

## LM-79-08 TEST REPORT

for

### ESPEN TECHNOLOGY, INC.

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

### LED Tube

**Model: L48T8/8T/12G-AB**

#### Laboratory: Leading Testing Laboratories

NVLAP CODE: 200960-0

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Report No.: HZ24030021c

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

Review by:

*Wei Fei*



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*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                       | L48T8/8T/12G-AB<br>3500K Setting | L48T8/8T/12G-AB<br>4000K Setting | L48T8/8T/12G-AB<br>5000K Setting |
|------------------------------------|----------------------------------|----------------------------------|----------------------------------|
| Luminous Efficacy (Lumens /Watt)   | 125.0                            | 132.2                            | 126.9                            |
| Total Luminous Flux (Lumens)       | 1850.3                           | 1920.5                           | 1882.8                           |
| Power (Watts)/2                    | 14.81                            | 14.53                            | 14.84                            |
| Power Factor                       | 0.9971                           | 0.9970                           | 0.9971                           |
| CCT (K)                            | 3471                             | 4216                             | 5165                             |
| CRI                                | 84.1                             | 85.7                             | 85.3                             |
| 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

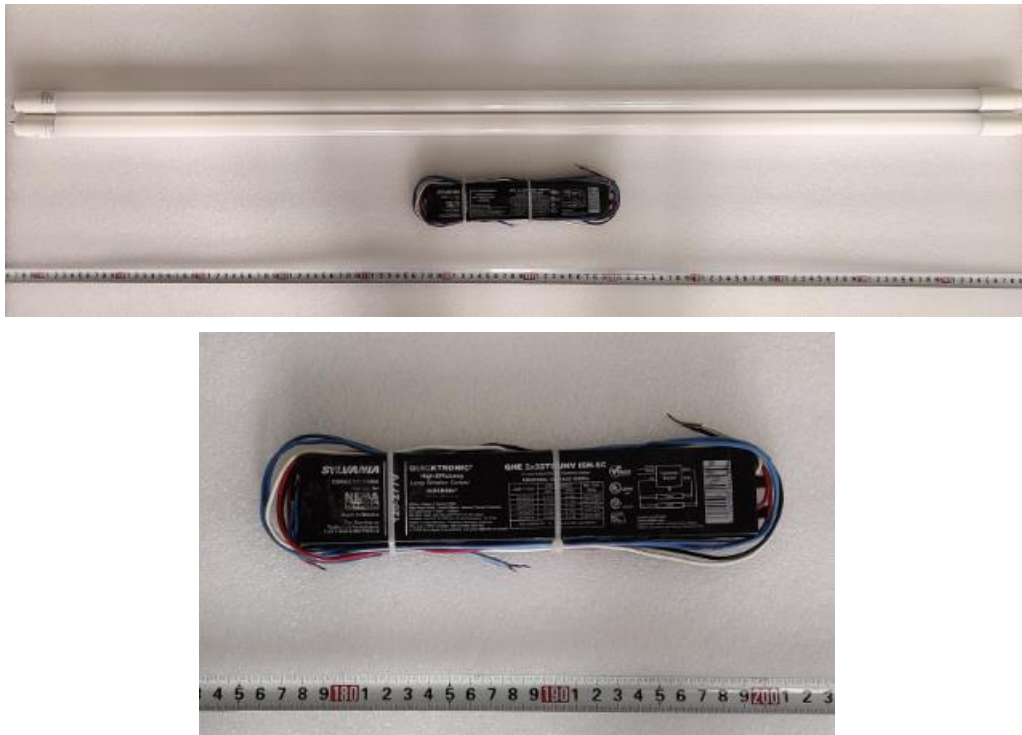


Figure 1- Overview of the sample

### Equipment Under Test(EUT)

|                            |                                                                                                                                 |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| <b>Name</b>                | : LED Tube                                                                                                                      |
| <b>Model</b>               | : L48T8/8T/12G-AB                                                                                                               |
| <b>Electrical Ratings</b>  | : 120-277V, 50/60Hz, 11W                                                                                                        |
| <b>Product Description</b> | : Color- Tunable 3500K/4000K/5000K<br>LED Tubes supplied by a high frequency fluorescent lamp ballast:<br>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)                      | 0.248   | 0.112  |
| Power Factor                          | 0.9971  | 0.9623 |
| Test Power (W)/2                      | 14.81   | 14.94  |
| THD A%                                | 5.64    | 9.89   |
| Luminous Efficacy (lm/W)              | 125.0   | 123.9  |
| Total Luminous Flux (lm)              | 1850.3  | 1850.6 |
| Color Rendering Index (CRI)           | 84.1    |        |
| R9                                    | 12      |        |
| Correlated Color Temperature (CCT)(K) | 3471    |        |
| Chromaticity Chroma x                 | 0.4062  |        |
| Chromaticity Chroma y                 | 0.3897  |        |
| Chromaticity Chroma u                 | 0.2367  |        |
| Chromaticity Chroma v                 | 0.3406  |        |
| Duv                                   | -0.0006 |        |
| Chromaticity Chroma u'                | 0.2367  |        |
| Chromaticity Chroma v'                | 0.5110  |        |

| Special Color Rendering Indices |      |
|---------------------------------|------|
| R1                              | 82.7 |
| R2                              | 90.8 |
| R3                              | 96.4 |
| R4                              | 83.2 |
| R5                              | 83   |
| R6                              | 88   |
| R7                              | 85   |
| R8                              | 63.5 |
| R9                              | 12   |
| R10                             | 78.6 |
| R11                             | 83.1 |
| R12                             | 68.9 |
| R13                             | 84.7 |
| 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)

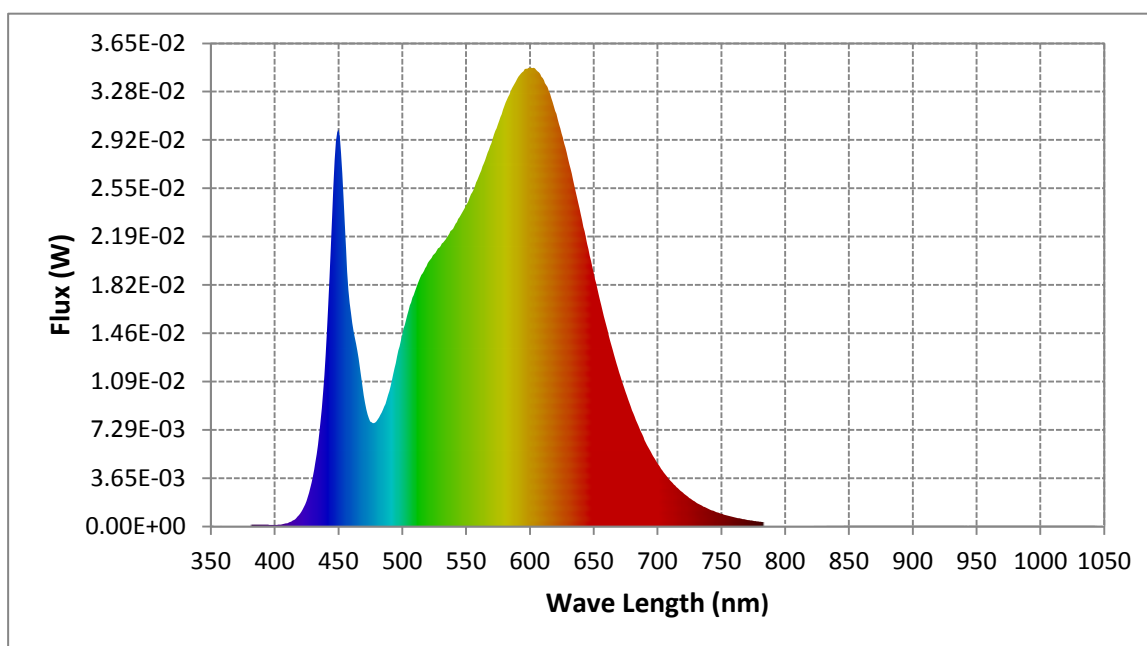
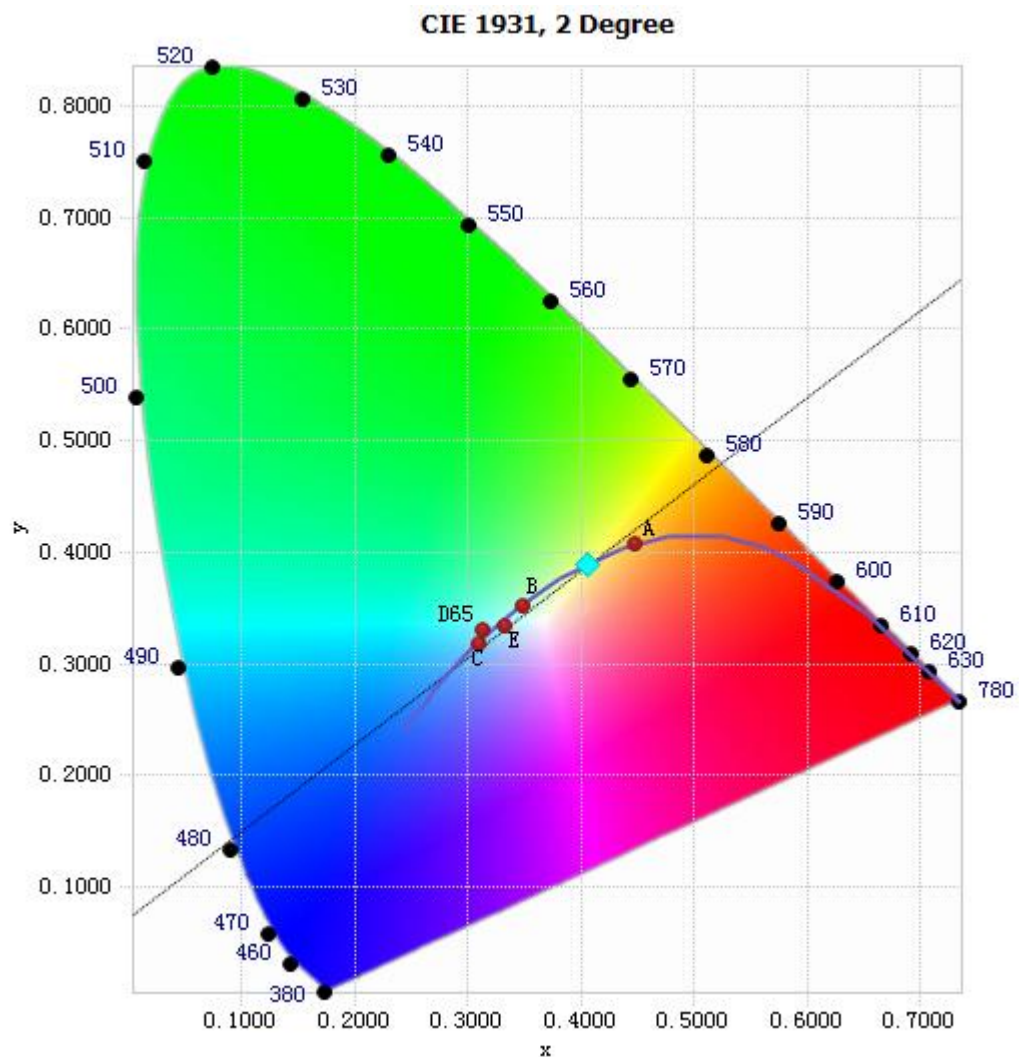


