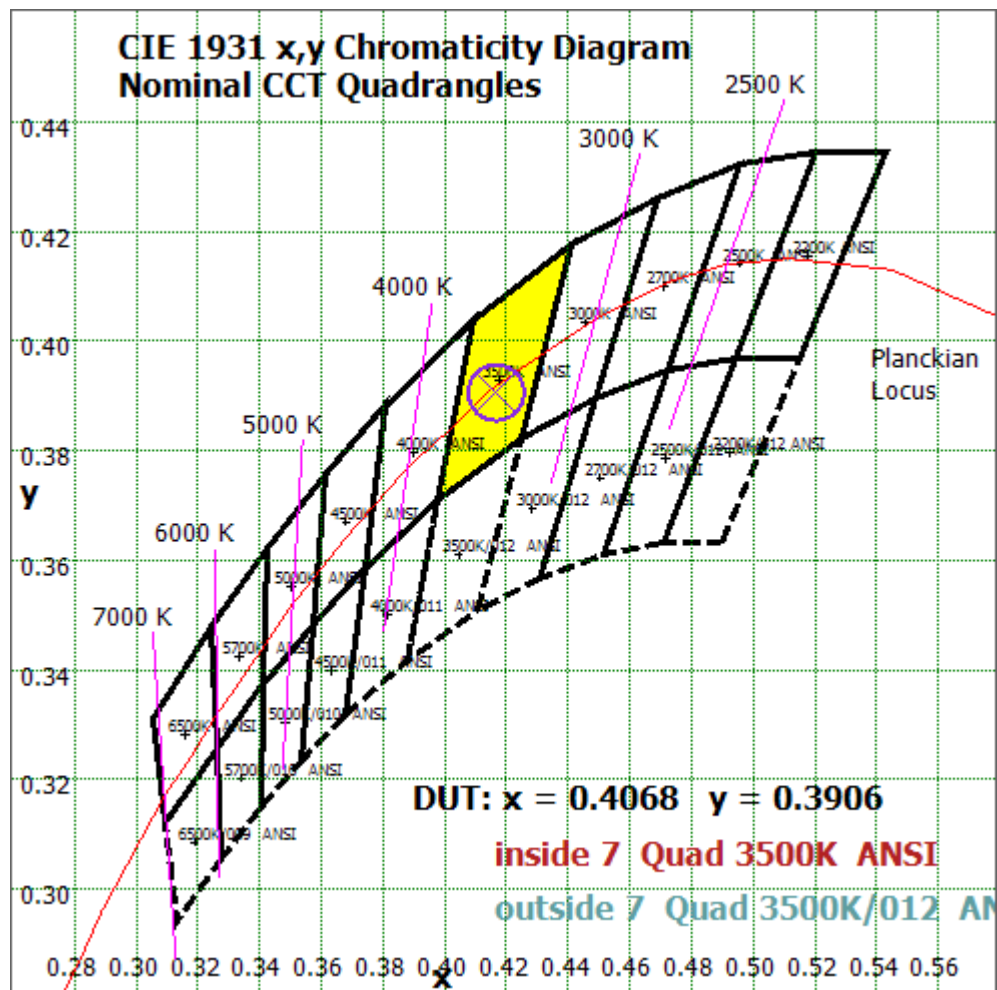


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

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

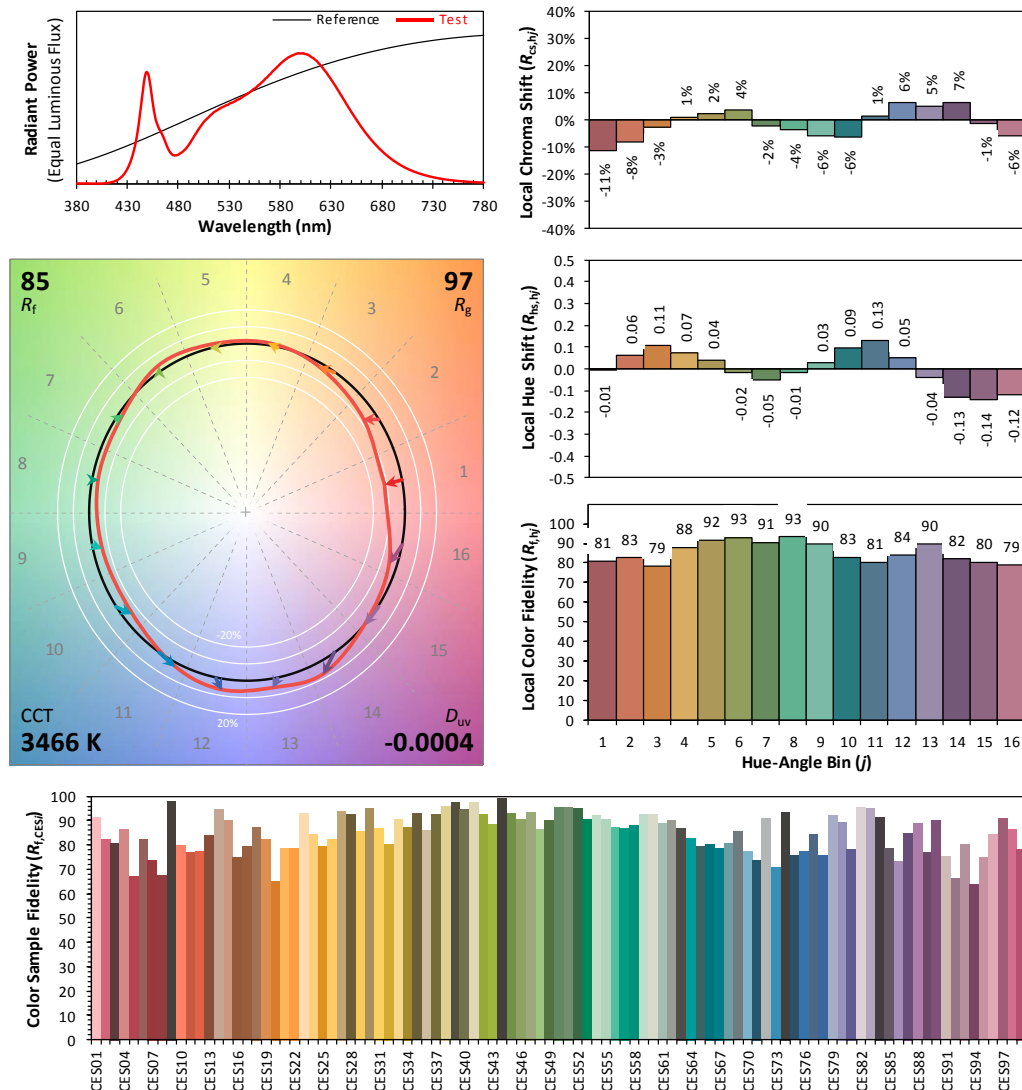
ANSI/IES TM-30-18 Color Rendition Report

Source: LED

Manufacturer: ESPEN TECHNOLOGY, INC.

