

Cooper Lighting Solutions Photometric Lab  
1121 Highway 74 South  
Peachtree City, GA 30269



Scaled data based on original data using  
LM-79-2019 Approved Method: Electrical and Photometric Measurements of Solid-  
State Lighting Products

Test Report Prepared for  
Cooper Lighting Solutions

Brand: FAIL-SAFE

Report Number: P1357220

Luminaire Tested: 4ASL4-30VHE-3-50-UNV

Issue Date: 2/17/2026

**Test Information**

Test Method: LM-79-2019  
Report Number: P1357220  
TEST IS SCALED FROM IESNA LM-79-08 TEST DATA (G2-2511-597-12)  
Test Lab: INNOVATION CENTER  
Issue Date: 2/17/2026  
Manufacturer: COOPER LIGHTING SOLUTIONS  
Product Line: FAIL-SAFE  
Catalog Number: 4ASL4-30VHE-3-50-UNV  
Description: 4FT 3000 LUMEN PER FOOT 4ASL LED LUMINAIRE WITH OPL LENS AND 5000K LEDS 3 ROW  
Light Source: -  
Ballast/Driver: -

**Summary**

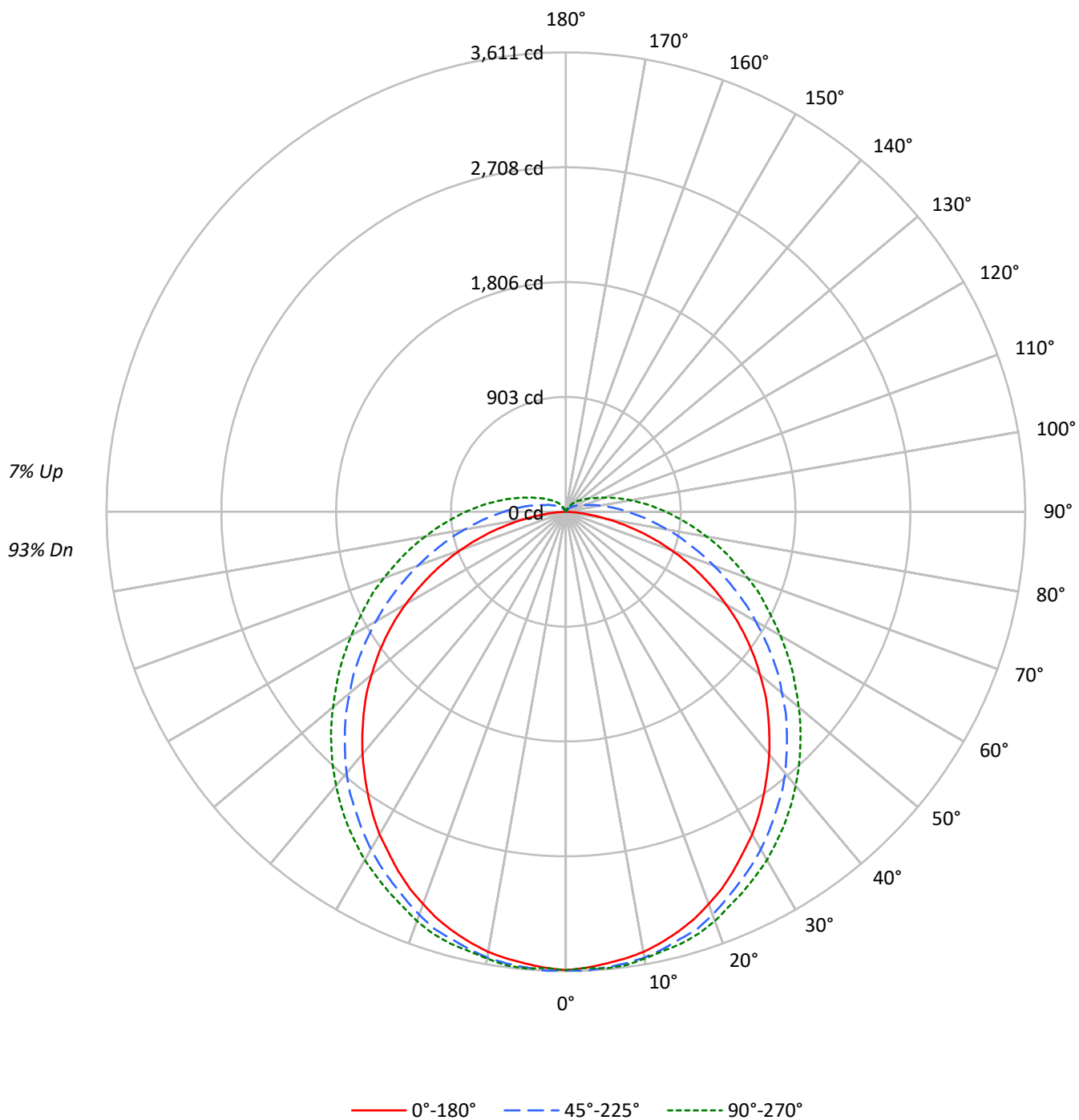
Lumens per Lamp: N/A  
Luminaire Lumens: 12252.0 lumens  
Efficiency: N/A  
Efficacy: 116.5 lumens/watt  
Spacing Criteria (0/90/45): 1.21 / 1.3 / 1.39  
Luminous Opening: Rectangular w/ Sides (W: 0.33' x L: 3.98' x H: 0.1')  
CIE Type: Direct

Input Watts (W): 105.2  
Input Voltage (V): NR  
Input Current (Ain): NR  
Voltage Rise (V): NR  
Power Factor: NR  
Total Harmonic Distortion (THDi): NR  
Frequency (hertz): 60  
Stabilization Time: NR  
Operation Time: NR  
Ambient Temperature (°C): NR  
Test Distance: 24 FT

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CATALOG NUMBER: 4ASL4-30VHE-3-50-UNV

### Luminous Intensity Polar Plot



TEST NUMBER: P1357220

CATALOG NUMBER: 4ASL4-30VHE-3-50-UNV

**COEFFICIENT OF UTILIZATION - ZONAL CAVITY METHOD:**

|     |     |     |     |     |     |     |     |     |     |     |     |  |     |     |     |  |    |    |    |    |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|-----|-----|-----|--|----|----|----|----|
| RF  | 20  |     |     |     | 20  |     |     |     | 20  |     |     |  | 20  |     |     |  | 20 |    |    |    |
| RC  | 80  |     |     |     | 70  |     |     |     | 50  |     |     |  | 30  |     |     |  | 10 |    |    | 0  |
| RW  | 70  | 50  | 30  | 10  | 70  | 50  | 30  | 10  | 50  | 30  | 10  |  | 50  | 30  | 10  |  | 50 | 30 | 10 | 0  |
| RCR |     |     |     |     |     |     |     |     |     |     |     |  |     |     |     |  |    |    |    |    |
| 0   | 117 | 117 | 117 | 117 | 114 | 114 | 114 | 114 | 107 | 107 | 107 |  | 101 | 101 | 101 |  | 96 | 96 | 96 | 93 |
| 1   | 105 | 100 | 95  | 91  | 102 | 97  | 92  | 88  | 91  | 88  | 84  |  | 86  | 83  | 80  |  | 81 | 79 | 77 | 74 |
| 2   | 95  | 86  | 79  | 72  | 92  | 84  | 77  | 71  | 79  | 73  | 68  |  | 75  | 70  | 66  |  | 71 | 67 | 63 | 61 |
| 3   | 86  | 75  | 67  | 60  | 83  | 73  | 65  | 59  | 69  | 62  | 57  |  | 65  | 60  | 55  |  | 62 | 57 | 53 | 50 |
| 4   | 79  | 66  | 57  | 50  | 76  | 65  | 56  | 49  | 61  | 54  | 48  |  | 58  | 52  | 47  |  | 55 | 50 | 45 | 43 |
| 5   | 73  | 59  | 50  | 43  | 70  | 58  | 49  | 42  | 55  | 47  | 41  |  | 52  | 45  | 40  |  | 49 | 44 | 39 | 37 |
| 6   | 67  | 53  | 44  | 37  | 64  | 52  | 43  | 37  | 49  | 42  | 36  |  | 47  | 40  | 35  |  | 45 | 39 | 34 | 32 |
| 7   | 62  | 48  | 39  | 33  | 60  | 47  | 38  | 32  | 45  | 37  | 32  |  | 43  | 36  | 31  |  | 41 | 35 | 30 | 28 |
| 8   | 58  | 44  | 35  | 29  | 56  | 43  | 35  | 29  | 41  | 34  | 28  |  | 39  | 32  | 28  |  | 37 | 32 | 27 | 25 |
| 9   | 54  | 40  | 32  | 26  | 52  | 39  | 31  | 26  | 38  | 30  | 25  |  | 36  | 30  | 25  |  | 35 | 29 | 24 | 22 |
| 10  | 50  | 37  | 29  | 24  | 49  | 36  | 29  | 23  | 35  | 28  | 23  |  | 33  | 27  | 23  |  | 32 | 26 | 22 | 20 |