Chart 1: Spectral Power Distribution

| Spectral Distribution over Visible Wavelength |                |        |                |        |                |        |                |
|-----------------------------------------------|----------------|--------|----------------|--------|----------------|--------|----------------|
| WL(nm)                                        | Radiant(Watts) | WL(nm) | Radiant(Watts) | WL(nm) | Radiant(Watts) | WL(nm) | Radiant(Watts) |
| 380                                           | 1.40E-04       | 485    | 8.82E-03       | 590    | 3.38E-02       | 695    | 5.61E-03       |
| 385                                           | 1.32E-04       | 490    | 1.02E-02       | 595    | 3.43E-02       | 700    | 4.79E-03       |
| 390                                           | 1.40E-04       | 495    | 1.23E-02       | 600    | 3.46E-02       | 705    | 4.08E-03       |
| 395                                           | 1.37E-04       | 500    | 1.44E-02       | 605    | 3.44E-02       | 710    | 3.46E-03       |
| 400                                           | 1.15E-04       | 505    | 1.63E-02       | 610    | 3.38E-02       | 715    | 2.97E-03       |
| 405                                           | 1.40E-04       | 510    | 1.77E-02       | 615    | 3.29E-02       | 720    | 2.55E-03       |
| 410                                           | 2.45E-04       | 515    | 1.90E-02       | 620    | 3.13E-02       | 725    | 2.15E-03       |
| 415                                           | 4.73E-04       | 520    | 1.99E-02       | 625    | 2.97E-02       | 730    | 1.83E-03       |
| 420                                           | 9.55E-04       | 525    | 2.06E-02       | 630    | 2.78E-02       | 735    | 1.56E-03       |
| 425                                           | 1.91E-03       | 530    | 2.12E-02       | 635    | 2.57E-02       | 740    | 1.32E-03       |
| 430                                           | 3.77E-03       | 535    | 2.18E-02       | 640    | 2.35E-02       | 745    | 1.13E-03       |
| 435                                           | 7.02E-03       | 540    | 2.25E-02       | 645    | 2.13E-02       | 750    | 9.63E-04       |
| 440                                           | 1.30E-02       | 545    | 2.33E-02       | 650    | 1.92E-02       | 755    | 8.13E-04       |
| 445                                           | 2.33E-02       | 550    | 2.42E-02       | 655    | 1.71E-02       | 760    | 6.97E-04       |
| 450                                           | 3.00E-02       | 555    | 2.52E-02       | 660    | 1.51E-02       | 765    | 5.92E-04       |
| 455                                           | 2.27E-02       | 560    | 2.64E-02       | 665    | 1.33E-02       | 770    | 5.05E-04       |
| 460                                           | 1.61E-02       | 565    | 2.76E-02       | 670    | 1.16E-02       | 775    | 4.31E-04       |
| 465                                           | 1.32E-02       | 570    | 2.89E-02       | 675    | 1.01E-02       | 780    | 3.69E-04       |
| 470                                           | 9.87E-03       | 575    | 3.03E-02       | 680    | 8.77E-03       |        |                |
| 475                                           | 7.92E-03       | 580    | 3.17E-02       | 685    | 7.59E-03       |        |                |
| 480                                           | 7.95E-03       | 585    | 3.28E-02       | 690    | 6.53E-03       |        |                |

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

### Chromaticity Diagram - Sphere Spectroradiometer Method (3500K Setting)



Tristimulus values(x, y): (0.4062, 0.3897)

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)

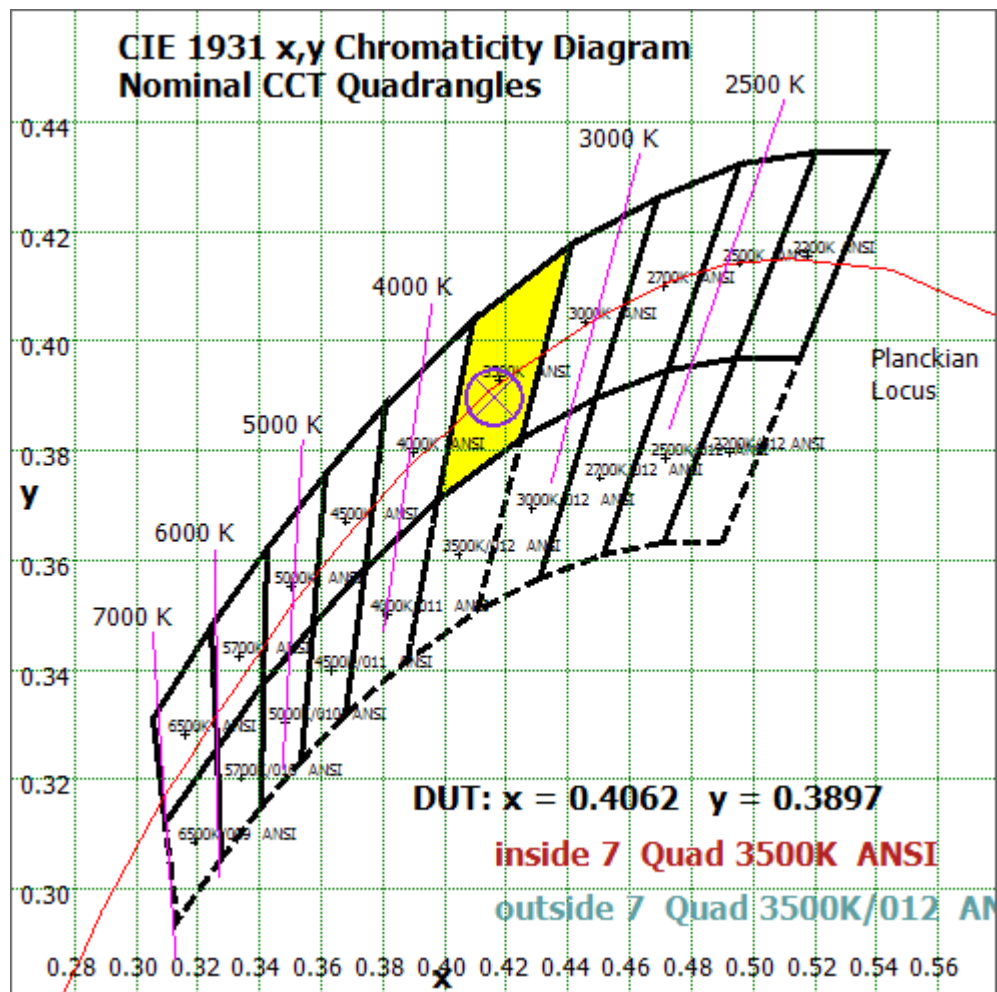


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

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

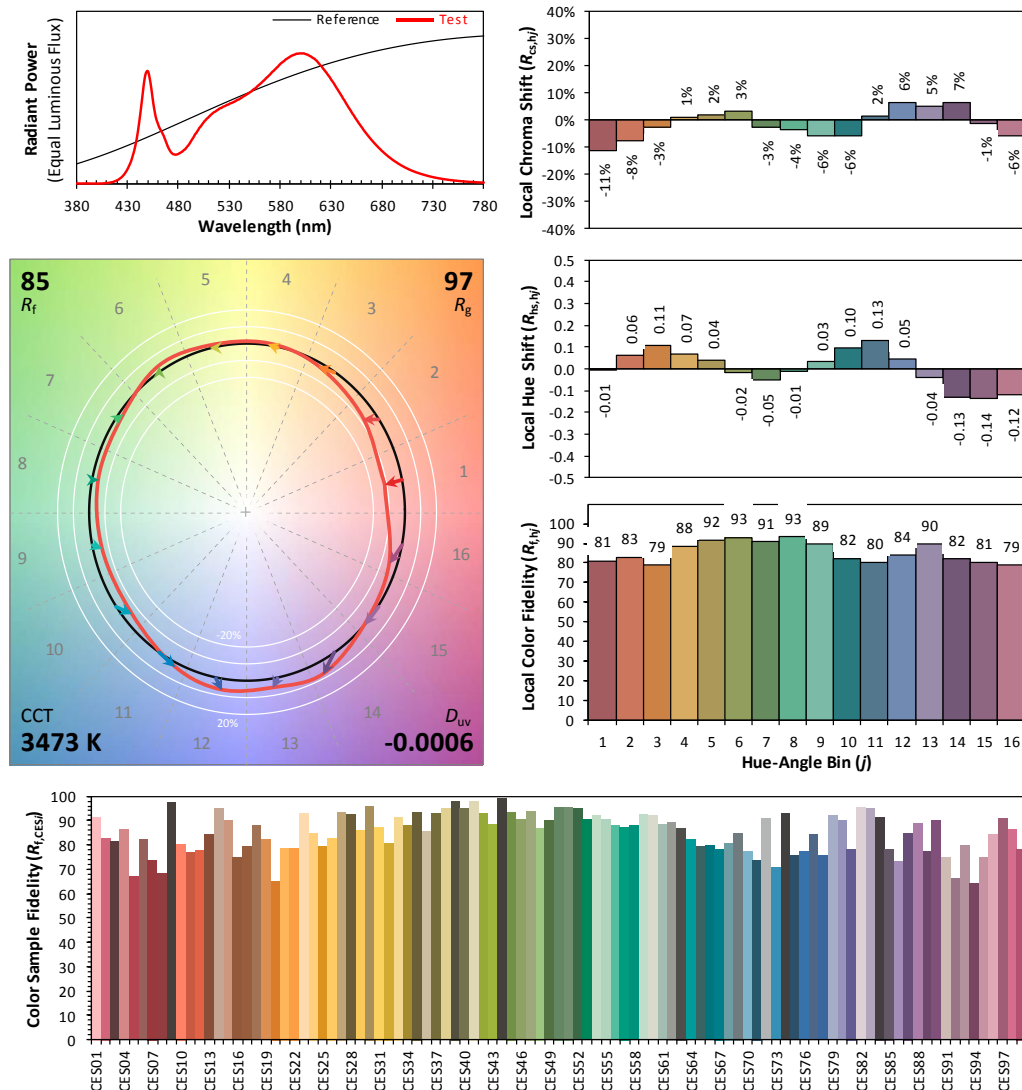
## ANSI/IES TM-30-18 Color Rendition Report

Source: LED

Manufacturer: ESPEN TECHNOLOGY, INC.