Date: 2021/04/14

Model: L36T8/8T/11G-AB



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

x 0.4068
 y 0.3906
 u' 0.2368
 v' 0.5114

CIE 13.3-1995
(CRI)
 R_a 84
 R_g 11

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)	0.242	0.110
Power Factor	0.9970	0.9607
Test Power (W)/2	14.48	14.63
THD A%	5.60	10.16
Luminous Efficacy (lm/W)	135.4	134.0
Total Luminous Flux (lm)	1959.2	1960.0
Color Rendering Index (CRI)	85.2	
R9	16.7	
Correlated Color Temperature (CCT)(K)	4184	
Chromaticity Chroma x	0.3720	
Chromaticity Chroma y	0.3694	
Chromaticity Chroma u	0.2225	
Chromaticity Chroma v	0.3314	
Duv	-0.0009	
Chromaticity Chroma u'	0.2225	
Chromaticity Chroma v'	0.4971	

Special Color Rendering Indices	
R1	84.2
R2	92.1
R3	95.9
R4	83.5
R5	84.2
R6	88
R7	86.3
R8	67.2
R9	16.7
R10	80.8
R11	83.3
R12	63.5
R13	86.6
R14	98.3

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)

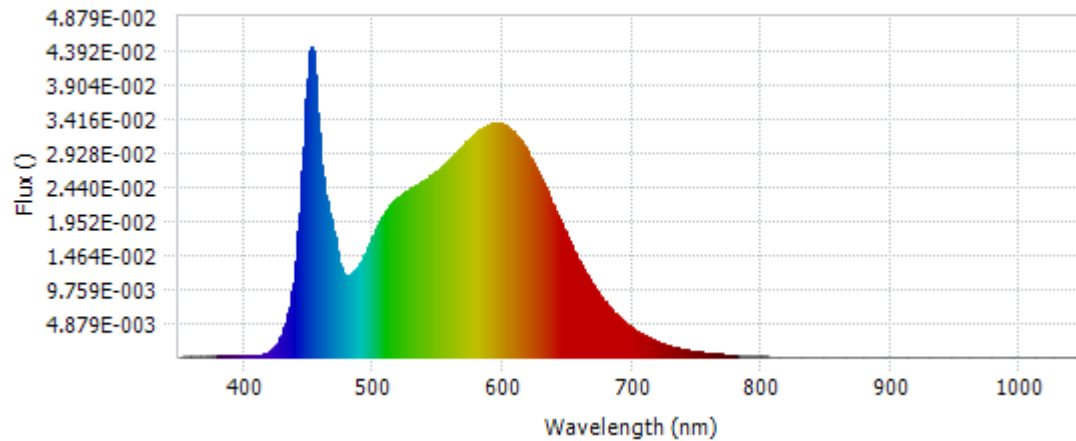


Chart 5: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	1.83E-04	485	1.23E-02	590	3.34E-02	695	4.89E-03
385	1.80E-04	490	1.35E-02	595	3.35E-02	700	4.18E-03
390	2.00E-04	495	1.54E-02	600	3.33E-02	705	3.56E-03
395	1.81E-04	500	1.76E-02	605	3.29E-02	710	3.02E-03
400	1.65E-04	505	1.96E-02	610	3.19E-02	715	2.58E-03
405	1.68E-04	510	2.10E-02	615	3.07E-02	720	2.20E-03
410	2.44E-04	515	2.23E-02	620	2.91E-02	725	1.87E-03
415	4.47E-04	520	2.31E-02	625	2.74E-02	730	1.59E-03
420	8.81E-04	525	2.37E-02	630	2.55E-02	735	1.35E-03
425	1.81E-03	530	2.43E-02	635	2.34E-02	740	1.14E-03
430	3.67E-03	535	2.48E-02	640	2.13E-02	745	9.73E-04
435	7.24E-03	540	2.54E-02	645	1.92E-02	750	8.34E-04
440	1.39E-02	545	2.61E-02	650	1.72E-02	755	7.02E-04
445	2.66E-02	550	2.68E-02	655	1.53E-02	760	6.02E-04
450	4.22E-02	555	2.77E-02	660	1.34E-02	765	5.16E-04
455	4.04E-02	560	2.85E-02	665	1.18E-02	770	4.36E-04
460	2.76E-02	565	2.95E-02	670	1.03E-02	775	3.76E-04
465	2.15E-02	570	3.04E-02	675	8.92E-03	780	3.21E-04
470	1.71E-02	575	3.14E-02	680	7.73E-03		
475	1.28E-02	580	3.23E-02	685	6.66E-03		
480	1.16E-02	585	3.30E-02	690	5.72E-03		

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

Chromaticity Diagram - Sphere Spectroradiometer Method (4000K Setting)

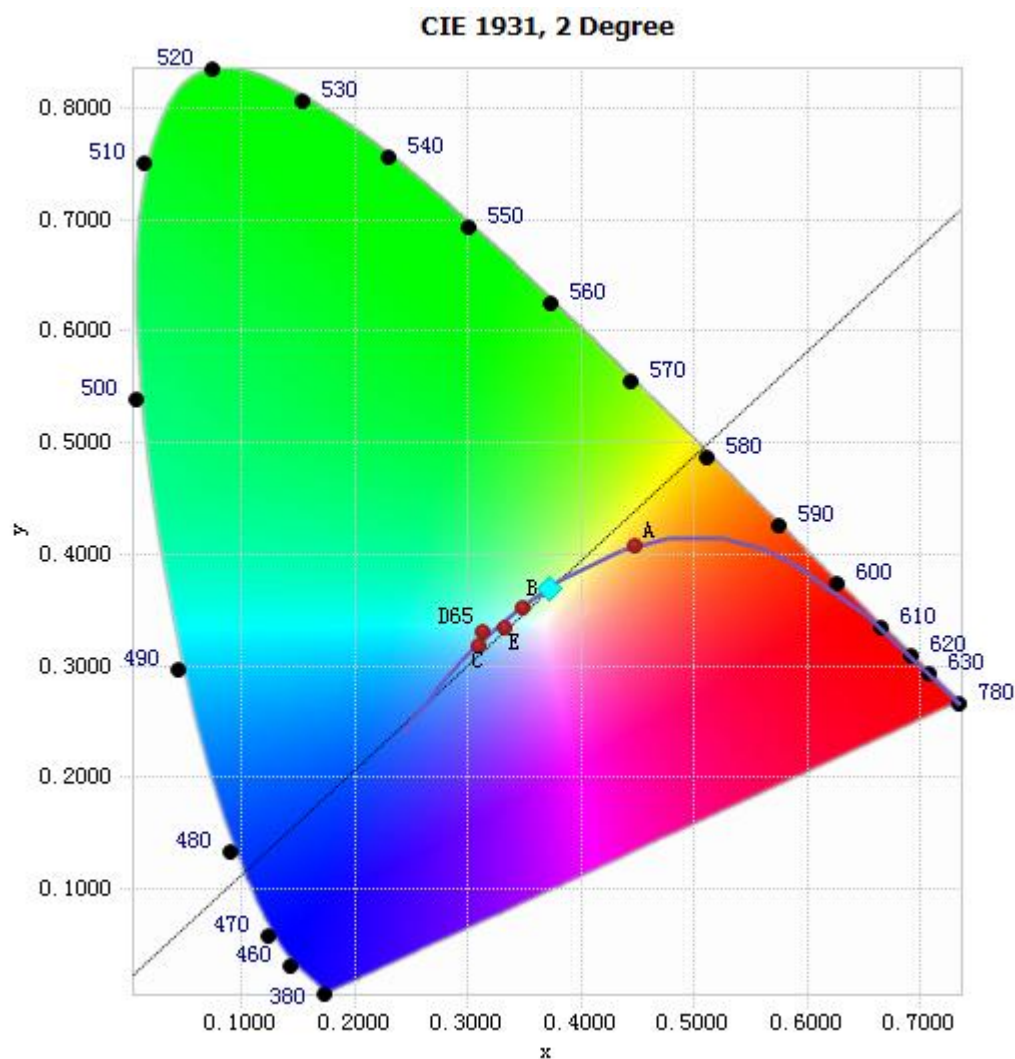


Chart 6: Chromaticity Diagram per Sphere - Spectroradiometer Method

Note: The location on the diagram of the tristimulus coordinates are indicated by the blue diamond.