**AVERAGE LUMINANCE (cd/sqm):**

|     | 0°    | 45°   | 90°   |
|-----|-------|-------|-------|
| 0°  | 29243 | 29243 | 29243 |
| 5°  | 28983 | 28693 | 28574 |
| 10° | 28821 | 28136 | 27851 |
| 15° | 28501 | 27444 | 27239 |
| 20° | 28070 | 26780 | 26548 |
| 25° | 27569 | 25947 | 25762 |
| 30° | 27040 | 25225 | 25097 |
| 35° | 26384 | 24407 | 24358 |
| 40° | 25782 | 23658 | 23579 |
| 45° | 25136 | 22753 | 22797 |
| 50° | 24398 | 21780 | 21984 |
| 55° | 23603 | 20851 | 21254 |
| 60° | 22566 | 19767 | 20512 |
| 65° | 21249 | 18724 | 19897 |
| 70° | 19568 | 17690 | 19415 |
| 75° | 17119 | 16746 | 19084 |
| 80° | 13412 | 16035 | 18943 |
| 85° | 8055  | 15865 | 19224 |

**MAXIMUM LUMINANCE 45°-90°:**

Horizontal Angle: 0°

Vertical Angle: 45°

Luminance: 25136 cd/sqm

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**ZONAL LUMENS:**

| Zone      | Lumens  | % Fixture |
|-----------|---------|-----------|
| 0°-10°    | 341.7   | 2.8       |
| 10°-20°   | 981.1   | 8.0       |
| 20°-30°   | 1483.3  | 12.1      |
| 30°-40°   | 1796.1  | 14.7      |
| 40°-50°   | 1886.4  | 15.4      |
| 50°-60°   | 1760.0  | 14.4      |
| 60°-70°   | 1454.5  | 11.9      |
| 70°-80°   | 1047.3  | 8.5       |
| 80°-90°   | 650.8   | 5.3       |
| 90°-100°  | 381.3   | 3.1       |
| 100°-110° | 218.1   | 1.8       |
| 110°-120° | 123.2   | 1.0       |
| 120°-130° | 70.9    | 0.6       |
| 130°-140° | 38.2    | 0.3       |
| 140°-150° | 16.1    | 0.1       |
| 150°-160° | 3.0     | 0.0       |
| 160°-170° | 0.0     | 0.0       |
| 170°-180° | 0.0     | 0.0       |
| 0°-30°    | 2806.1  | 22.9      |
| 0°-40°    | 4602.3  | 37.6      |
| 0°-60°    | 8248.7  | 67.3      |
| 0°-90°    | 11401.3 | 93.1      |
| 90°-120°  | 722.6   | 5.9       |
| 90°-150°  | 847.8   | 6.9       |
| 90°-180°  | 851.0   | 6.9       |
| 0°-180°   | 12252.0 | 100.0     |

**CANDELA DISTRIBUTION:**

|      | 0°   | 22.5° | 45°  | 67.5° | 90°  | Flux |
|------|------|-------|------|-------|------|------|
| 0°   | 3604 | 3604  | 3604 | 3604  | 3604 |      |
| 5°   | 3566 | 3596  | 3596 | 3596  | 3604 | 339  |
| 15°  | 3416 | 3461  | 3476 | 3499  | 3514 | 963  |
| 25°  | 3116 | 3169  | 3221 | 3266  | 3296 | 1435 |
| 35°  | 2712 | 2787  | 2877 | 2959  | 2997 | 1698 |
| 45°  | 2248 | 2330  | 2457 | 2562  | 2607 | 1734 |
| 55°  | 1731 | 1828  | 1978 | 2120  | 2173 | 1546 |
| 65°  | 1169 | 1281  | 1476 | 1663  | 1731 | 1156 |
| 75°  | 599  | 749   | 1011 | 1229  | 1318 | 634  |
| 85°  | 112  | 337   | 637  | 862   | 944  | 137  |
| 90°  | 0    | 202   | 487  | 697   | 787  | 5    |
| 95°  | 0    | 127   | 367  | 562   | 644  | 0    |
| 105° | 0    | 45    | 202  | 352   | 412  | 0    |
| 115° | 0    | 22    | 120  | 217   | 255  | 0    |
| 125° | 0    | 15    | 75   | 142   | 165  | 0    |
| 135° | 0    | 0     | 45   | 90    | 112  | 0    |
| 145° | 0    | 0     | 22   | 52    | 60   | 0    |
| 155° | 0    | 0     | 0    | 15    | 22   | 0    |
| 165° | 0    | 0     | 0    | 0     | 0    | 0    |
| 175° | 0    | 0     | 0    | 0     | 0    | 0    |
| 180° | 0    | 0     | 0    | 0     | 0    | 0    |

TEST NUMBER: P1357220

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**CANDELA DISTRIBUTION (FULL):**

|        | 0°     | 22.5°  | 45°    | 67.5°  | 90°    |
|--------|--------|--------|--------|--------|--------|
| 0°     | 3603.5 | 3603.5 | 3603.5 | 3603.5 | 3603.5 |
| 2.5°   | 3588.5 | 3611.0 | 3611.0 | 3588.5 | 3588.5 |
| 5°     | 3566.0 | 3596.0 | 3596.0 | 3596.0 | 3603.5 |
| 7.5°   | 3543.5 | 3581.0 | 3581.0 | 3581.0 | 3596.0 |
| 10°    | 3513.6 | 3551.0 | 3558.5 | 3558.5 | 3566.0 |
| 12.5°  | 3468.6 | 3513.6 | 3521.1 | 3528.6 | 3536.1 |
| 15°    | 3416.2 | 3461.1 | 3476.1 | 3498.6 | 3513.6 |
| 17.5°  | 3356.3 | 3408.7 | 3438.7 | 3461.1 | 3476.1 |
| 20°    | 3281.3 | 3333.8 | 3371.2 | 3401.2 | 3423.7 |
| 22.5°  | 3206.4 | 3251.4 | 3296.3 | 3333.8 | 3356.3 |
| 25°    | 3116.5 | 3169.0 | 3221.4 | 3266.4 | 3296.3 |
| 27.5°  | 3019.1 | 3079.1 | 3146.5 | 3198.9 | 3228.9 |
| 30°    | 2929.2 | 2989.2 | 3064.1 | 3131.5 | 3161.5 |
| 32.5°  | 2824.3 | 2891.8 | 2974.2 | 3041.6 | 3079.1 |
| 35°    | 2712.0 | 2786.9 | 2876.8 | 2959.2 | 2996.7 |
| 37.5°  | 2599.6 | 2674.5 | 2786.9 | 2869.3 | 2906.8 |
| 40°    | 2487.2 | 2562.1 | 2682.0 | 2771.9 | 2809.4 |
| 42.5°  | 2367.4 | 2442.3 | 2569.6 | 2667.0 | 2712.0 |
| 45°    | 2247.5 | 2329.9 | 2457.3 | 2562.1 | 2607.1 |
| 47.5°  | 2127.6 | 2210.0 | 2344.9 | 2457.3 | 2502.2 |
| 50°    | 1992.8 | 2082.7 | 2217.5 | 2344.9 | 2389.8 |
| 52.5°  | 1865.4 | 1955.3 | 2105.2 | 2232.5 | 2277.5 |
| 55°    | 1730.6 | 1828.0 | 1977.8 | 2120.1 | 2172.6 |
| 57.5°  | 1595.7 | 1693.1 | 1850.4 | 2000.3 | 2060.2 |
| 60°    | 1453.4 | 1558.3 | 1723.1 | 1880.4 | 1947.8 |
| 62.5°  | 1311.0 | 1423.4 | 1603.2 | 1768.0 | 1835.5 |
| 65°    | 1168.7 | 1281.1 | 1475.9 | 1663.1 | 1730.6 |
| 67.5°  | 1026.4 | 1146.2 | 1356.0 | 1550.8 | 1633.2 |
| 70°    | 884.0  | 1011.4 | 1236.1 | 1438.4 | 1520.8 |
| 72.5°  | 741.7  | 876.5  | 1123.7 | 1333.5 | 1415.9 |
| 75°    | 599.3  | 749.2  | 1011.4 | 1228.6 | 1318.5 |
| 77.5°  | 457.0  | 629.3  | 914.0  | 1131.2 | 1221.1 |
| 80°    | 329.6  | 524.4  | 809.1  | 1033.8 | 1123.7 |
| 82.5°  | 209.8  | 419.5  | 719.2  | 943.9  | 1033.8 |
| 85°    | 112.4  | 337.1  | 636.8  | 861.5  | 943.9  |
| 87.5°  | 37.5   | 262.2  | 554.4  | 779.1  | 861.5  |
| 90°    | 0.0    | 202.3  | 487.0  | 696.7  | 786.6  |
| 92.5°  | 0.0    | 157.3  | 427.0  | 629.3  | 711.7  |
| 95°    | 0.0    | 127.4  | 367.1  | 561.9  | 644.3  |
| 97.5°  | 0.0    | 104.9  | 322.1  | 501.9  | 576.9  |
| 100°   | 0.0    | 82.4   | 277.2  | 449.5  | 516.9  |
| 102.5° | 0.0    | 67.4   | 239.7  | 397.1  | 464.5  |
| 105°   | 0.0    | 44.9   | 202.3  | 352.1  | 412.0  |
| 107.5° | 0.0    | 37.5   | 172.3  | 314.6  | 367.1  |
| 110°   | 0.0    | 30.0   | 157.3  | 269.7  | 322.1  |