Date: 2021/04/14

Model: L48T8/8T/12G-AB



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

$x$  0.4062  
 $y$  0.3897  
 $u'$  0.2367  
 $v'$  0.5110

CIE 13.3-1995  
(CRI)  
 $R_a$  84  
 $R_9$  12

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)                      | 0.243   | 0.110  |
| Power Factor                          | 0.9970  | 0.9609 |
| Test Power (W)/2                      | 14.53   | 14.66  |
| THD A%                                | 5.63    | 10.08  |
| Luminous Efficacy (lm/W)              | 132.2   | 131.0  |
| Total Luminous Flux (lm)              | 1920.5  | 1920.6 |
| Color Rendering Index (CRI)           | 85.7    |        |
| R9                                    | 19.6    |        |
| Correlated Color Temperature (CCT)(K) | 4216    |        |
| Chromaticity Chroma x                 | 0.3702  |        |
| Chromaticity Chroma y                 | 0.3663  |        |
| Chromaticity Chroma u                 | 0.2225  |        |
| Chromaticity Chroma v                 | 0.3302  |        |
| Duv                                   | -0.0019 |        |
| Chromaticity Chroma u'                | 0.2225  |        |
| Chromaticity Chroma v'                | 0.4954  |        |

| Special Color Rendering Indices |      |
|---------------------------------|------|
| R1                              | 85.1 |
| R2                              | 93   |
| R3                              | 95.9 |
| R4                              | 83.9 |
| R5                              | 85   |
| R6                              | 88.7 |
| R7                              | 86.2 |
| R8                              | 68.1 |
| R9                              | 19.6 |
| R10                             | 82.5 |
| R11                             | 83.7 |
| R12                             | 63.9 |
| 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)

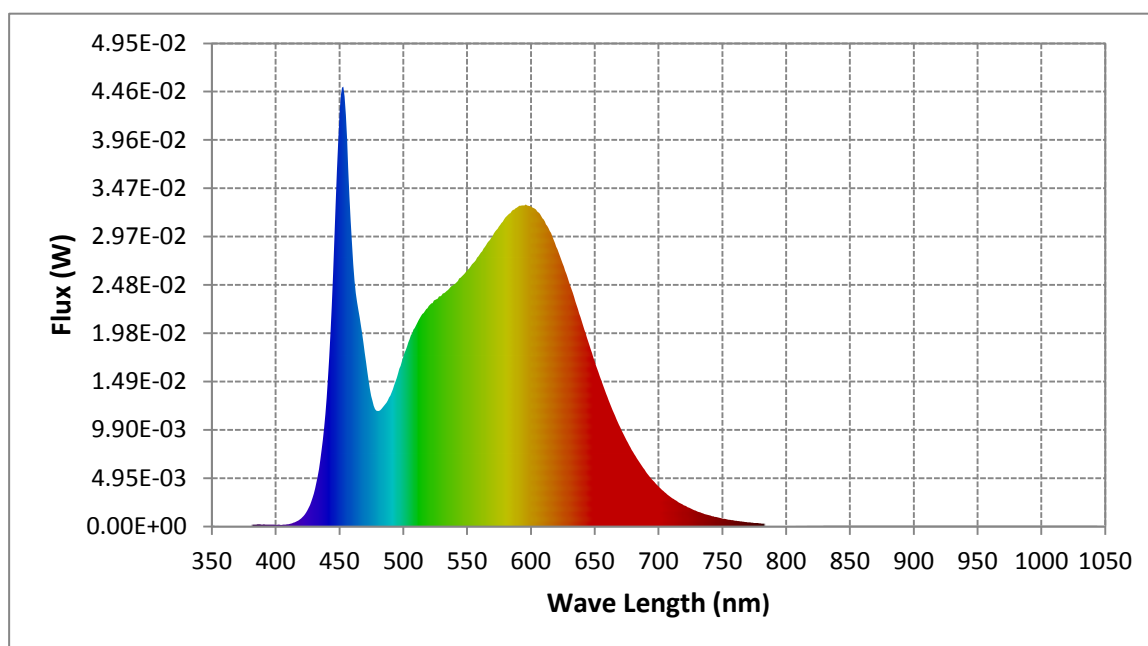
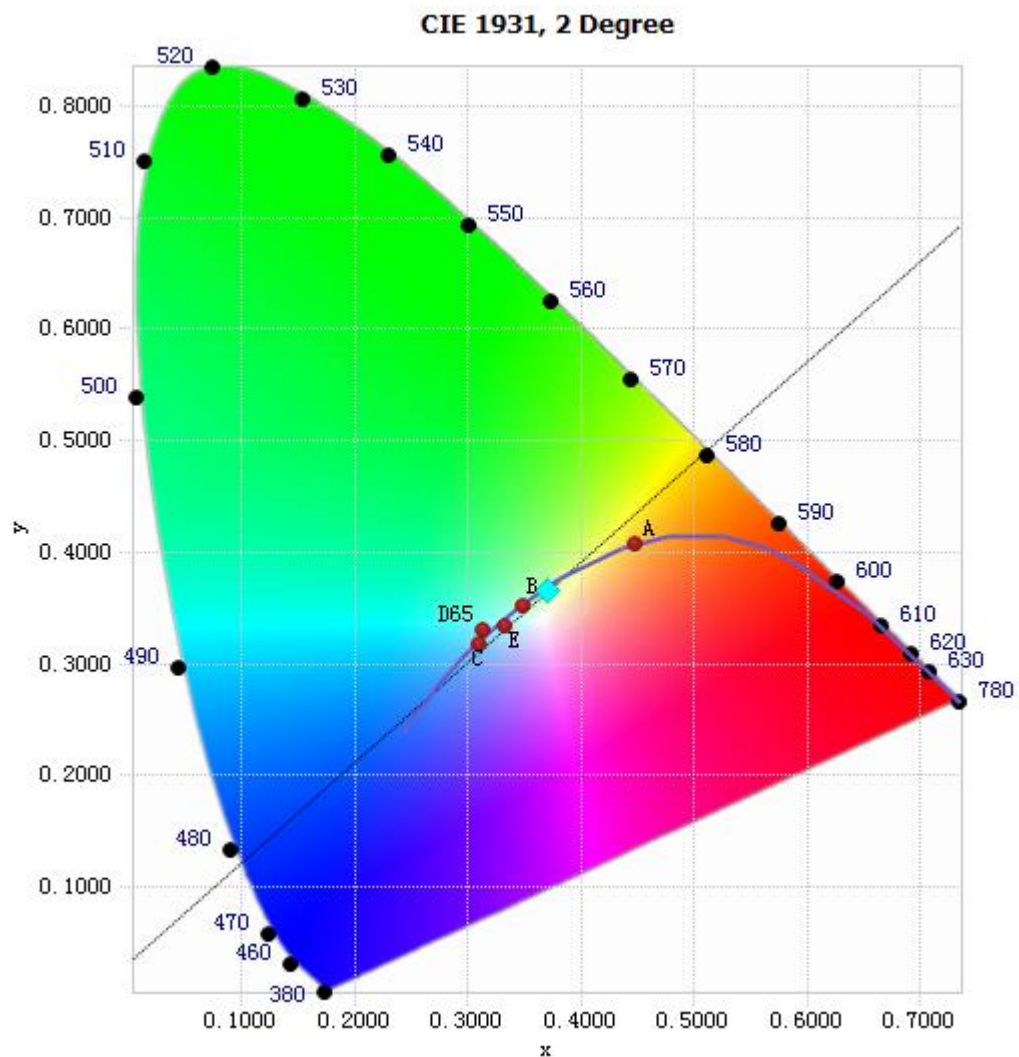


Chart 5: Spectral Power Distribution

| Spectral Distribution over Visible Wavelength |                |        |                |        |                |        |                |
|-----------------------------------------------|----------------|--------|----------------|--------|----------------|--------|----------------|
| WL(nm)                                        | Radiant(Watts) | WL(nm) | Radiant(Watts) | WL(nm) | Radiant(Watts) | WL(nm) | Radiant(Watts) |
| 380                                           | 2.10E-04       | 485    | 1.24E-02       | 590    | 3.28E-02       | 695    | 4.83E-03       |
| 385                                           | 2.03E-04       | 490    | 1.34E-02       | 595    | 3.29E-02       | 700    | 4.13E-03       |
| 390                                           | 2.00E-04       | 495    | 1.52E-02       | 600    | 3.28E-02       | 705    | 3.51E-03       |
| 395                                           | 1.88E-04       | 500    | 1.73E-02       | 605    | 3.23E-02       | 710    | 2.98E-03       |
| 400                                           | 1.60E-04       | 505    | 1.92E-02       | 610    | 3.14E-02       | 715    | 2.55E-03       |
| 405                                           | 1.70E-04       | 510    | 2.06E-02       | 615    | 3.03E-02       | 720    | 2.17E-03       |
| 410                                           | 2.29E-04       | 515    | 2.18E-02       | 620    | 2.87E-02       | 725    | 1.85E-03       |
| 415                                           | 4.18E-04       | 520    | 2.26E-02       | 625    | 2.70E-02       | 730    | 1.57E-03       |
| 420                                           | 8.04E-04       | 525    | 2.32E-02       | 630    | 2.51E-02       | 735    | 1.33E-03       |
| 425                                           | 1.65E-03       | 530    | 2.37E-02       | 635    | 2.30E-02       | 740    | 1.13E-03       |
| 430                                           | 3.38E-03       | 535    | 2.42E-02       | 640    | 2.10E-02       | 745    | 9.63E-04       |
| 435                                           | 6.79E-03       | 540    | 2.48E-02       | 645    | 1.90E-02       | 750    | 8.18E-04       |
| 440                                           | 1.32E-02       | 545    | 2.55E-02       | 650    | 1.70E-02       | 755    | 6.95E-04       |
| 445                                           | 2.58E-02       | 550    | 2.62E-02       | 655    | 1.50E-02       | 760    | 5.92E-04       |
| 450                                           | 4.22E-02       | 555    | 2.70E-02       | 660    | 1.33E-02       | 765    | 5.05E-04       |
| 455                                           | 4.22E-02       | 560    | 2.79E-02       | 665    | 1.16E-02       | 770    | 4.32E-04       |
| 460                                           | 2.91E-02       | 565    | 2.88E-02       | 670    | 1.02E-02       | 775    | 3.69E-04       |
| 465                                           | 2.22E-02       | 570    | 2.97E-02       | 675    | 8.82E-03       | 780    | 3.16E-04       |
| 470                                           | 1.78E-02       | 575    | 3.07E-02       | 680    | 7.63E-03       |        |                |
| 475                                           | 1.34E-02       | 580    | 3.16E-02       | 685    | 6.58E-03       |        |                |
| 480                                           | 1.18E-02       | 585    | 3.23E-02       | 690    | 5.66E-03       |        |                |