Nominal CCT Quadrangles – Sphere Spectroradiometer Method (4000K Setting)

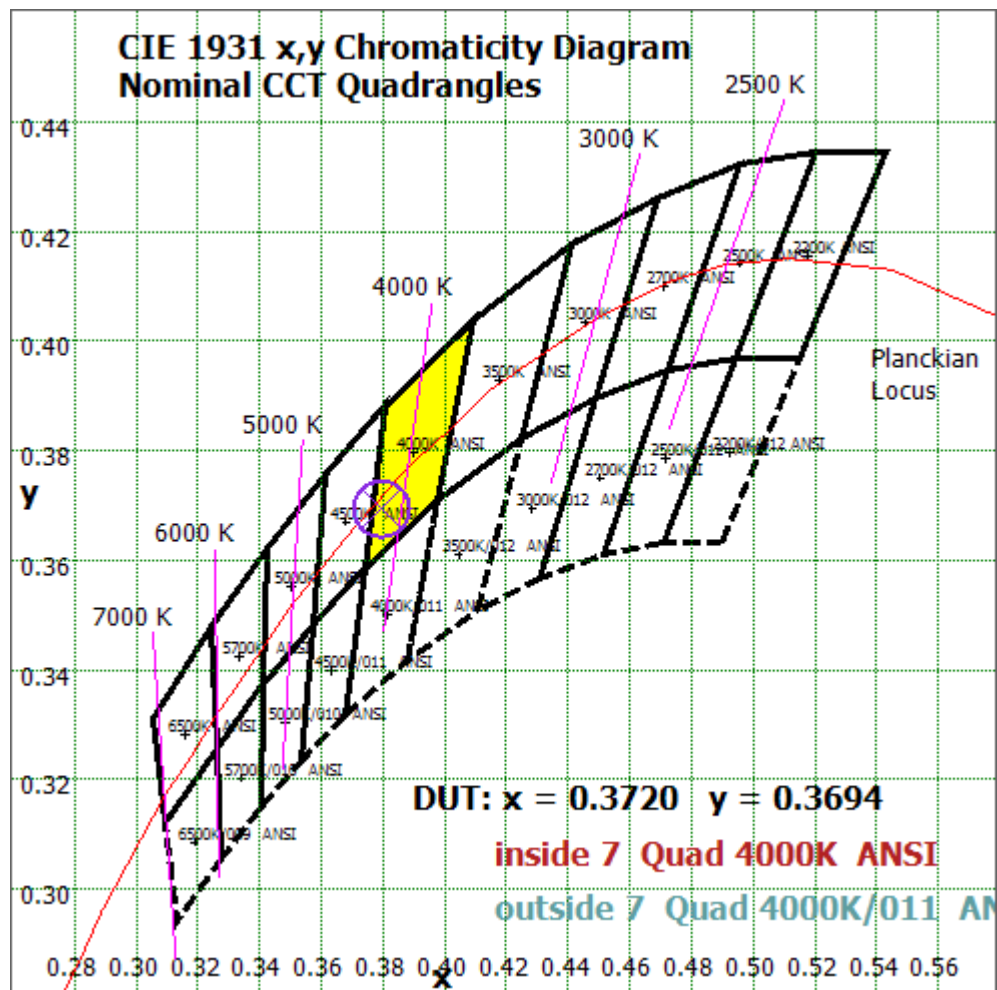


Chart 7: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

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

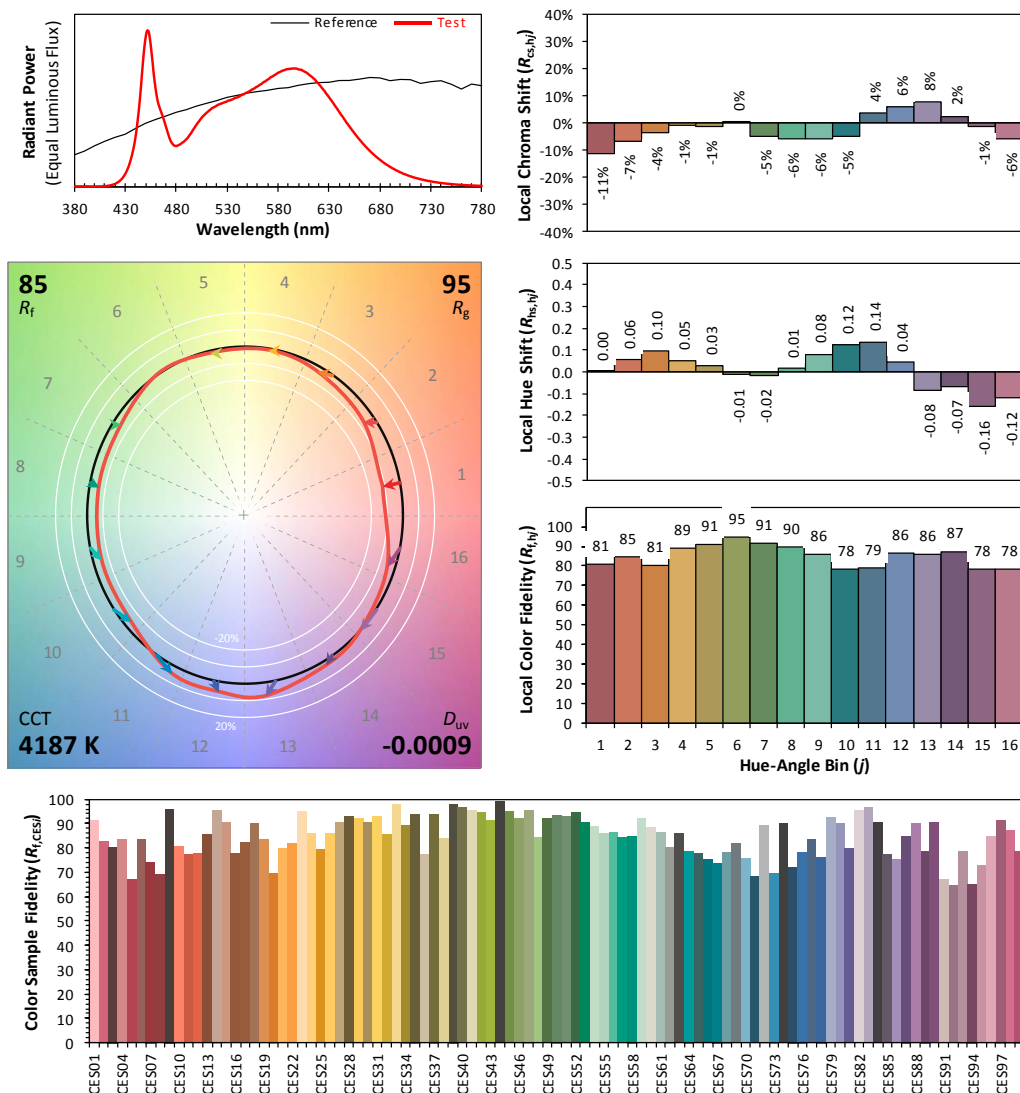
ANSI/IES TM-30-18 Color Rendition Report

Source: LED

Manufacturer: ESPEN TECHNOLOGY, INC.