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CATALOG NUMBER: 4ASL4-30VHE-3-50-UNV

**CANDELA DISTRIBUTION (continued):**

|        | 0°  | 22.5° | 45°   | 67.5° | 90°   |
|--------|-----|-------|-------|-------|-------|
| 112.5° | 0.0 | 22.5  | 142.3 | 239.7 | 292.2 |
| 115°   | 0.0 | 22.5  | 119.9 | 217.3 | 254.7 |
| 117.5° | 0.0 | 22.5  | 104.9 | 194.8 | 232.2 |
| 120°   | 0.0 | 15.0  | 97.4  | 172.3 | 209.8 |
| 122.5° | 0.0 | 15.0  | 82.4  | 157.3 | 187.3 |
| 125°   | 0.0 | 15.0  | 74.9  | 142.3 | 164.8 |
| 127.5° | 0.0 | 7.5   | 67.4  | 127.4 | 149.8 |
| 130°   | 0.0 | 7.5   | 59.9  | 112.4 | 134.8 |
| 132.5° | 0.0 | 7.5   | 52.4  | 104.9 | 127.4 |
| 135°   | 0.0 | 0.0   | 44.9  | 89.9  | 112.4 |
| 137.5° | 0.0 | 0.0   | 37.5  | 82.4  | 97.4  |
| 140°   | 0.0 | 0.0   | 30.0  | 67.4  | 89.9  |
| 142.5° | 0.0 | 0.0   | 22.5  | 59.9  | 74.9  |
| 145°   | 0.0 | 0.0   | 22.5  | 52.4  | 59.9  |
| 147.5° | 0.0 | 0.0   | 15.0  | 37.5  | 52.4  |
| 150°   | 0.0 | 0.0   | 7.5   | 30.0  | 37.5  |
| 152.5° | 0.0 | 0.0   | 0.0   | 22.5  | 30.0  |
| 155°   | 0.0 | 0.0   | 0.0   | 15.0  | 22.5  |
| 157.5° | 0.0 | 0.0   | 0.0   | 0.0   | 7.5   |
| 160°   | 0.0 | 0.0   | 0.0   | 0.0   | 0.0   |
| 162.5° | 0.0 | 0.0   | 0.0   | 0.0   | 0.0   |
| 165°   | 0.0 | 0.0   | 0.0   | 0.0   | 0.0   |
| 167.5° | 0.0 | 0.0   | 0.0   | 0.0   | 0.0   |
| 170°   | 0.0 | 0.0   | 0.0   | 0.0   | 0.0   |
| 172.5° | 0.0 | 0.0   | 0.0   | 0.0   | 0.0   |
| 175°   | 0.0 | 0.0   | 0.0   | 0.0   | 0.0   |
| 177.5° | 0.0 | 0.0   | 0.0   | 0.0   | 0.0   |
| 180°   | 0.0 | 0.0   | 0.0   | 0.0   | 0.0   |

TEST NUMBER: P1357220

CATALOG NUMBER: 4ASL4-30VHE-3-50-UNV

**CIE UGR TABLE:**

| Reflectances:   |      |                  |       |       |       |       |                |       |       |       |       |
|-----------------|------|------------------|-------|-------|-------|-------|----------------|-------|-------|-------|-------|
| Ceiling         |      | 0.7              | 0.7   | 0.5   | 0.5   | 0.3   | 0.7            | 0.7   | 0.5   | 0.5   | 0.3   |
| Wall            |      | 0.5              | 0.3   | 0.5   | 0.3   | 0.3   | 0.5            | 0.3   | 0.5   | 0.3   | 0.3   |
| Reference plane |      | 0.2              | 0.2   | 0.2   | 0.2   | 0.2   | 0.2            | 0.2   | 0.2   | 0.2   | 0.2   |
| Room dimensions |      | Viewed crosswise |       |       |       |       | Viewed endwise |       |       |       |       |
| X=2H            | Y=2H | 21.06            | 22.60 | 21.53 | 23.06 | 23.54 | 23.09          | 24.63 | 23.56 | 25.08 | 25.57 |
|                 | 3H   | 22.56            | 23.96 | 23.04 | 24.43 | 24.95 | 25.55          | 26.95 | 26.03 | 27.42 | 27.94 |
|                 | 4H   | 23.04            | 24.37 | 23.54 | 24.85 | 25.39 | 26.75          | 28.08 | 27.25 | 28.56 | 29.10 |
|                 | 6H   | 23.31            | 24.55 | 23.83 | 25.05 | 25.60 | 28.00          | 29.24 | 28.52 | 29.74 | 30.29 |
|                 | 8H   | 23.37            | 24.55 | 23.89 | 25.07 | 25.63 | 28.65          | 29.84 | 29.17 | 30.36 | 30.91 |
|                 | 12H  | 23.38            | 24.52 | 23.91 | 25.03 | 25.62 | 29.36          | 30.50 | 29.89 | 31.01 | 31.60 |
| 4H              | 2H   | 21.94            | 23.27 | 22.44 | 23.75 | 24.29 | 23.52          | 24.85 | 24.02 | 25.34 | 25.87 |
|                 | 3H   | 23.67            | 24.81 | 24.19 | 25.33 | 25.89 | 26.21          | 27.34 | 26.73 | 27.87 | 28.43 |
|                 | 4H   | 24.28            | 25.32 | 24.81 | 25.85 | 26.44 | 27.58          | 28.62 | 28.11 | 29.15 | 29.75 |
|                 | 6H   | 24.68            | 25.59 | 25.23 | 26.15 | 26.76 | 29.02          | 29.94 | 29.58 | 30.50 | 31.11 |
|                 | 8H   | 24.77            | 25.63 | 25.33 | 26.19 | 26.81 | 29.78          | 30.64 | 30.34 | 31.20 | 31.82 |
|                 | 12H  | 24.81            | 25.60 | 25.40 | 26.19 | 26.81 | 30.61          | 31.39 | 31.19 | 31.98 | 32.61 |
| 8H              | 4H   | 24.96            | 25.82 | 25.52 | 26.38 | 27.00 | 27.80          | 28.66 | 28.36 | 29.22 | 29.84 |
|                 | 6H   | 25.54            | 26.27 | 26.13 | 26.87 | 27.50 | 29.41          | 30.14 | 30.00 | 30.74 | 31.37 |
|                 | 8H   | 25.72            | 26.38 | 26.32 | 26.99 | 27.63 | 30.30          | 30.96 | 30.91 | 31.58 | 32.22 |
|                 | 12H  | 25.83            | 26.42 | 26.44 | 27.03 | 27.73 | 31.32          | 31.91 | 31.93 | 32.52 | 33.22 |
| 12H             | 4H   | 25.15            | 25.94 | 25.73 | 26.53 | 27.15 | 27.80          | 28.59 | 28.39 | 29.18 | 29.80 |
|                 | 6H   | 25.83            | 26.49 | 26.44 | 27.11 | 27.74 | 29.45          | 30.11 | 30.05 | 30.72 | 31.36 |
|                 | 8H   | 26.11            | 26.70 | 26.72 | 27.30 | 28.01 | 30.41          | 31.00 | 31.02 | 31.60 | 32.31 |

LM-79-2019: Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products

Report Prepared for

Cooper Lighting Solutions

Fail-Safe

Report Number: SP1-2511-597-5

Test Date: 11/18/2025

Luminaire Tested: 4ASL-2-50-UNV-OPL-1\_600mA

Data in this report applies to families of products including 4ASL

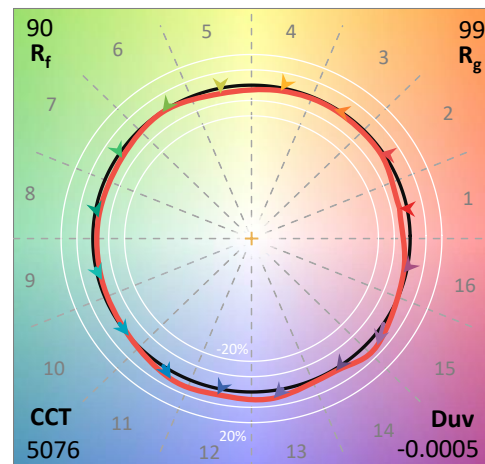
### Test Information

Test Method: LM-79-2019  
 Report Number: SP1-2511-597-5  
 Test Lab: COOPER LIGHTING SOLUTIONS  
 Photometer: SP1 - 76IN SPHERE  
 Measurement Geometry:  $4\pi$   
 Issue Date: 11/18/2025  
 Manufacturer: COOPER LIGHTING SOLUTIONS  
 Product Line: Fail-Safe  
 Catalog Number: **4ASL-2-50-UNV-OPL-1\_600mA**  
 Description: 2foot 4ASL LED LUMINAIRE WITH OPL LENS AND 5000K LEDS with 1 rows at 600mA