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

### Chromaticity Diagram - Sphere Spectroradiometer Method (4000K Setting)



Tristimulus values(x, y): (0.3702, 0.3663)

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)

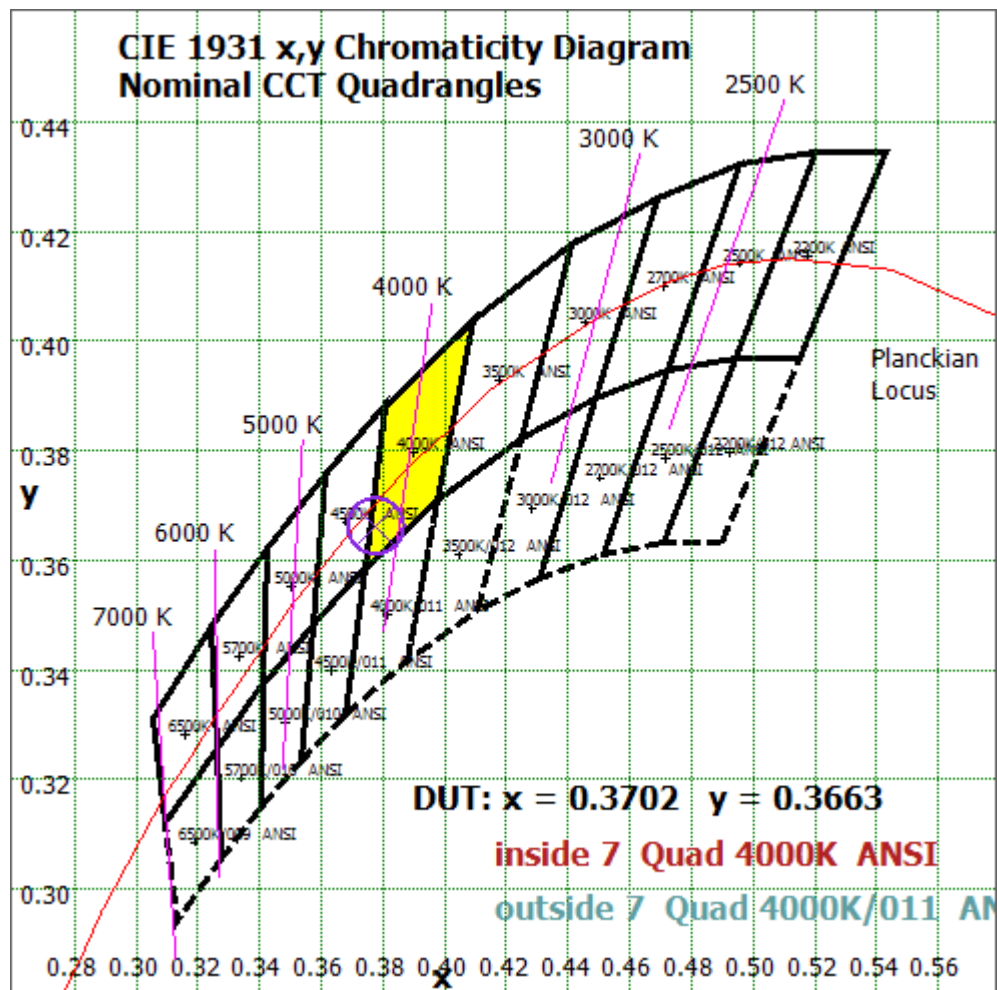


Chart 7: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

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

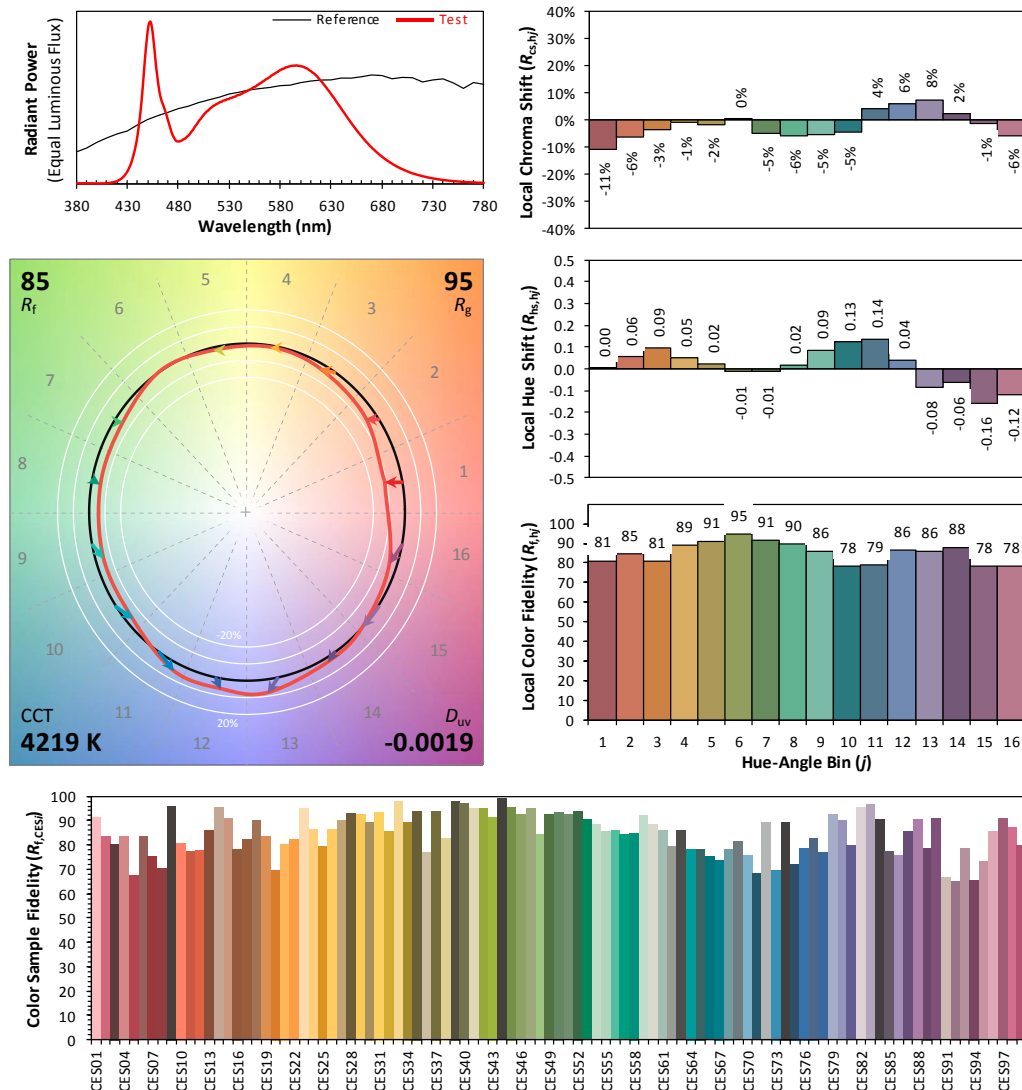
## ANSI/IES TM-30-18 Color Rendition Report

Source: LED

Manufacturer: ESPEN TECHNOLOGY, INC.

Date: 2021/04/14

Model: L48T8/8T/12G-AB



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

$x$  0.3702  
 $y$  0.3663  
 $u'$  0.2225  
 $v'$  0.4954

CIE 13.3-1995  
(CRI)  
 $R_a$  86  
 $R_9$  20

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)                      | 0.248  | 0.112  |
| Power Factor                          | 0.9971 | 0.9624 |
| Test Power (W)/2                      | 14.84  | 14.96  |
| THD A%                                | 5.51   | 9.82   |
| Luminous Efficacy (lm/W)              | 126.9  | 125.9  |
| Total Luminous Flux (lm)              | 1882.8 | 1882.9 |
| Color Rendering Index (CRI)           | 85.3   |        |
| R9                                    | 15.1   |        |
| Correlated Color Temperature (CCT)(K) | 5165   |        |
| Chromaticity Chroma x                 | 0.3405 |        |
| Chromaticity Chroma y                 | 0.3481 |        |
| Chromaticity Chroma u                 | 0.2097 |        |
| Chromaticity Chroma v                 | 0.3215 |        |
| Duv                                   | 0.0001 |        |
| Chromaticity Chroma u'                | 0.2097 |        |
| Chromaticity Chroma v'                | 0.4823 |        |

| Special Color Rendering Indices |      |
|---------------------------------|------|
| R1                              | 84.5 |
| R2                              | 92.1 |
| R3                              | 94.8 |
| R4                              | 84   |
| R5                              | 84.7 |
| R6                              | 87.1 |
| R7                              | 86.5 |
| R8                              | 68.7 |
| R9                              | 15.1 |
| R10                             | 80.3 |
| R11                             | 83.8 |
| R12                             | 63.6 |
| R13                             | 87   |
| R14                             | 97.8 |

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)