Date: 2021/04/14

Model: L36T8/8T/11G-AB



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

x 0.3720
 y 0.3694
 u' 0.2225
 v' 0.4971

CIE 13.3-1995
(CRI)
 R_a 85
 R_g 17

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)	0.247	0.112
Power Factor	0.9971	0.9623
Test Power (W)/2	14.79	14.92
THD A%	5.54	9.58
Luminous Efficacy (lm/W)	129.4	128.4
Total Luminous Flux (lm)	1914.5	1915.1
Color Rendering Index (CRI)	84.2	
R9	9.2	
Correlated Color Temperature (CCT)(K)	5067	
Chromaticity Chroma x	0.3434	
Chromaticity Chroma y	0.3537	
Chromaticity Chroma u	0.2095	
Chromaticity Chroma v	0.3236	
Duv	0.0017	
Chromaticity Chroma u'	0.2095	
Chromaticity Chroma v'	0.4855	

Special Color Rendering Indices	
R1	82.7
R2	90.6
R3	94.6
R4	83.1
R5	83.3
R6	85.9
R7	86.4
R8	66.9
R9	9.2
R10	77.2
R11	82.8
R12	62.9
R13	85.1
R14	97.5

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)

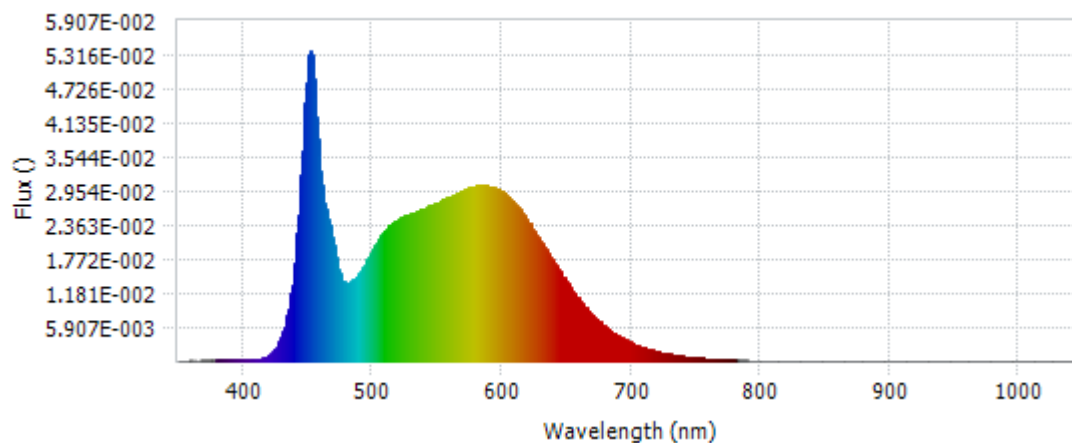
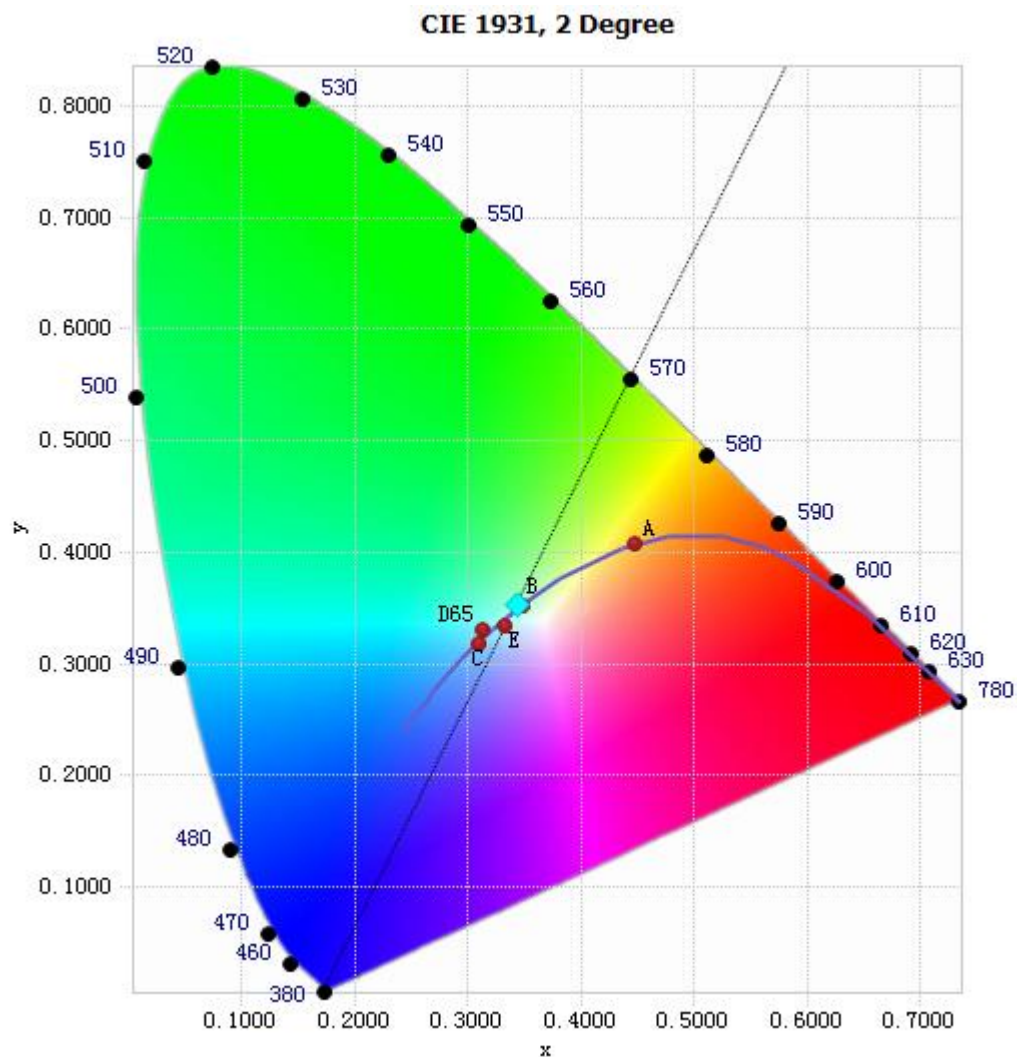