### Spectral Parameters

CCT (K): 5076  
 CIE  $u'$ : 0.2110  
 CIE  $v'$ : 0.4830  
 Duv: -0.0005  
 CIE x: 0.3429  
 CIE y: 0.3489  
 CIE z: 0.3082  
 Peak Wavelength (nm): 630  
 Dominant Wavelength (nm): 572  
 Purity: 7.553016  
 R<sub>f</sub>: 90.4  
 R<sub>g</sub>: 99

CRI (Ra): 94.9  
 R1: 96.7  
 R2: 98.2  
 R3: 96.6  
 R4: 95.6  
 R5: 95.1  
 R6: 93.6  
 R7: 94.0  
 R8: 89.6  
 R9: 74.0  
 R10: 93.9  
 R11: 96.2  
 R12: 72.4  
 R13: 98.1  
 R14: 97.8  
 R15: 95.6



### Test Conditions

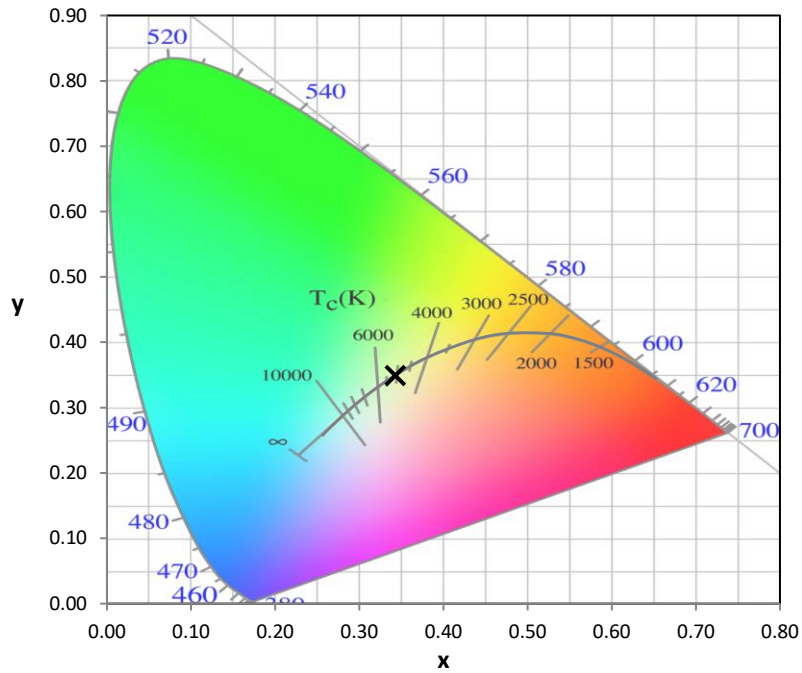
Stabilization Time: 24M  
 Operation Time: 1H 24M  
 Sphere Temperature (°C): 24.1

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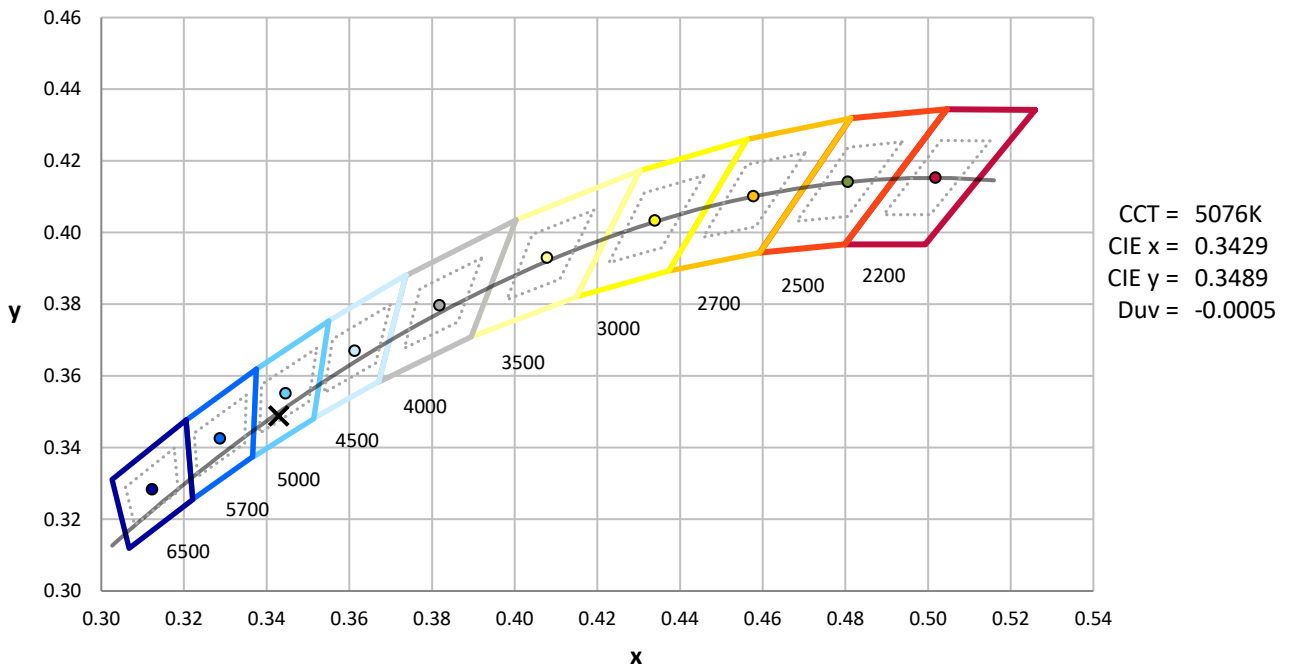
| Measurement and Test Equipment |                       |                  |                      |
|--------------------------------|-----------------------|------------------|----------------------|
| Instrument                     | Identification Number | Calibration Date | Calibration Due Date |
| Photometer                     | 76INCH SPHERE IN0058  | 6/16/2025        | 12/16/2025           |
| Power Meter                    | XITRON INXT2011004    | 10/21/2025       | 10/21/2026           |
| AC Power Source                | CHROMA 61603 IN0063   | 10/21/2025       | 10/21/2026           |
| DC Power Source                | AGILENT E3634A IN0208 | 10/21/2025       | 10/21/2026           |
| Sphere Thermometer             | ONSET IN0085          | 10/21/2025       | 10/21/2026           |
| Room Thermometer               | ONSET IN0046          | 10/21/2025       | 10/21/2026           |

REPORT NUMBER: SP1-2511-597-5

**CIE 1931 Chromaticity Diagram**



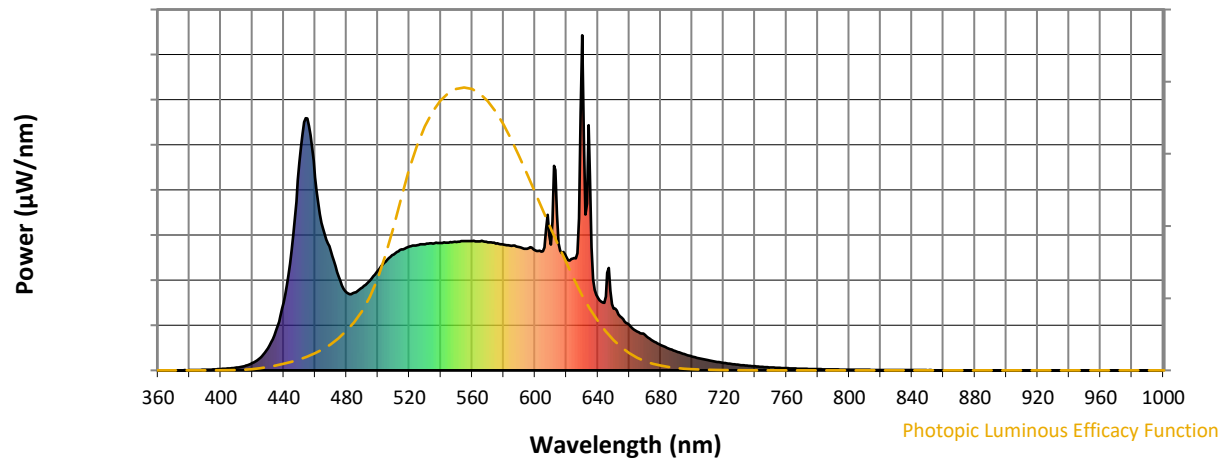
**CIE 1931 Chromaticity Diagram with 2017 ANSI 7-Step and 4-Step Quadrangles**



Point lies inside the ANSI 5000K 4-step quadrangle

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### Photopic Flux vs. Wavelength