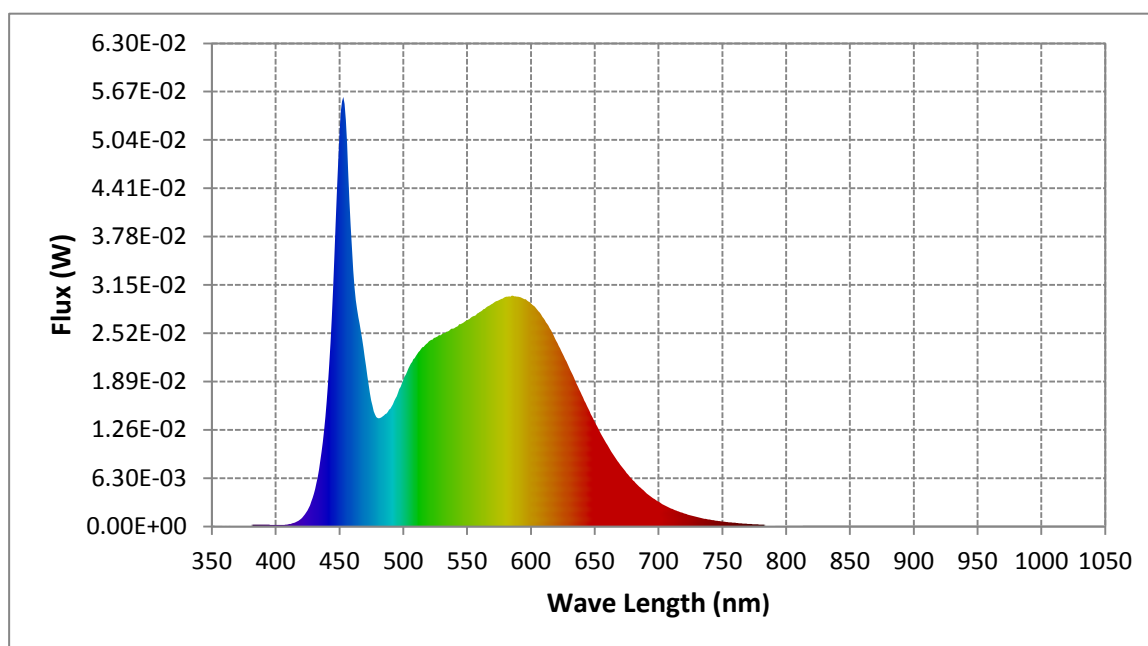
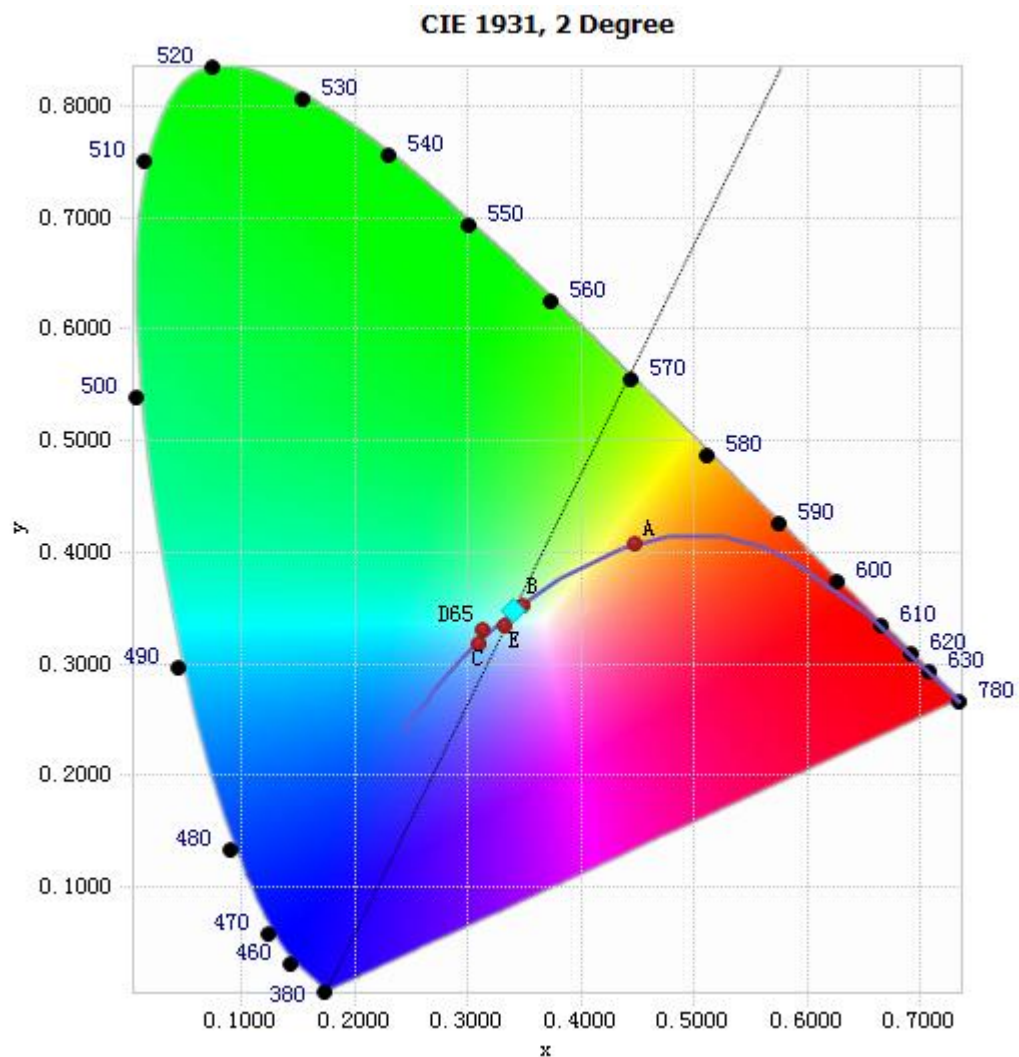


Chart 9: Spectral Power Distribution

| Spectral Distribution over Visible Wavelength |                |        |                |        |                |        |                |
|-----------------------------------------------|----------------|--------|----------------|--------|----------------|--------|----------------|
| WL(nm)                                        | Radiant(Watts) | WL(nm) | Radiant(Watts) | WL(nm) | Radiant(Watts) | WL(nm) | Radiant(Watts) |
| 380                                           | 2.34E-04       | 485    | 1.45E-02       | 590    | 3.00E-02       | 695    | 3.79E-03       |
| 385                                           | 2.33E-04       | 490    | 1.54E-02       | 595    | 2.96E-02       | 700    | 3.24E-03       |
| 390                                           | 2.38E-04       | 495    | 1.70E-02       | 600    | 2.91E-02       | 705    | 2.76E-03       |
| 395                                           | 2.29E-04       | 500    | 1.91E-02       | 605    | 2.82E-02       | 710    | 2.34E-03       |
| 400                                           | 2.01E-04       | 505    | 2.09E-02       | 610    | 2.71E-02       | 715    | 2.00E-03       |
| 405                                           | 2.03E-04       | 510    | 2.22E-02       | 615    | 2.58E-02       | 720    | 1.71E-03       |
| 410                                           | 2.87E-04       | 515    | 2.34E-02       | 620    | 2.42E-02       | 725    | 1.45E-03       |
| 415                                           | 5.10E-04       | 520    | 2.41E-02       | 625    | 2.25E-02       | 730    | 1.23E-03       |
| 420                                           | 1.00E-03       | 525    | 2.46E-02       | 630    | 2.08E-02       | 735    | 1.05E-03       |
| 425                                           | 2.07E-03       | 530    | 2.50E-02       | 635    | 1.90E-02       | 740    | 8.92E-04       |
| 430                                           | 4.26E-03       | 535    | 2.54E-02       | 640    | 1.72E-02       | 745    | 7.57E-04       |
| 435                                           | 8.54E-03       | 540    | 2.58E-02       | 645    | 1.54E-02       | 750    | 6.49E-04       |
| 440                                           | 1.63E-02       | 545    | 2.64E-02       | 650    | 1.37E-02       | 755    | 5.54E-04       |
| 445                                           | 3.09E-02       | 550    | 2.69E-02       | 655    | 1.21E-02       | 760    | 4.73E-04       |
| 450                                           | 5.12E-02       | 555    | 2.74E-02       | 660    | 1.06E-02       | 765    | 4.06E-04       |
| 455                                           | 5.29E-02       | 560    | 2.80E-02       | 665    | 9.26E-03       | 770    | 3.43E-04       |
| 460                                           | 3.63E-02       | 565    | 2.85E-02       | 670    | 8.05E-03       | 775    | 2.96E-04       |
| 465                                           | 2.73E-02       | 570    | 2.90E-02       | 675    | 6.98E-03       | 780    | 2.57E-04       |
| 470                                           | 2.20E-02       | 575    | 2.95E-02       | 680    | 6.02E-03       |        |                |
| 475                                           | 1.64E-02       | 580    | 2.99E-02       | 685    | 5.19E-03       |        |                |
| 480                                           | 1.41E-02       | 585    | 3.01E-02       | 690    | 4.45E-03       |        |                |

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

### Chromaticity Diagram - Sphere Spectroradiometer Method (5000K Setting)



Tristimulus values(x, y): (0.3405, 0.3481)

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)