Chart 9: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	2.25E-04	485	1.41E-02	590	3.04E-02	695	3.81E-03
385	2.09E-04	490	1.53E-02	595	3.00E-02	700	3.24E-03
390	2.17E-04	495	1.71E-02	600	2.94E-02	705	2.76E-03
395	2.08E-04	500	1.94E-02	605	2.86E-02	710	2.35E-03
400	1.84E-04	505	2.13E-02	610	2.74E-02	715	2.00E-03
405	1.97E-04	510	2.27E-02	615	2.60E-02	720	1.71E-03
410	2.86E-04	515	2.40E-02	620	2.44E-02	725	1.45E-03
415	5.33E-04	520	2.46E-02	625	2.27E-02	730	1.23E-03
420	1.08E-03	525	2.52E-02	630	2.09E-02	735	1.05E-03
425	2.25E-03	530	2.56E-02	635	1.91E-02	740	8.91E-04
430	4.59E-03	535	2.60E-02	640	1.73E-02	745	7.57E-04
435	9.14E-03	540	2.65E-02	645	1.55E-02	750	6.47E-04
440	1.72E-02	545	2.70E-02	650	1.38E-02	755	5.50E-04
445	3.23E-02	550	2.75E-02	655	1.22E-02	760	4.73E-04
450	5.09E-02	555	2.80E-02	660	1.07E-02	765	3.99E-04
455	4.89E-02	560	2.86E-02	665	9.32E-03	770	3.44E-04
460	3.29E-02	565	2.92E-02	670	8.08E-03	775	2.96E-04
465	2.55E-02	570	2.97E-02	675	7.00E-03	780	2.53E-04
470	2.03E-02	575	3.01E-02	680	6.05E-03		
475	1.51E-02	580	3.04E-02	685	5.20E-03		
480	1.35E-02	585	3.06E-02	690	4.46E-03		

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

Chromaticity Diagram - Sphere Spectroradiometer Method (5000K Setting)



Tristimulus values(x, y): (0.3434, 0.3537)

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)