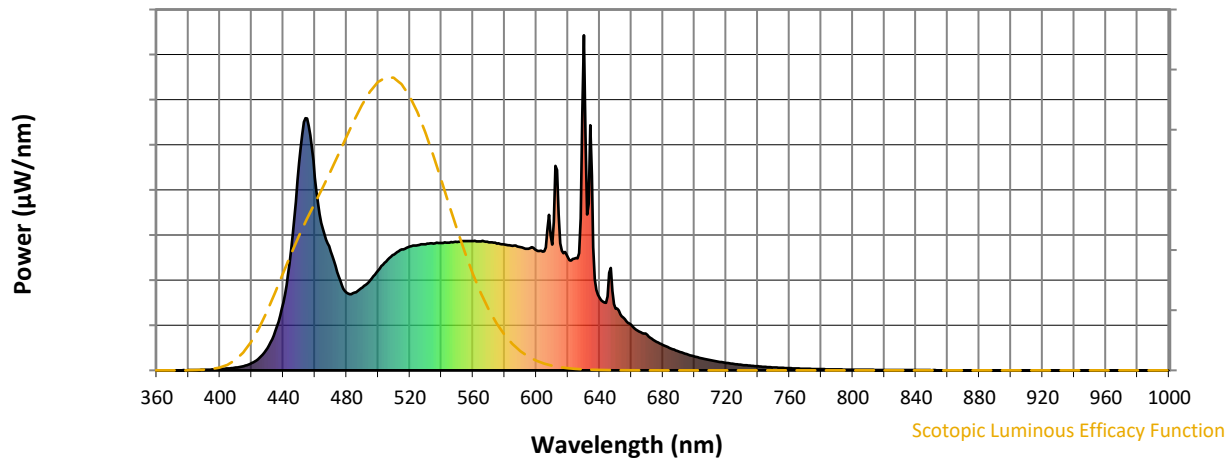


### Photopic Lumens: NR

| λ (nm) | Power W <sup>λ</sup> /nm | Lumens (φ/nm) | λ (nm) | Power W <sup>λ</sup> /nm | Lumens (φ/nm) | λ (nm) | Power W <sup>λ</sup> /nm | Lumens (φ/nm) | λ (nm) | Power W <sup>λ</sup> /nm | Lumens (φ/nm) | λ (nm) | Power W <sup>λ</sup> /nm | Lumens (φ/nm) |
|--------|--------------------------|---------------|--------|--------------------------|---------------|--------|--------------------------|---------------|--------|--------------------------|---------------|--------|--------------------------|---------------|
| 360    | 0                        | NR            | 490    | 248                      | NR            | 620    | 337                      | NR            | 750    | 9                        | NR            | 880    | 0                        | NR            |
| 365    | 0                        | NR            | 495    | 269                      | NR            | 625    | 335                      | NR            | 755    | 8                        | NR            | 885    | 0                        | NR            |
| 370    | 0                        | NR            | 500    | 298                      | NR            | 630    | 1000                     | NR            | 760    | 6                        | NR            | 890    | 0                        | NR            |
| 375    | 0                        | NR            | 505    | 325                      | NR            | 635    | 580                      | NR            | 765    | 6                        | NR            | 895    | 0                        | NR            |
| 380    | 1                        | NR            | 510    | 346                      | NR            | 640    | 216                      | NR            | 770    | 5                        | NR            | 900    | 0                        | NR            |
| 385    | 1                        | NR            | 515    | 361                      | NR            | 645    | 221                      | NR            | 775    | 4                        | NR            | 905    | 0                        | NR            |
| 390    | 2                        | NR            | 520    | 369                      | NR            | 650    | 185                      | NR            | 780    | 4                        | NR            | 910    | 0                        | NR            |
| 395    | 3                        | NR            | 525    | 374                      | NR            | 655    | 158                      | NR            | 785    | 3                        | NR            | 915    | 0                        | NR            |
| 400    | 4                        | NR            | 530    | 376                      | NR            | 660    | 136                      | NR            | 790    | 3                        | NR            | 920    | 0                        | NR            |
| 405    | 6                        | NR            | 535    | 379                      | NR            | 665    | 116                      | NR            | 795    | 2                        | NR            | 925    | 0                        | NR            |
| 410    | 8                        | NR            | 540    | 381                      | NR            | 670    | 106                      | NR            | 800    | 2                        | NR            | 930    | 0                        | NR            |
| 415    | 13                       | NR            | 545    | 381                      | NR            | 675    | 88                       | NR            | 805    | 2                        | NR            | 935    | 0                        | NR            |
| 420    | 22                       | NR            | 550    | 383                      | NR            | 680    | 76                       | NR            | 810    | 2                        | NR            | 940    | 0                        | NR            |
| 425    | 37                       | NR            | 555    | 386                      | NR            | 685    | 65                       | NR            | 815    | 1                        | NR            | 945    | 0                        | NR            |
| 430    | 66                       | NR            | 560    | 386                      | NR            | 690    | 56                       | NR            | 820    | 1                        | NR            | 950    | 0                        | NR            |
| 435    | 119                      | NR            | 565    | 385                      | NR            | 695    | 48                       | NR            | 825    | 1                        | NR            | 955    | 0                        | NR            |
| 440    | 203                      | NR            | 570    | 382                      | NR            | 700    | 41                       | NR            | 830    | 1                        | NR            | 960    | 0                        | NR            |
| 445    | 359                      | NR            | 575    | 379                      | NR            | 705    | 35                       | NR            | 835    | 1                        | NR            | 965    | 0                        | NR            |
| 450    | 620                      | NR            | 580    | 376                      | NR            | 710    | 30                       | NR            | 840    | 1                        | NR            | 970    | 0                        | NR            |
| 455    | 752                      | NR            | 585    | 372                      | NR            | 715    | 26                       | NR            | 845    | 1                        | NR            | 975    | 0                        | NR            |
| 460    | 576                      | NR            | 590    | 368                      | NR            | 720    | 22                       | NR            | 850    | 1                        | NR            | 980    | 0                        | NR            |
| 465    | 423                      | NR            | 595    | 363                      | NR            | 725    | 19                       | NR            | 855    | 0                        | NR            | 985    | 0                        | NR            |
| 470    | 354                      | NR            | 600    | 358                      | NR            | 730    | 16                       | NR            | 860    | 0                        | NR            | 990    | 0                        | NR            |
| 475    | 280                      | NR            | 605    | 355                      | NR            | 735    | 14                       | NR            | 865    | 0                        | NR            | 995    | 0                        | NR            |
| 480    | 232                      | NR            | 610    | 375                      | NR            | 740    | 12                       | NR            | 870    | 0                        | NR            | 1000   | 0                        | NR            |
| 485    | 232                      | NR            | 615    | 379                      | NR            | 745    | 10                       | NR            | 875    | 0                        | NR            |        |                          |               |

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### Scotopic Flux vs. Wavelength