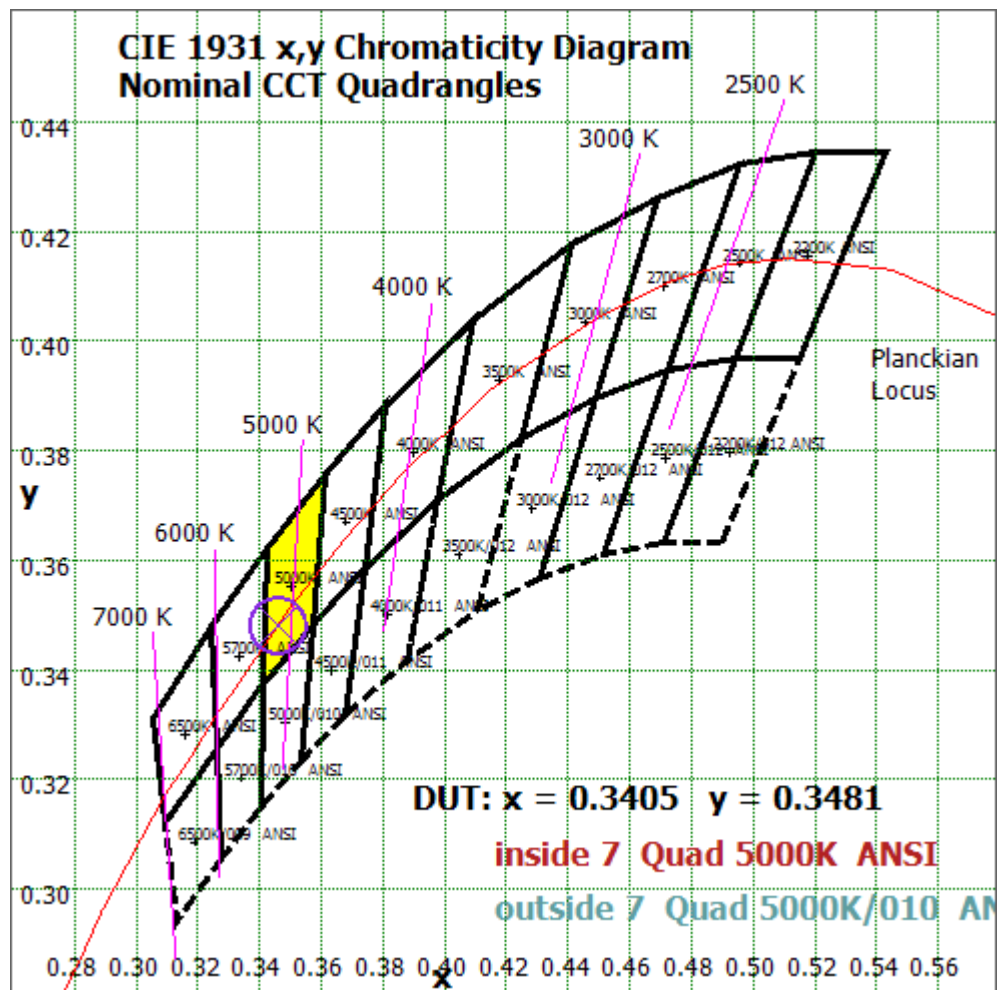


Chart 11: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

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

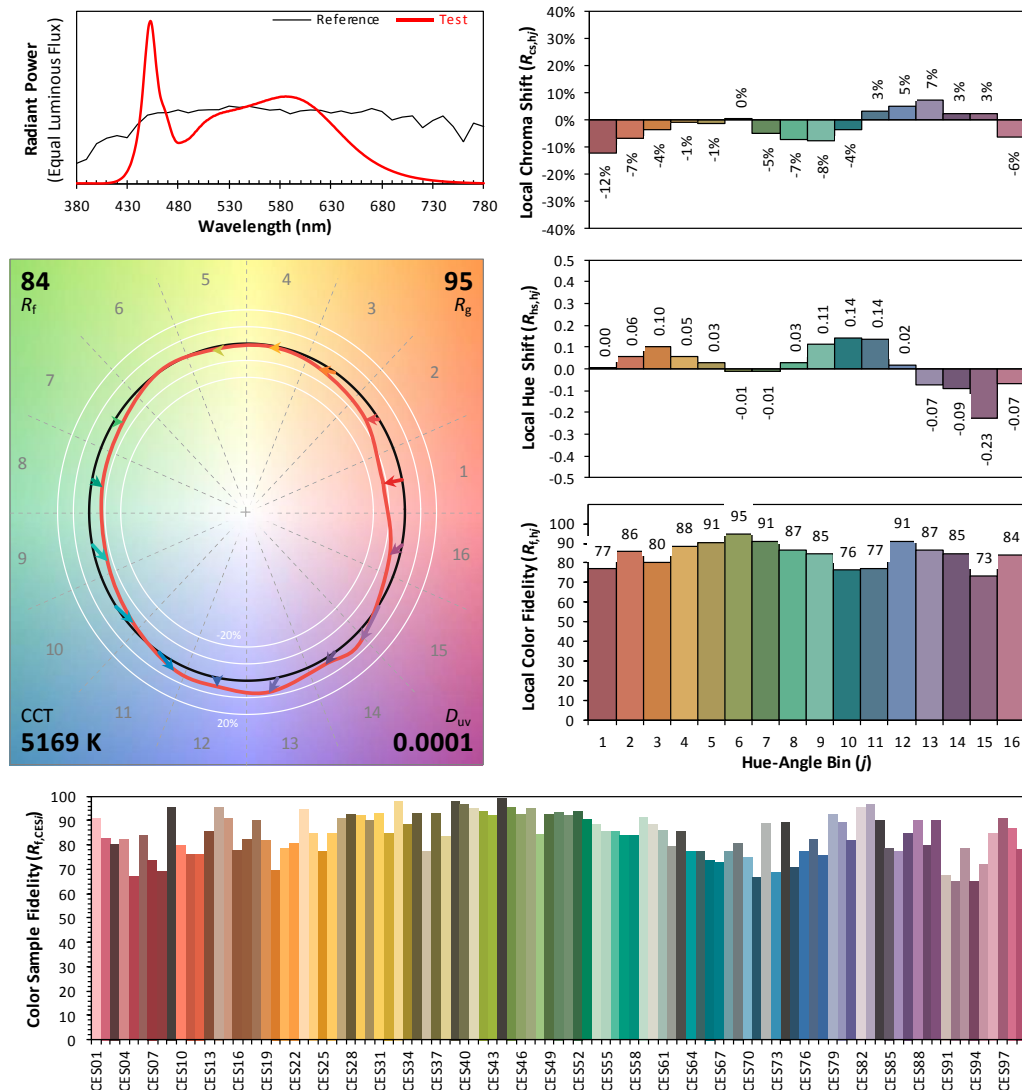
## ANSI/IES TM-30-18 Color Rendition Report

Source: LED

Manufacturer: ESPEN TECHNOLOGY, INC.

Date: 2021/04/14

Model: L48T8/8T/12G-AB



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

$x$  0.3405  
 $y$  0.3481  
 $u'$  0.2097  
 $v'$  0.4823

CIE 13.3-1995  
(CRI)  
 $R_a$  85  
 $R_9$  15

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                        | 0.9951                             |
| Power (W)/2                         | 14.76                              |
| Luminous Efficacy (lm/W)            | 123.4                              |
| Total Luminous Flux (lm)            | 1821.7                             |
| Beam Angle ( °)                     | 114.7 (0°-180°) / 217.3 (90°-270°) |
| Center Beam Candle Power (cd)       | 308                                |
| Maximum Beam Candle Power (cd)      | 308.0 (At: C=340.0, Gamma=2.0)     |
| Spacing Criteria                    | 1.27 (0°-180°) / 1.44 (90°-270°)   |
| Zonal Lumens in the 0 °-60 °Zone    | 43.96%                             |
| Zonal Lumens in the 60 °-90 °Zone   | 27.32%                             |
| Zonal Lumens in the 90 °-120 °Zone  | 17.28%                             |
| Zonal Lumens in the 120 °-180 °Zone | 11.45%                             |

Table 8: Test data per Goniophotometer Method

**Zonal Lumen Tabulation- Goniophotometer Method (3500K Setting)**

| $\gamma(^{\circ})$ | Lumens  | % Total |
|--------------------|---------|---------|
| 0- 10              | 29.23   | 1.60%   |
| 10- 20             | 84.981  | 4.66%   |
| 20- 30             | 132.919 | 7.30%   |
| 30- 40             | 168.786 | 9.27%   |
| 40- 50             | 189.756 | 10.42%  |
| 50- 60             | 195.086 | 10.71%  |
| 60- 70             | 186.341 | 10.23%  |
| 70- 80             | 167.196 | 9.18%   |
| 80- 90             | 144.083 | 7.91%   |
| 90-100             | 123.684 | 6.79%   |
| 100-110            | 104.66  | 5.75%   |
| 110-120            | 86.388  | 4.74%   |
| 120-130            | 69.418  | 3.81%   |
| 130-140            | 54.135  | 2.97%   |
| 140-150            | 39.975  | 2.19%   |
| 150-160            | 26.671  | 1.46%   |
| 160-170            | 14.188  | 0.78%   |
| 170-180            | 4.185   | 0.23%   |
| Total              | 1821.7  | 100%    |

| $\gamma(^{\circ})$ | Lumens  | % Total |
|--------------------|---------|---------|
| 0- 60              | 800.758 | 43.96%  |
| 60- 90             | 497.62  | 27.32%  |
| 0-90               | 1298.38 | 71.27%  |
| 90- 180            | 523.304 | 28.73%  |
| 0- 180             | 1821.7  | 100%    |

Table 9: Zonal Lumen

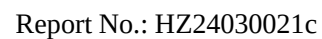


Diagram illustrating the relationship between wind speed (ft/s) and distance (m) for different wind speed levels (3%, 5%, 10%, 30%, 50%) relative to a central point (0.0').

The diagram shows concentric circles representing the distance from the central point for each wind speed level. The grid dimensions are provided in feet (ft) and meters (m).

Legend:

- 3% 0.09231x 0.008578fc
- 5% 0.15391x 0.0143fc
- 10% 0.30781x 0.02859fc
- 30% 0.92331x 0.08578fc
- 50% 1.5391x 0.143fc

Mounting Height: 33' (10.0m)