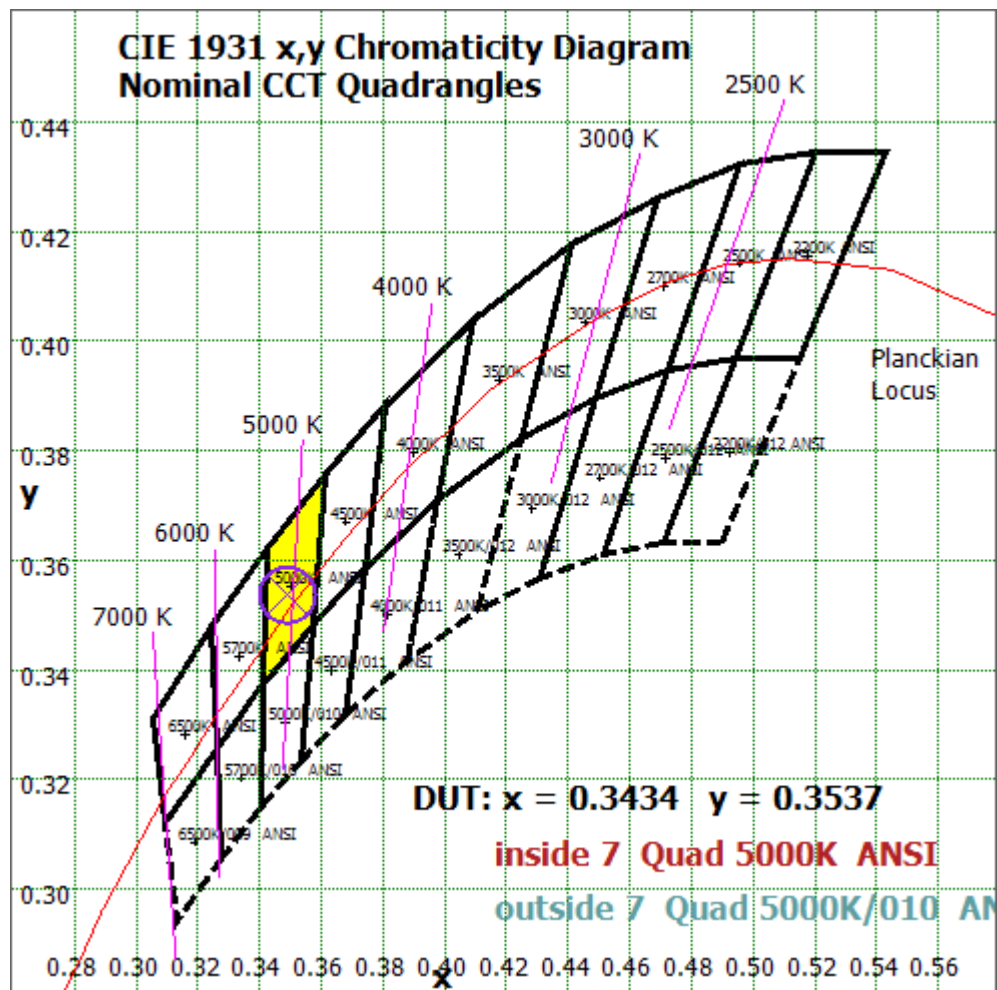


Chart 11: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

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

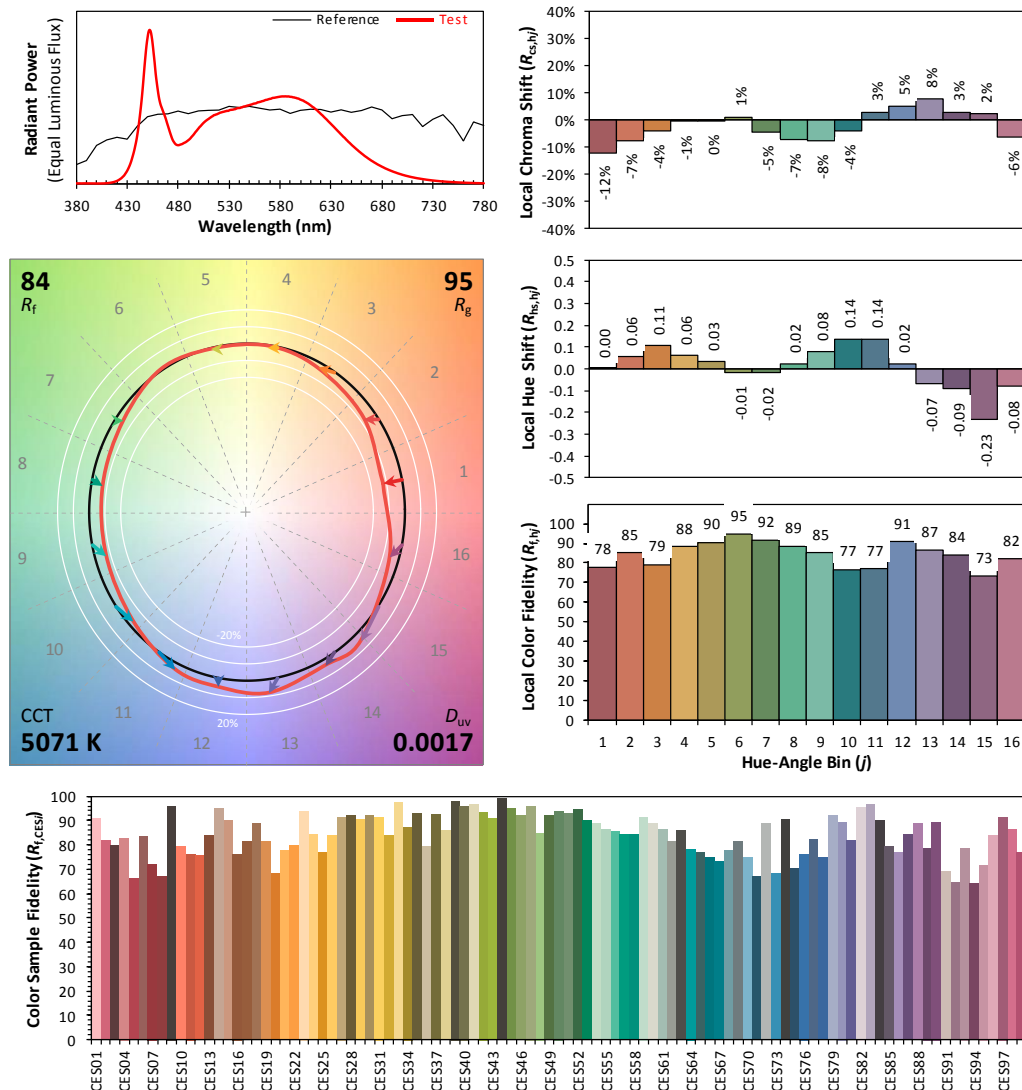
ANSI/IES TM-30-18 Color Rendition Report

Source: LED

Manufacturer: ESPEN TECHNOLOGY, INC.

Date: 2021/04/14

Model: L36T8/8T/11G-AB



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

x 0.3434
 y 0.3537
 u' 0.2095
 v' 0.4855

CIE 13.3-1995
(CRI)
 R_a 84
 R_9 9

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 25.1 °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)	0.247
Power Factor	0.9971
Power (W)/2	14.76
Luminous Efficacy (lm/W)	126.6
Total Luminous Flux (lm)	1868.5
Beam Angle (°)	112.7 (0°-180°) / 221.3 (90°-270°)
Center Beam Candle Power (cd)	315
Maximum Beam Candle Power (cd)	315.6 (At: C=230.0, Gamma=3.0)
Spacing Criteria	1.29 (0°-180°) / 1.46 (90°-270°)
Zonal Lumens in the 0 °-60 °Zone	43.99%
Zonal Lumens in the 60 °-90 °Zone	27.70%
Zonal Lumens in the 90 °-120 °Zone	17.49%
Zonal Lumens in the 120 °-180 °Zone	10.82%

Table 8: Test data per Goniophotometer Method

Zonal Lumen Tabulation- Goniophotometer Method (3500K Setting)

$\gamma(^{\circ})$	Lumens	% Total
0- 10	29.936	1.60%
10- 20	87.038	4.66%
20- 30	136.135	7.29%
30- 40	172.972	9.26%
40- 50	194.849	10.43%
50- 60	200.998	10.76%
60- 70	192.884	10.32%
70- 80	174.093	9.32%
80- 90	150.666	8.06%
90-100	128.875	6.90%
100-110	108.567	5.81%
110-120	89.381	4.78%
120-130	71.187	3.81%
130-140	54.303	2.91%
140-150	38.561	2.06%
150-160	24.33	1.30%
160-170	11.335	0.61%
170-180	2.377	0.13%
Total	1868.5	100%

$\gamma(^{\circ})$	Lumens	% Total
0- 60	821.928	43.99%
60- 90	517.643	27.70%
0-90	1339.57	71.69%
90- 180	528.916	28.31%
0- 180	1868.5	100%

Table 9: Zonal Lumen

Illuminance Plots- Goniophotometer Method (3500K Setting)

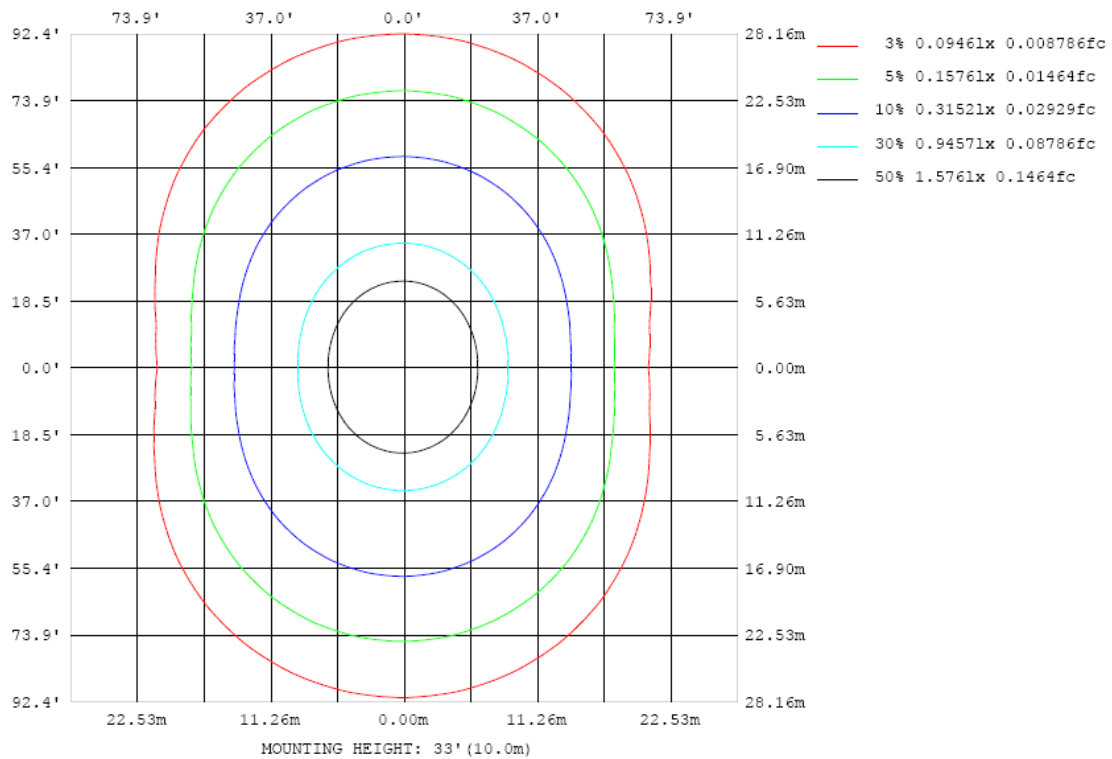


Chart 13: Illuminance Plot (Footcandles)