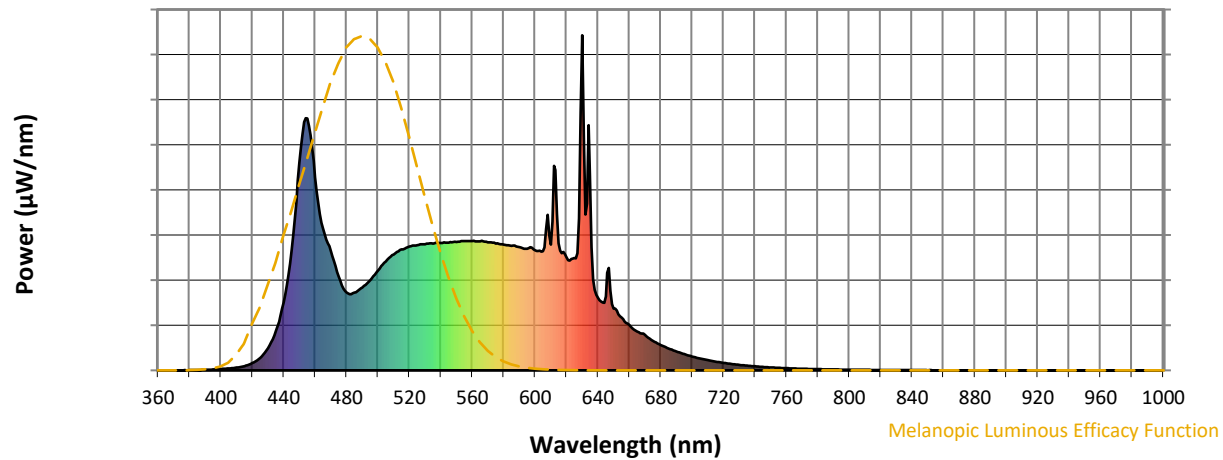
Scotopic Lumens: NR

S/P: 2.12

| λ<br>(nm) | Power<br>W <sup>^</sup> /nm | Lumens<br>(φ/nm) | λ<br>(nm) | Power<br>W <sup>^</sup> /nm | Lumens<br>(φ/nm) | λ<br>(nm) | Power<br>W <sup>^</sup> /nm | Lumens<br>(φ/nm) | λ<br>(nm) | Power<br>W <sup>^</sup> /nm | Lumens<br>(φ/nm) | λ<br>(nm) | Power<br>W <sup>^</sup> /nm | Lumens<br>(φ/nm) |
|-----------|-----------------------------|------------------|-----------|-----------------------------|------------------|-----------|-----------------------------|------------------|-----------|-----------------------------|------------------|-----------|-----------------------------|------------------|
| 360       | 0                           | NR               | 490       | 248                         | NR               | 620       | 337                         | NR               | 750       | 9                           | NR               | 880       | 0                           | NR               |
| 365       | 0                           | NR               | 495       | 269                         | NR               | 625       | 335                         | NR               | 755       | 8                           | NR               | 885       | 0                           | NR               |
| 370       | 0                           | NR               | 500       | 298                         | NR               | 630       | 1000                        | NR               | 760       | 6                           | NR               | 890       | 0                           | NR               |
| 375       | 0                           | NR               | 505       | 325                         | NR               | 635       | 580                         | NR               | 765       | 6                           | NR               | 895       | 0                           | NR               |
| 380       | 1                           | NR               | 510       | 346                         | NR               | 640       | 216                         | NR               | 770       | 5                           | NR               | 900       | 0                           | NR               |
| 385       | 1                           | NR               | 515       | 361                         | NR               | 645       | 221                         | NR               | 775       | 4                           | NR               | 905       | 0                           | NR               |
| 390       | 2                           | NR               | 520       | 369                         | NR               | 650       | 185                         | NR               | 780       | 4                           | NR               | 910       | 0                           | NR               |
| 395       | 3                           | NR               | 525       | 374                         | NR               | 655       | 158                         | NR               | 785       | 3                           | NR               | 915       | 0                           | NR               |
| 400       | 4                           | NR               | 530       | 376                         | NR               | 660       | 136                         | NR               | 790       | 3                           | NR               | 920       | 0                           | NR               |
| 405       | 6                           | NR               | 535       | 379                         | NR               | 665       | 116                         | NR               | 795       | 2                           | NR               | 925       | 0                           | NR               |
| 410       | 8                           | NR               | 540       | 381                         | NR               | 670       | 106                         | NR               | 800       | 2                           | NR               | 930       | 0                           | NR               |
| 415       | 13                          | NR               | 545       | 381                         | NR               | 675       | 88                          | NR               | 805       | 2                           | NR               | 935       | 0                           | NR               |
| 420       | 22                          | NR               | 550       | 383                         | NR               | 680       | 76                          | NR               | 810       | 2                           | NR               | 940       | 0                           | NR               |
| 425       | 37                          | NR               | 555       | 386                         | NR               | 685       | 65                          | NR               | 815       | 1                           | NR               | 945       | 0                           | NR               |
| 430       | 66                          | NR               | 560       | 386                         | NR               | 690       | 56                          | NR               | 820       | 1                           | NR               | 950       | 0                           | NR               |
| 435       | 119                         | NR               | 565       | 385                         | NR               | 695       | 48                          | NR               | 825       | 1                           | NR               | 955       | 0                           | NR               |
| 440       | 203                         | NR               | 570       | 382                         | NR               | 700       | 41                          | NR               | 830       | 1                           | NR               | 960       | 0                           | NR               |
| 445       | 359                         | NR               | 575       | 379                         | NR               | 705       | 35                          | NR               | 835       | 1                           | NR               | 965       | 0                           | NR               |
| 450       | 620                         | NR               | 580       | 376                         | NR               | 710       | 30                          | NR               | 840       | 1                           | NR               | 970       | 0                           | NR               |
| 455       | 752                         | NR               | 585       | 372                         | NR               | 715       | 26                          | NR               | 845       | 1                           | NR               | 975       | 0                           | NR               |
| 460       | 576                         | NR               | 590       | 368                         | NR               | 720       | 22                          | NR               | 850       | 1                           | NR               | 980       | 0                           | NR               |
| 465       | 423                         | NR               | 595       | 363                         | NR               | 725       | 19                          | NR               | 855       | 0                           | NR               | 985       | 0                           | NR               |
| 470       | 354                         | NR               | 600       | 358                         | NR               | 730       | 16                          | NR               | 860       | 0                           | NR               | 990       | 0                           | NR               |
| 475       | 280                         | NR               | 605       | 355                         | NR               | 735       | 14                          | NR               | 865       | 0                           | NR               | 995       | 0                           | NR               |
| 480       | 232                         | NR               | 610       | 375                         | NR               | 740       | 12                          | NR               | 870       | 0                           | NR               | 1000      | 0                           | NR               |
| 485       | 232                         | NR               | 615       | 379                         | NR               | 745       | 10                          | NR               | 875       | 0                           | NR               |           |                             |                  |

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### Melanopic Flux vs. Wavelength



Melanopic Lumens: NR

M/P: 4.65

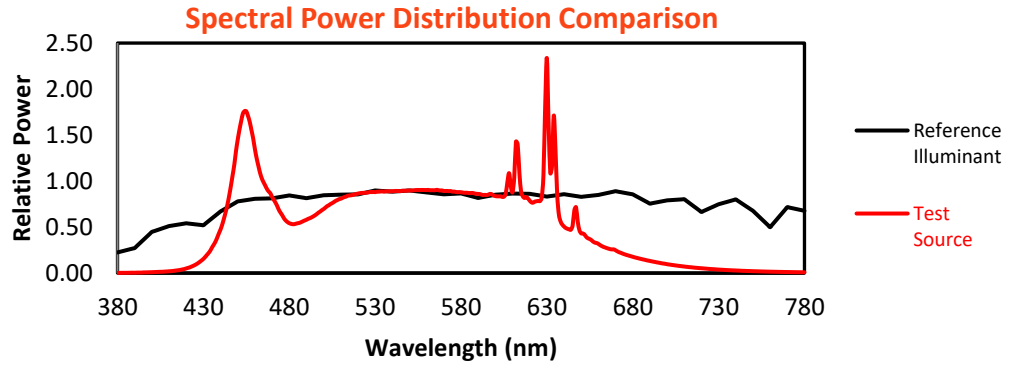
| $\lambda$<br>(nm) | Power<br>$\text{W}^{\wedge}/\text{nm}$ | Lumens<br>( $\phi/\text{nm}$ ) | $\lambda$<br>(nm) | Power<br>$\text{W}^{\wedge}/\text{nm}$ | Lumens<br>( $\phi/\text{nm}$ ) | $\lambda$<br>(nm) | Power<br>$\text{W}^{\wedge}/\text{nm}$ | Lumens<br>( $\phi/\text{nm}$ ) | $\lambda$<br>(nm) | Power<br>$\text{W}^{\wedge}/\text{nm}$ | Lumens<br>( $\phi/\text{nm}$ ) | $\lambda$<br>(nm) | Power<br>$\text{W}^{\wedge}/\text{nm}$ | Lumens<br>( $\phi/\text{nm}$ ) |
|-------------------|----------------------------------------|--------------------------------|-------------------|----------------------------------------|--------------------------------|-------------------|----------------------------------------|--------------------------------|-------------------|----------------------------------------|--------------------------------|-------------------|----------------------------------------|--------------------------------|
| 360               | 0                                      | NR                             | 490               | 248                                    | NR                             | 620               | 337                                    | NR                             | 750               | 9                                      | NR                             | 880               | 0                                      | NR                             |
| 365               | 0                                      | NR                             | 495               | 269                                    | NR                             | 625               | 335                                    | NR                             | 755               | 8                                      | NR                             | 885               | 0                                      | NR                             |
| 370               | 0                                      | NR                             | 500               | 298                                    | NR                             | 630               | 1000                                   | NR                             | 760               | 6                                      | NR                             | 890               | 0                                      | NR                             |
| 375               | 0                                      | NR                             | 505               | 325                                    | NR                             | 635               | 580                                    | NR                             | 765               | 6                                      | NR                             | 895               | 0                                      | NR                             |
| 380               | 1                                      | NR                             | 510               | 346                                    | NR                             | 640               | 216                                    | NR                             | 770               | 5                                      | NR                             | 900               | 0                                      | NR                             |
| 385               | 1                                      | NR                             | 515               | 361                                    | NR                             | 645               | 221                                    | NR                             | 775               | 4                                      | NR                             | 905               | 0                                      | NR                             |
| 390               | 2                                      | NR                             | 520               | 369                                    | NR                             | 650               | 185                                    | NR                             | 780               | 4                                      | NR                             | 910               | 0                                      | NR                             |
| 395               | 3                                      | NR                             | 525               | 374                                    | NR                             | 655               | 158                                    | NR                             | 785               | 3                                      | NR                             | 915               | 0                                      | NR                             |
| 400               | 4                                      | NR                             | 530               | 376                                    | NR                             | 660               | 136                                    | NR                             | 790               | 3                                      | NR                             | 920               | 0                                      | NR                             |
| 405               | 6                                      | NR                             | 535               | 379                                    | NR                             | 665               | 116                                    | NR                             | 795               | 2                                      | NR                             | 925               | 0                                      | NR                             |
| 410               | 8                                      | NR                             | 540               | 381                                    | NR                             | 670               | 106                                    | NR                             | 800               | 2                                      | NR                             | 930               | 0                                      | NR                             |
| 415               | 13                                     | NR                             | 545               | 381                                    | NR                             | 675               | 88                                     | NR                             | 805               | 2                                      | NR                             | 935               | 0                                      | NR                             |
| 420               | 22                                     | NR                             | 550               | 383                                    | NR                             | 680               | 76                                     | NR                             | 810               | 2                                      | NR                             | 940               | 0                                      | NR                             |
| 425               | 37                                     | NR                             | 555               | 386                                    | NR                             | 685               | 65                                     | NR                             | 815               | 1                                      | NR                             | 945               | 0                                      | NR                             |
| 430               | 66                                     | NR                             | 560               | 386                                    | NR                             | 690               | 56                                     | NR                             | 820               | 1                                      | NR                             | 950               | 0                                      | NR                             |
| 435               | 119                                    | NR                             | 565               | 385                                    | NR                             | 695               | 48                                     | NR                             | 825               | 1                                      | NR                             | 955               | 0                                      | NR                             |
| 440               | 203                                    | NR                             | 570               | 382                                    | NR                             | 700               | 41                                     | NR                             | 830               | 1                                      | NR                             | 960               | 0                                      | NR                             |
| 445               | 359                                    | NR                             | 575               | 379                                    | NR                             | 705               | 35                                     | NR                             | 835               | 1                                      | NR                             | 965               | 0                                      | NR                             |
| 450               | 620                                    | NR                             | 580               | 376                                    | NR                             | 710               | 30                                     | NR                             | 840               | 1                                      | NR                             | 970               | 0                                      | NR                             |
| 455               | 752                                    | NR                             | 585               | 372                                    | NR                             | 715               | 26                                     | NR                             | 845               | 1                                      | NR                             | 975               | 0                                      | NR                             |
| 460               | 576                                    | NR                             | 590               | 368                                    | NR                             | 720               | 22                                     | NR                             | 850               | 1                                      | NR                             | 980               | 0                                      | NR                             |
| 465               | 423                                    | NR                             | 595               | 363                                    | NR                             | 725               | 19                                     | NR                             | 855               | 0                                      | NR                             | 985               | 0                                      | NR                             |
| 470               | 354                                    | NR                             | 600               | 358                                    | NR                             | 730               | 16                                     | NR                             | 860               | 0                                      | NR                             | 990               | 0                                      | NR                             |
| 475               | 280                                    | NR                             | 605               | 355                                    | NR                             | 735               | 14                                     | NR                             | 865               | 0                                      | NR                             | 995               | 0                                      | NR                             |
| 480               | 232                                    | NR                             | 610               | 375                                    | NR                             | 740               | 12                                     | NR                             | 870               | 0                                      | NR                             | 1000              | 0                                      | NR                             |
| 485               | 232                                    | NR                             | 615               | 379                                    | NR                             | 745               | 10                                     | NR                             | 875               | 0                                      | NR                             |                   |                                        |                                |