### Chart 13: Illuminance Plot (Footcandles)

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

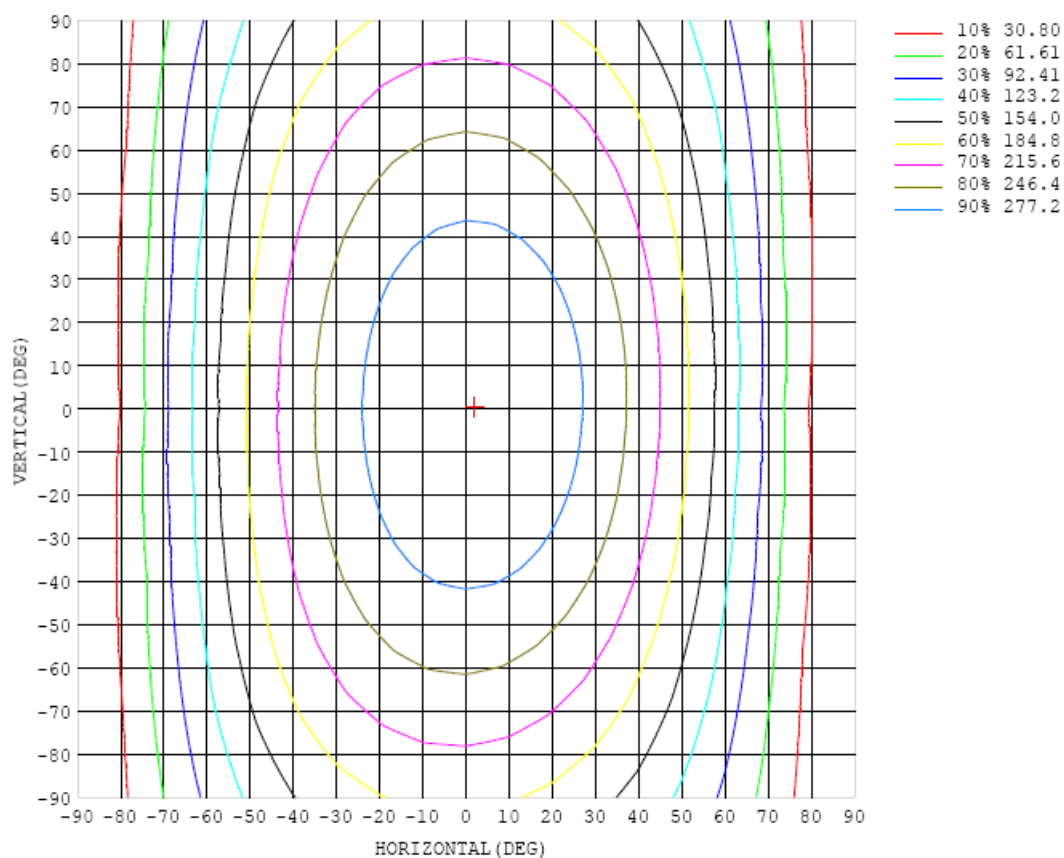


Chart 14: Isocandela Plot

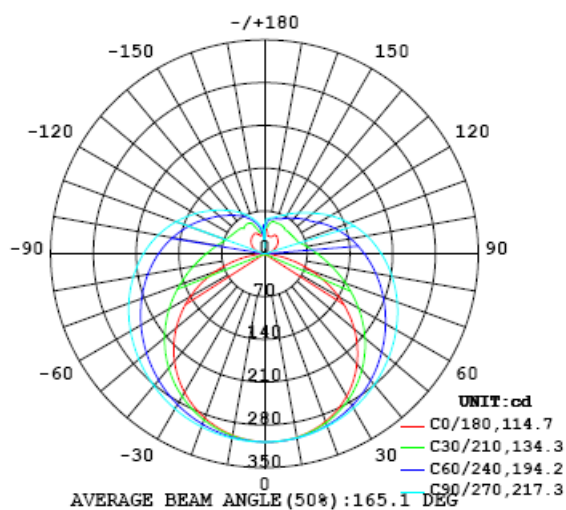


Chart 15: Polar Candela Distribution



### Luminous Intensity Data- Goniophotometer Method (3500K Setting)

Table--1 UNIT: cd

| C (DEG)<br>γ (DEG) | 0    | 10   | 20   | 30   | 40   | 50   | 60   | 70   | 80   | 90   | 100  | 110  | 120  | 130  | 140  | 150  | 160  | 170  | 180  |
|--------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0                  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  |
| 5                  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 307  | 307  | 307  | 307  | 307  | 306  | 306  | 306  | 306  | 306  | 306  |
| 10                 | 305  | 305  | 305  | 305  | 306  | 306  | 306  | 306  | 306  | 306  | 306  | 305  | 304  | 304  | 303  | 302  | 302  | 301  | 301  |
| 15                 | 300  | 300  | 300  | 301  | 302  | 302  | 303  | 304  | 304  | 304  | 303  | 302  | 301  | 299  | 298  | 297  | 295  | 295  | 295  |
| 20                 | 292  | 292  | 293  | 294  | 296  | 297  | 299  | 300  | 301  | 300  | 300  | 298  | 296  | 294  | 291  | 289  | 287  | 286  | 286  |
| 25                 | 282  | 282  | 283  | 286  | 288  | 291  | 294  | 295  | 297  | 296  | 295  | 294  | 291  | 287  | 284  | 280  | 277  | 275  | 275  |
| 30                 | 269  | 269  | 272  | 275  | 279  | 283  | 287  | 290  | 291  | 292  | 291  | 288  | 284  | 280  | 275  | 270  | 265  | 263  | 262  |
| 35                 | 254  | 254  | 258  | 262  | 268  | 274  | 279  | 283  | 285  | 286  | 285  | 282  | 277  | 271  | 264  | 258  | 252  | 248  | 247  |
| 40                 | 236  | 237  | 241  | 248  | 256  | 264  | 270  | 275  | 279  | 280  | 278  | 275  | 269  | 262  | 253  | 244  | 236  | 231  | 229  |
| 45                 | 215  | 217  | 223  | 232  | 242  | 252  | 261  | 267  | 271  | 272  | 271  | 267  | 260  | 252  | 241  | 230  | 220  | 212  | 210  |
| 50                 | 192  | 194  | 203  | 215  | 228  | 240  | 250  | 258  | 263  | 265  | 264  | 259  | 251  | 241  | 228  | 214  | 201  | 192  | 188  |
| 55                 | 167  | 170  | 181  | 196  | 212  | 227  | 240  | 249  | 255  | 257  | 256  | 251  | 242  | 230  | 215  | 198  | 182  | 170  | 165  |
| 60                 | 140  | 145  | 159  | 178  | 197  | 215  | 229  | 239  | 246  | 249  | 248  | 242  | 233  | 219  | 202  | 182  | 162  | 146  | 140  |
| 65                 | 112  | 118  | 136  | 159  | 182  | 202  | 218  | 230  | 237  | 240  | 239  | 233  | 223  | 208  | 188  | 166  | 142  | 122  | 114  |
| 70                 | 82.5 | 90.8 | 114  | 141  | 167  | 190  | 207  | 220  | 228  | 231  | 230  | 224  | 213  | 197  | 175  | 150  | 122  | 96.9 | 86.1 |
| 75                 | 54.5 | 65.0 | 93.4 | 125  | 154  | 177  | 196  | 210  | 218  | 222  | 221  | 214  | 203  | 185  | 163  | 135  | 103  | 72.8 | 58.1 |
| 80                 | 27.7 | 42.7 | 75.7 | 110  | 141  | 166  | 185  | 199  | 208  | 212  | 211  | 204  | 192  | 174  | 151  | 121  | 86.1 | 51.6 | 31.6 |
| 85                 | 7.65 | 25.7 | 61.6 | 97.5 | 129  | 154  | 174  | 189  | 198  | 202  | 201  | 194  | 182  | 164  | 139  | 109  | 72.3 | 34.7 | 10.5 |
| 90                 | 0.57 | 16.7 | 51.8 | 86.8 | 118  | 144  | 164  | 178  | 188  | 192  | 190  | 184  | 171  | 153  | 129  | 97.9 | 61.8 | 24.7 | 0.45 |
| 95                 | 2.10 | 13.0 | 44.8 | 78.0 | 108  | 134  | 153  | 168  | 177  | 181  | 180  | 173  | 161  | 143  | 119  | 89.0 | 54.9 | 20.2 | 1.64 |
| 100                | 5.22 | 13.9 | 39.4 | 70.4 | 99.2 | 124  | 143  | 157  | 166  | 170  | 169  | 163  | 151  | 133  | 110  | 81.1 | 49.2 | 19.6 | 4.59 |
| 105                | 9.14 | 16.2 | 36.2 | 63.8 | 90.8 | 114  | 133  | 146  | 155  | 159  | 158  | 152  | 140  | 123  | 101  | 74.2 | 44.7 | 21.2 | 8.58 |
| 110                | 13.5 | 19.9 | 36.8 | 58.0 | 82.9 | 105  | 122  | 136  | 144  | 148  | 147  | 141  | 130  | 113  | 92.8 | 67.9 | 44.5 | 24.4 | 13.3 |
| 115                | 17.9 | 24.0 | 37.4 | 56.7 | 75.2 | 95.7 | 112  | 125  | 133  | 136  | 135  | 130  | 119  | 104  | 85.1 | 64.7 | 44.7 | 28.2 | 18.1 |
| 120                | 21.6 | 28.0 | 38.7 | 55.0 | 71.7 | 87.0 | 102  | 114  | 122  | 125  | 124  | 119  | 109  | 95.7 | 79.7 | 62.2 | 45.5 | 31.9 | 22.3 |
| 125                | 25.6 | 31.8 | 39.8 | 53.9 | 68.3 | 82.2 | 93.2 | 104  | 111  | 114  | 113  | 108  | 100  | 88.9 | 75.3 | 60.9 | 46.6 | 35.5 | 25.8 |
| 130                | 28.6 | 34.2 | 42.2 | 53.3 | 65.3 | 77.3 | 87.7 | 95.5 | 101  | 104  | 103  | 99.4 | 92.5 | 83.0 | 71.6 | 59.7 | 46.0 | 38.3 | 28.9 |
| 135                | 31.1 | 38.1 | 45.3 | 52.9 | 62.9 | 72.9 | 81.6 | 88.6 | 93.4 | 95.4 | 94.8 | 91.6 | 85.8 | 77.9 | 68.4 | 58.8 | 48.3 | 40.9 | 31.4 |
| 140                | 33.1 | 39.6 | 46.9 | 52.1 | 61.4 | 69.1 | 76.3 | 82.1 | 85.9 | 87.7 | 87.2 | 84.6 | 79.8 | 73.4 | 65.8 | 56.5 | 50.2 | 43.3 | 33.3 |
| 145                | 35.2 | 41.8 | 48.6 | 54.0 | 59.1 | 65.8 | 71.5 | 76.2 | 79.4 | 80.8 | 80.5 | 78.3 | 74.5 | 69.4 | 62.9 | 56.2 | 50.7 | 44.6 | 34.7 |
| 150                | 35.5 | 42.3 | 50.0 | 54.5 | 58.3 | 62.4 | 67.3 | 70.9 | 73.4 | 74.6 | 74.4 | 72.7 | 69.7 | 65.4 | 60.1 | 57.0 | 51.8 | 46.8 | 36.4 |
| 155                | 32.1 | 40.6 | 52.0 | 54.5 | 58.2 | 60.5 | 62.9 | 66.1 | 68.2 | 69.4 | 69.3 | 68.1 | 65.1 | 61.6 | 60.0 | 55.5 | 51.4 | 46.6 | 36.6 |
| 160                | 29.7 | 39.9 | 52.2 | 54.5 | 57.0 | 59.6 | 61.3 | 62.5 | 64.2 | 65.4 | 65.3 | 64.1 | 62.6 | 61.1 | 57.2 | 53.2 | 48.7 | 41.8 | 35.1 |
| 165                | 29.9 | 34.3 | 47.7 | 55.2 | 56.2 | 57.8 | 59.4 | 60.5 | 61.5 | 62.2 | 61.9 | 61.2 | 60.8 | 57.6 | 50.9 | 45.0 | 42.1 | 37.1 | 32.0 |
| 170                | 30.9 | 32.2 | 40.9 | 50.6 | 54.0 | 55.8 | 57.7 | 58.8 | 59.5 | 59.9 | 59.9 | 59.6 | 54.6 | 47.4 | 42.2 | 39.9 | 39.3 | 35.3 | 30.1 |
| 175                | 40.5 | 40.6 | 41.9 | 43.4 | 46.5 | 50.0 | 52.4 | 55.8 | 58.0 | 57.6 | 57.3 | 49.1 | 38.8 | 36.3 | 39.2 | 40.5 | 40.0 | 39.8 | 37.8 |
| 180                | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 |