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

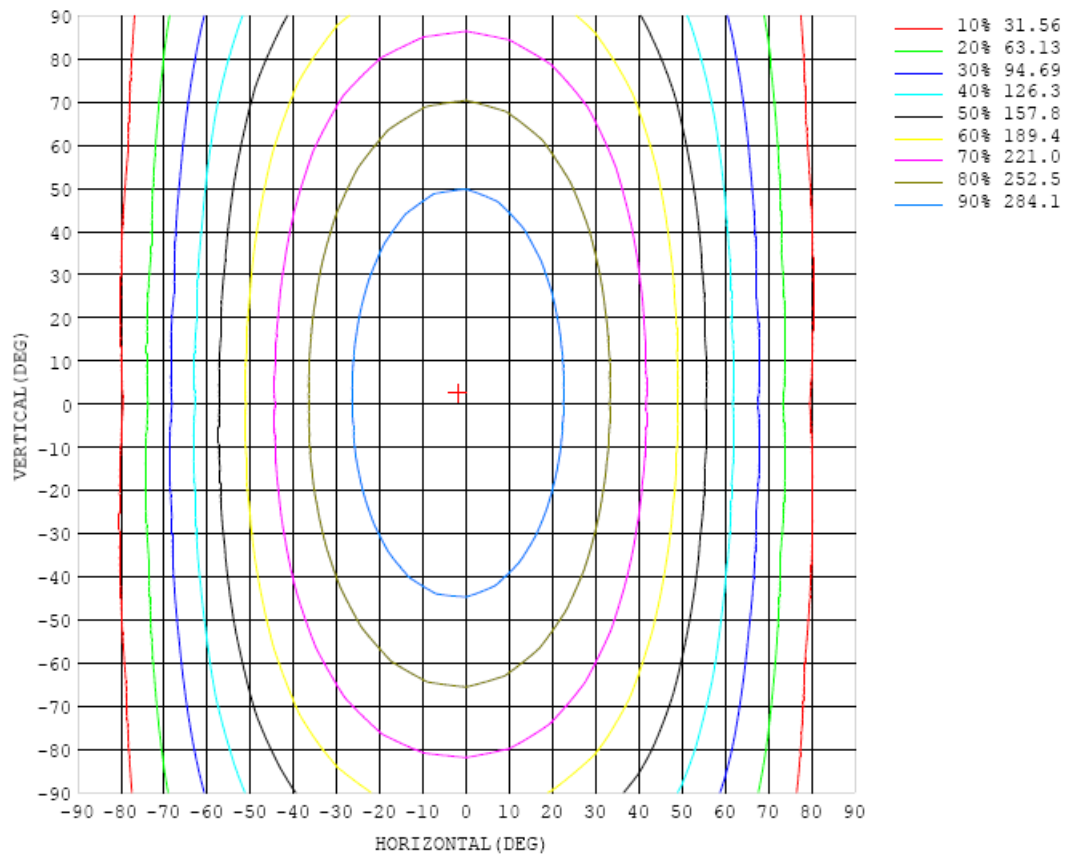


Chart 14: Isocandela Plot

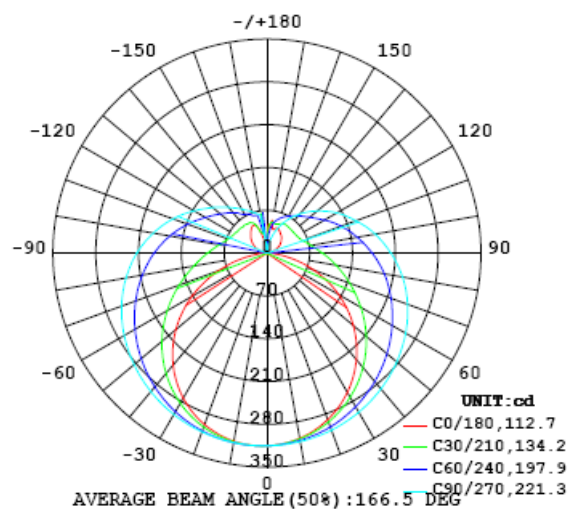


Chart 15: Polar Candela Distribution

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	315	315	315	315	315	315	315	315	315	315	315	315	315	315	315	315	315	315	315
5	313	313	313	313	313	313	314	314	314	314	315	315	315	315	315	315	315	315	315
10	308	308	308	309	309	310	311	312	313	313	313	314	313	313	313	313	312	312	312
15	300	300	301	302	304	306	307	309	310	311	311	311	311	310	309	308	307	307	307
20	290	290	292	294	297	300	303	305	307	308	308	308	307	305	303	302	300	299	298
25	278	278	281	284	288	293	297	300	303	305	305	304	302	299	296	293	290	288	288
30	263	264	267	272	278	284	290	295	298	300	301	299	296	292	287	282	278	275	274
35	246	248	252	259	267	275	282	289	293	295	296	293	289	283	276	270	264	259	258
40	228	230	236	244	254	265	274	282	287	290	290	287	281	274	265	255	247	241	239
45	207	210	217	228	241	254	265	274	281	284	283	280	273	263	252	240	229	221	218
50	184	188	198	212	227	243	256	267	274	277	276	272	263	252	238	223	209	199	195
55	160	165	177	195	213	231	246	258	266	270	269	263	254	240	224	205	188	175	169
60	135	141	157	177	199	219	236	249	258	262	261	255	243	228	209	187	166	150	142
65	109	117	136	160	185	208	226	240	250	253	252	245	233	216	194	169	144	124	113
70	81.6	91.5	116	144	171	196	216	231	241	245	243	236	222	204	180	152	123	97.3	84.2
75	54.6	67.3	96.2	129	158	184	205	221	231	235	233	226	212	192	166	137	103	71.8	55.7
80	29.7	45.8	79.3	115	146	173	195	211	221	225	223	215	201	180	154	122	84.8	49.2	29.0
85	9.70	29.3	65.6	102	135	162	183	200	210	214	212	204	189	168	142	109	70.5	31.9	8.57
90	0.41	19.5	54.7	90.8	123	150	172	188	199	203	201	192	178	157	130	97.3	59.7	22.1	0.58
95	1.67	14.8	46.8	81.3	113	140	161	177	187	191	189	181	166	146	120	87.9	52.0	17.7	2.13
100	4.39	14.5	41.6	73.1	103	130	150	166	176	180	178	170	155	136	110	79.4	46.1	17.0	5.15
105	8.38	16.3	38.5	66.9	94.6	119	140	154	164	167	165	158	144	125	101	72.4	42.5	18.7	9.37
110	13.0	20.0	37.7	61.4	87.2	110	129	143	151	155	153	146	134	116	92.6	66.4	41.1	22.3	14.4
115	17.8	24.1	38.5	58.2	79.9	101	119	132	140	143	142	135	123	106	84.8	62.3	40.6	25.8	19.5
120	22.7	28.1	40.0	56.4	74.6	92.4	108	121	129	132	130	123	112	96.2	77.2	58.2	39.9	28.8	24.5
125	26.8	32.2	41.9	55.5	70.7	85.7	98.8	109	117	119	118	112	101	86.5	69.6	53.8	38.9	31.4	29.4
130	30.3	36.2	44.1	55.2	67.8	80.3	91.3	100	106	107	105	100	90.2	76.8	61.8	49.1	37.6	33.6	33.6
135	33.8	40.1	46.4	55.2	65.5	75.8	84.9	92.0	96.2	95.5	93.3	88.6	79.3	67.0	53.8	43.9	35.9	35.0	37.6
140	36.6	43.2	48.4	55.4	63.6	71.9	79.4	84.9	86.5	83.7	81.1	77.0	68.4	57.3	45.7	38.3	33.9	35.5	41.6
145	38.7	46.0	49.7	55.3	62.3	68.7	74.7	78.2	76.7	71.8	68.9	65.4	57.6	47.4	37.5	32.0	31.3	34.8	45.7
150	41.7	49.0	51.8	55.3	60.7	65.8	70.1	71.2	66.8	59.9	56.7	53.7	46.8	37.6	29.1	25.1	28.0	32.3	49.3
155	45.2	51.7	53.5	53.2	58.5	62.8	65.4	63.9	56.6	48.0	44.5	42.1	36.1	27.8	20.6	17.2	23.5	28.5	50.4
160	43.9	52.5	53.5	50.6	57.0	59.5	60.4	55.9	46.1	36.1	32.3	30.3	25.6	18.1	11.9	8.72	16.0	23.9	45.2
165	40.8	53.5	49.2	49.7	55.2	55.5	54.5	46.8	35.1	24.2	20.2	18.6	15.4	8.72	3.20	0.13	4.44	16.7	29.1
170	52.1	48.1	44.9	51.5	51.8	50.5	46.4	35.7	23.2	12.3	8.20	6.70	5.35	1.52	0.00	0.00	0.00	3.21	12.0
175	45.9	48.7	47.8	46.2	44.1	39.1	29.9	19.5	8.79	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
180	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 10: Luminous Intensity Data