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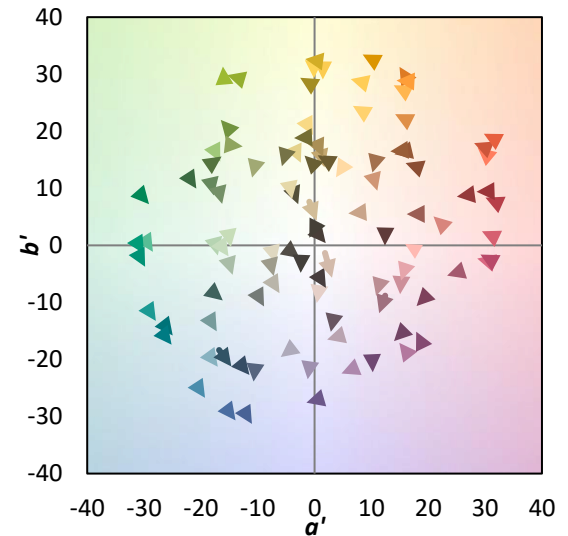
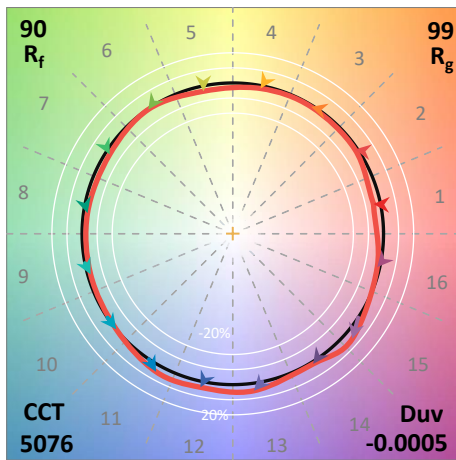
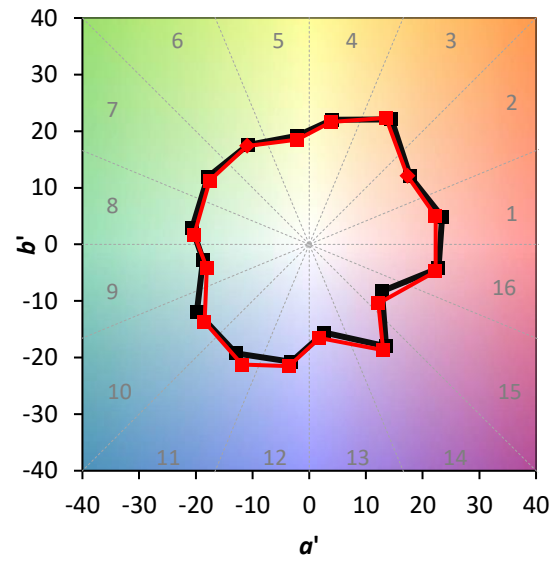
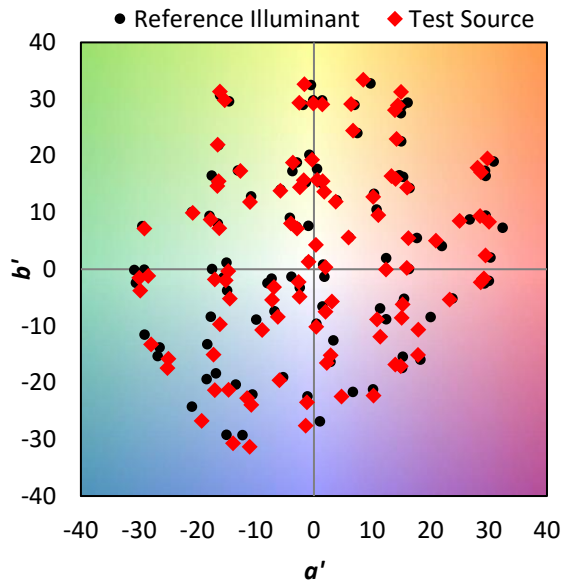
TM-30-18