Table 10: Luminous Intensity Data

Table--2

UNIT: cd

| C (DEG)<br>γ (DEG) | 190  | 200  | 210  | 220  | 230  | 240  | 250  | 260  | 270  | 280  | 290  | 300  | 310  | 320  | 330  | 340  | 350  |  |  |
|--------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|--|--|
| 0                  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  |  |  |
| 5                  | 306  | 306  | 306  | 306  | 307  | 307  | 307  | 307  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  | 308  |  |  |
| 10                 | 301  | 302  | 302  | 303  | 304  | 305  | 305  | 306  | 306  | 307  | 307  | 307  | 306  | 306  | 306  | 305  | 305  |  |  |
| 15                 | 295  | 296  | 297  | 298  | 300  | 301  | 303  | 304  | 304  | 305  | 304  | 304  | 303  | 302  | 301  | 301  | 300  |  |  |
| 20                 | 286  | 288  | 289  | 292  | 294  | 297  | 299  | 300  | 301  | 302  | 301  | 300  | 299  | 297  | 295  | 294  | 293  |  |  |
| 25                 | 275  | 277  | 280  | 284  | 288  | 291  | 294  | 296  | 298  | 298  | 297  | 295  | 293  | 290  | 287  | 285  | 283  |  |  |
| 30                 | 263  | 265  | 270  | 275  | 280  | 285  | 289  | 292  | 293  | 293  | 292  | 289  | 286  | 281  | 277  | 273  | 270  |  |  |
| 35                 | 248  | 252  | 258  | 264  | 271  | 278  | 283  | 286  | 288  | 288  | 286  | 282  | 277  | 271  | 265  | 260  | 255  |  |  |
| 40                 | 231  | 236  | 244  | 253  | 262  | 270  | 276  | 280  | 282  | 281  | 279  | 274  | 267  | 259  | 251  | 244  | 238  |  |  |
| 45                 | 212  | 219  | 229  | 241  | 252  | 261  | 268  | 273  | 275  | 275  | 271  | 265  | 257  | 247  | 236  | 226  | 218  |  |  |
| 50                 | 192  | 201  | 214  | 228  | 241  | 252  | 261  | 266  | 268  | 267  | 263  | 255  | 245  | 233  | 219  | 206  | 196  |  |  |
| 55                 | 169  | 181  | 197  | 214  | 230  | 243  | 253  | 259  | 261  | 260  | 254  | 245  | 233  | 218  | 202  | 185  | 173  |  |  |
| 60                 | 145  | 160  | 180  | 201  | 219  | 233  | 244  | 251  | 253  | 252  | 245  | 235  | 221  | 204  | 184  | 163  | 147  |  |  |
| 65                 | 121  | 139  | 163  | 187  | 207  | 224  | 236  | 243  | 245  | 243  | 236  | 225  | 209  | 189  | 166  | 141  | 122  |  |  |
| 70                 | 95.2 | 119  | 147  | 174  | 196  | 214  | 227  | 234  | 236  | 234  | 227  | 215  | 198  | 175  | 149  | 121  | 95.1 |  |  |
| 75                 | 70.1 | 99.6 | 132  | 161  | 185  | 204  | 217  | 225  | 228  | 225  | 217  | 204  | 186  | 162  | 133  | 101  | 69.7 |  |  |
| 80                 | 47.3 | 82.1 | 118  | 149  | 174  | 194  | 208  | 216  | 218  | 215  | 207  | 194  | 175  | 150  | 119  | 83.5 | 47.5 |  |  |
| 85                 | 29.6 | 68.0 | 106  | 138  | 164  | 184  | 198  | 206  | 208  | 206  | 197  | 183  | 164  | 138  | 107  | 69.7 | 31.0 |  |  |
| 90                 | 19.8 | 57.6 | 95.5 | 128  | 154  | 174  | 188  | 196  | 198  | 196  | 187  | 173  | 154  | 129  | 96.5 | 59.6 | 22.1 |  |  |
| 95                 | 16.0 | 50.4 | 86.6 | 118  | 144  | 163  | 177  | 185  | 188  | 185  | 177  | 163  | 143  | 119  | 87.6 | 52.4 | 18.5 |  |  |
| 100                | 16.3 | 45.6 | 78.9 | 109  | 134  | 153  | 166  | 174  | 177  | 174  | 166  | 152  | 133  | 109  | 79.9 | 47.4 | 18.5 |  |  |
| 105                | 18.1 | 43.1 | 72.6 | 101  | 125  | 142  | 155  | 163  | 166  | 163  | 155  | 142  | 124  | 101  | 73.4 | 44.6 | 20.3 |  |  |
| 110                | 21.5 | 42.4 | 67.7 | 93.0 | 115  | 132  | 144  | 152  | 154  | 151  | 144  | 132  | 115  | 93.0 | 68.2 | 43.4 | 23.4 |  |  |
| 115                | 25.4 | 42.6 | 64.5 | 86.2 | 106  | 123  | 134  | 140  | 142  | 140  | 133  | 122  | 106  | 86.1 | 64.5 | 43.2 | 27.0 |  |  |
| 120                | 29.7 | 43.5 | 61.9 | 81.1 | 98.2 | 113  | 123  | 130  | 131  | 130  | 123  | 112  | 97.7 | 80.6 | 61.7 | 43.7 | 30.8 |  |  |
| 125                | 33.4 | 44.7 | 60.0 | 76.4 | 91.5 | 104  | 113  | 119  | 121  | 119  | 113  | 103  | 90.9 | 75.8 | 59.5 | 44.3 | 34.7 |  |  |
| 130                | 36.9 | 46.1 | 58.7 | 72.4 | 85.2 | 96.2 | 104  | 109  | 111  | 109  | 104  | 95.5 | 84.7 | 71.0 | 57.3 | 45.1 | 38.6 |  |  |
| 135                | 39.6 | 47.6 | 57.6 | 69.0 | 79.7 | 88.9 | 95.9 | 100  | 101  | 99.9 | 95.4 | 88.3 | 79.0 | 66.4 | 55.3 | 46.2 | 42.3 |  |  |
| 140                | 41.9 | 49.8 | 54.3 | 65.4 | 74.9 | 82.4 | 88.2 | 91.7 | 92.8 | 91.7 | 87.5 | 81.2 | 73.4 | 61.7 | 53.2 | 47.4 | 45.9 |  |  |
| 145                | 43.5 | 51.4 | 56.0 | 63.1 | 70.3 | 76.4 | 81.1 | 84.0 | 85.0 | 83.7 | 79.6 | 74.2 | 67.8 | 57.2 | 51.3 | 49.0 | 49.3 |  |  |
| 150                | 43.3 | 52.4 | 56.7 | 58.8 | 65.6 | 71.0 | 74.7 | 76.6 | 77.7 | 75.6 | 71.8 | 67.2 | 62.2 | 52.7 | 49.6 | 51.2 | 52.2 |  |  |
| 155                | 40.5 | 50.4 | 55.2 | 58.6 | 58.4 | 64.5 | 68.5 | 69.2 | 70.4 | 67.6 | 63.9 | 60.3 | 56.4 | 48.5 | 48.0 | 54.1 | 54.0 |  |  |
| 160                | 36.4 | 43.7 | 48.4 | 52.9 | 53.3 | 58.6 | 62.3 | 61.9 | 63.1 | 59.6 | 56.0 | 53.6 | 50.4 | 44.6 | 46.9 | 58.3 | 53.8 |  |  |
| 165                | 34.3 | 36.6 | 39.7 | 44.9 | 46.6 | 51.7 | 56.2 | 54.5 | 55.8 | 51.4 | 48.0 | 47.2 | 44.0 | 41.6 | 46.7 | 64.3 | 49.0 |  |  |
| 170                | 33.4 | 34.3 | 35.6 | 34.7 | 40.5 | 43.2 | 50.4 | 47.4 | 48.5 | 43.2 | 39.8 | 41.6 | 36.6 | 41.1 | 49.6 | 71.7 | 32.1 |  |  |
| 175                | 39.8 | 42.4 | 40.3 | 37.6 | 26.9 | 32.8 | 43.7 | 41.4 | 41.2 | 34.2 | 32.1 | 33.8 | 37.2 | 50.1 | 75.4 | 40.9 | 40.6 |  |  |
| 180                | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 |  |  |

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  $4\pi$ . 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**

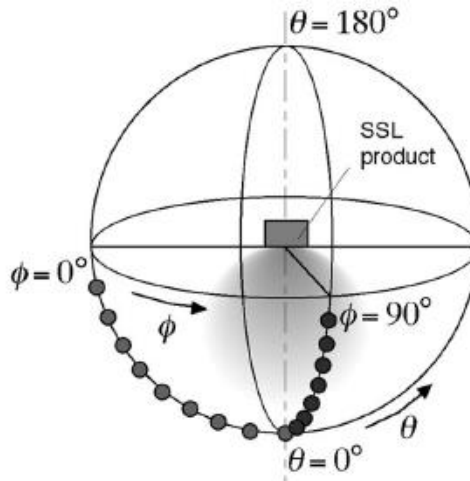
The color characteristics of SSL products include chromaticity coordinates, correlated color temperature, and color rendering index. These characteristics of SSL products may be spatially non-uniform, and thus, in order that they can be specified accurately, the color quantities shall be measured as 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  $10^\circ$  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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