Table--2

UNIT: cd

C (DEG) γ (DEG)	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350		
0	315	315	315	315	315	315	315	315	315	315	315	315	315	315	315	315	315		
5	315	315	315	315	316	316	316	316	315	315	315	314	314	314	313	313	313		
10	313	313	313	314	314	315	315	315	315	314	313	312	311	310	309	308	308		
15	307	308	309	310	312	313	313	314	313	312	311	309	307	305	303	302	301		
20	299	301	303	305	307	310	311	311	311	310	308	305	302	299	295	293	291		
25	288	291	294	298	302	305	307	309	308	307	304	300	295	290	286	282	279		
30	275	279	284	289	295	300	303	305	305	303	299	294	287	281	274	269	265		
35	260	264	271	279	286	293	298	300	301	298	293	287	279	270	261	254	248		
40	241	248	257	267	277	286	292	295	296	293	287	279	269	258	247	237	230		
45	221	229	241	254	267	277	285	289	290	287	280	271	259	245	231	219	210		
50	199	209	224	241	256	269	278	283	284	280	273	262	248	232	215	200	189		
55	174	188	207	226	244	259	270	276	277	273	265	253	237	218	198	180	166		
60	148	166	188	212	232	249	261	268	270	266	257	243	225	204	181	159	141		
65	122	143	170	197	220	239	252	260	262	258	248	233	214	190	164	138	117		
70	94.6	121	153	183	208	229	243	251	253	249	239	223	203	177	148	118	91.9		
75	68.4	101	136	169	196	218	233	242	244	240	230	213	191	164	133	98.8	67.9		
80	45.8	82.7	122	156	185	207	223	232	234	230	220	203	180	152	119	82.3	47.6		
85	28.6	68.3	108	144	173	196	212	221	224	220	209	192	170	141	107	69.0	31.6		
90	19.3	58.1	97.4	133	162	185	201	210	213	209	199	182	159	130	96.6	59.5	22.3		
95	15.9	50.4	87.6	122	151	173	189	198	201	197	187	171	148	120	87.6	52.1	18.1		
100	16.3	45.4	79.3	112	139	161	177	186	189	185	176	160	138	111	79.8	47.0	18.1		
105	18.5	42.9	72.7	103	129	150	165	174	177	173	164	148	128	102	73.3	44.4	19.9		
110	22.4	42.3	67.9	94.4	119	138	152	161	164	161	152	137	118	94.2	68.6	43.9	23.1		
115	26.8	42.9	64.5	87.7	109	127	140	148	151	148	140	126	109	87.6	65.5	44.5	26.9		
120	31.2	44.3	62.2	82.3	101	117	129	136	138	136	128	116	101	82.6	63.4	45.7	30.3		
125	35.0	46.0	60.6	77.9	94.1	108	118	124	127	124	118	107	94.0	78.4	61.5	46.5	33.3		
130	37.7	48.0	60.0	74.0	88.1	99.8	109	114	116	114	108	99.6	88.1	75.0	59.0	45.7	35.9		
135	38.1	48.8	59.1	69.9	83.0	92.7	100	105	107	105	100	92.6	83.1	70.9	59.6	49.2	36.2		
140	38.3	49.4	59.0	67.5	77.5	86.5	92.6	96.5	97.8	96.4	92.5	86.4	77.8	66.2	58.0	50.4	36.7		
145	37.8	48.7	57.9	66.3	71.8	79.3	85.5	88.8	90.0	89.0	85.7	79.8	70.5	65.3	57.8	50.1	36.2		
150	36.8	47.0	57.4	64.5	69.8	73.2	76.8	80.5	83.1	82.5	78.8	72.5	69.0	63.9	55.8	50.3	34.8		
155	41.0	39.9	54.4	61.0	66.0	70.5	73.4	75.6	77.3	76.5	74.0	70.8	66.1	58.9	55.8	46.3	34.9		
160	52.9	34.1	45.3	57.7	63.3	65.1	67.5	70.6	72.0	71.2	69.8	64.3	55.2	51.3	44.4	36.2	35.7		
165	59.3	38.2	35.0	36.1	54.1	63.7	65.6	66.8	67.3	67.0	57.0	46.0	41.5	37.8	33.1	32.9	35.3		
170	25.5	59.2	48.0	34.2	33.0	36.1	40.6	52.0	60.9	32.1	39.6	39.3	37.4	32.9	32.8	30.0	28.3		
175	0.00	0.18	1.31	3.48	7.55	11.8	11.2	0.00	0.00	51.4	29.6	30.5	44.2	54.8	49.4	40.7	40.7		
180	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		

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

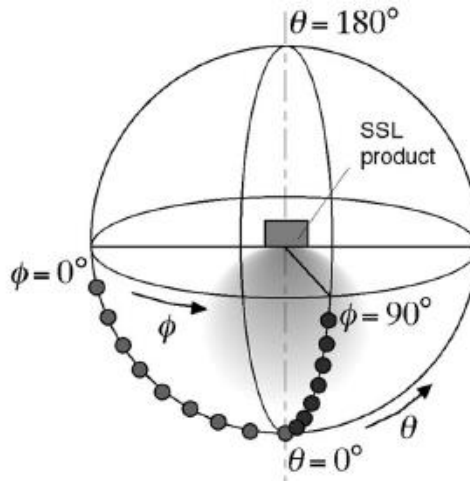
The color characteristics of SSL products include chromaticity coordinates, correlated color temperature, and color rendering index. These characteristics of SSL products may be spatially non-uniform, and thus, in order that they can be specified accurately, the color quantities shall be measured as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