### Summary

$R_f = 90.4$   
 $R_g = 99$   
 $\text{CIE } R_a = 94.9$   
 $R_9 = 74.0$

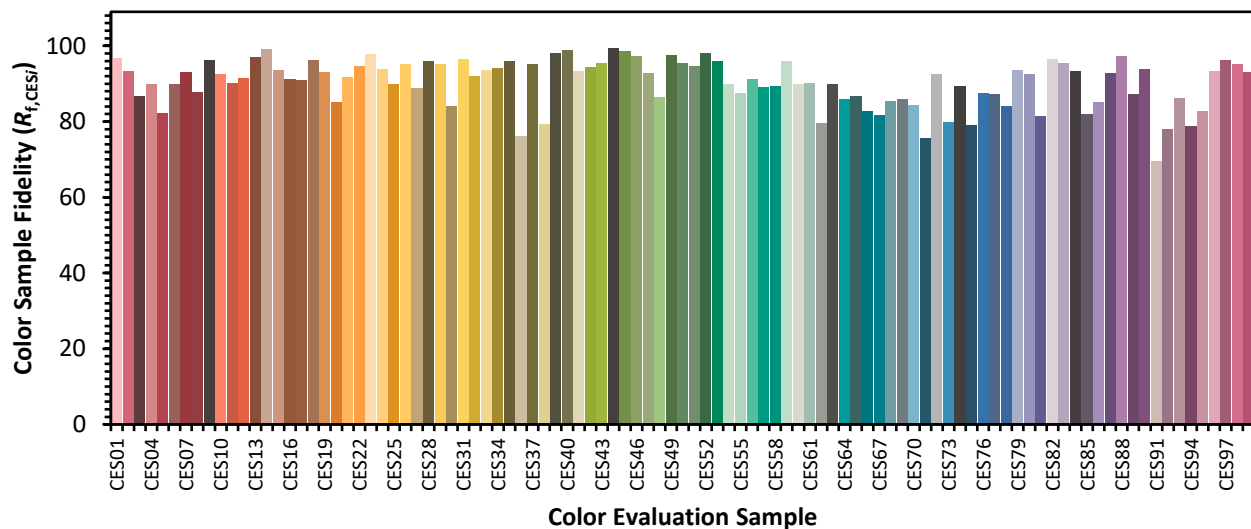


### Color Vector Graphics

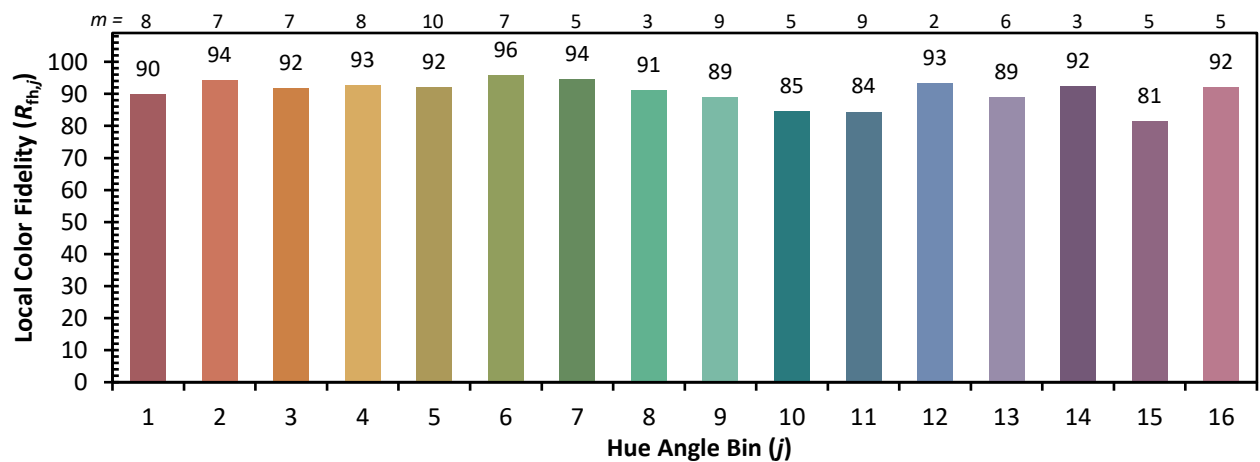
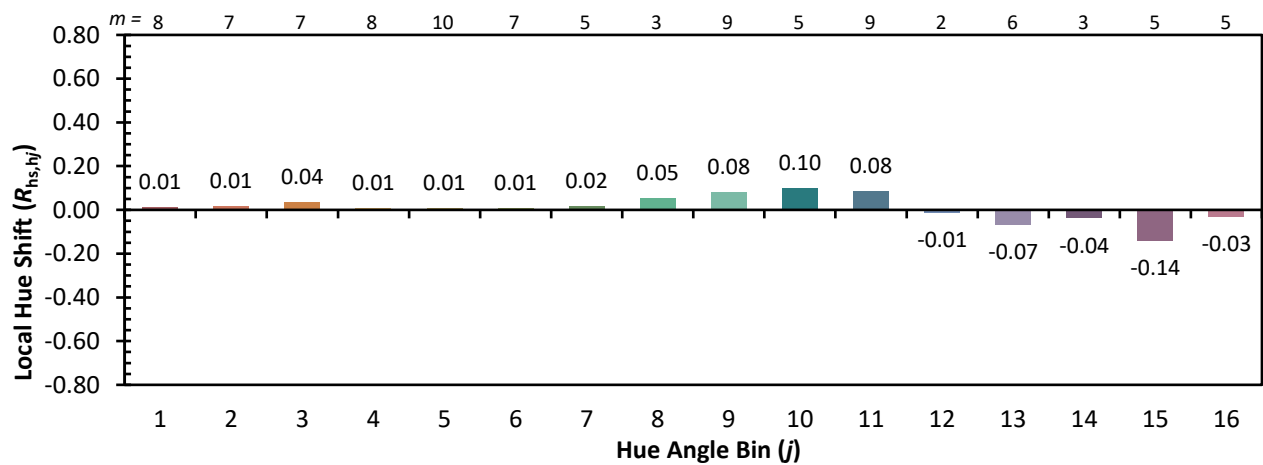
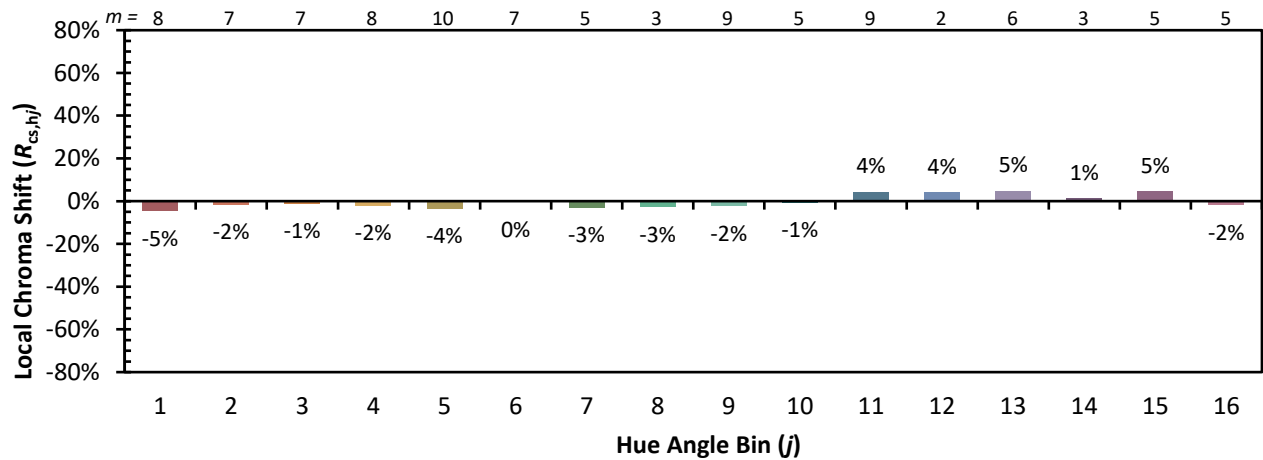


**Individual Sample Fidelity Index ( $R_{f,i}$ )**

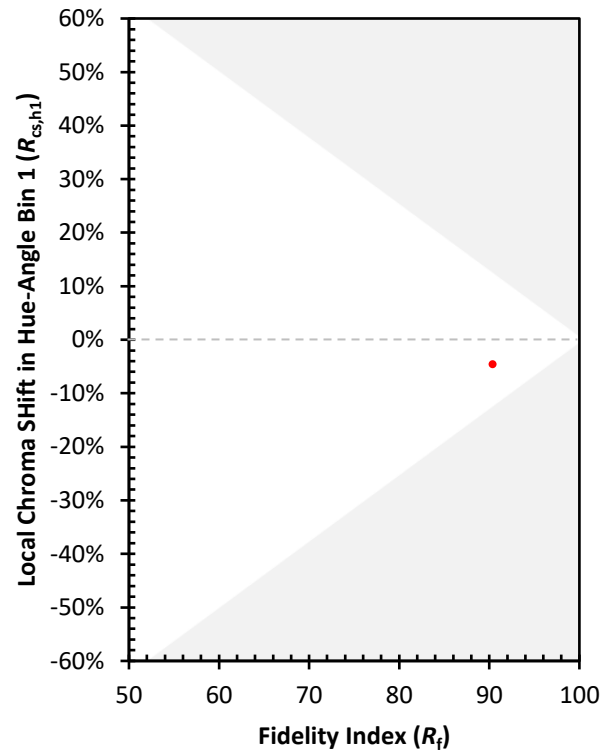
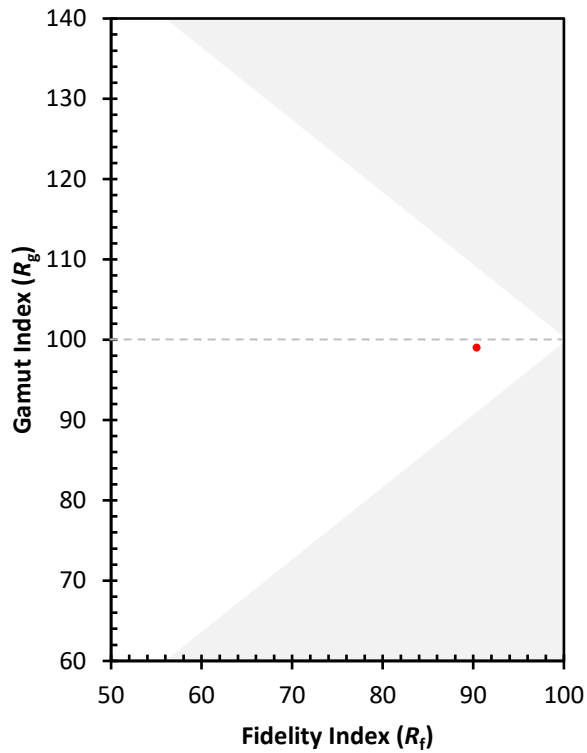
|            |            |            |            |
|------------|------------|------------|------------|
| CES01 = 85 | CES26 = 95 | CES51 = 95 | CES76 = 87 |
| CES02 = 61 | CES27 = 89 | CES52 = 98 | CES77 = 87 |
| CES03 = 31 | CES28 = 96 | CES53 = 96 | CES78 = 84 |
| CES04 = 69 | CES29 = 95 | CES54 = 90 | CES79 = 94 |
| CES05 = 48 | CES30 = 84 | CES55 = 88 | CES80 = 93 |
| CES06 = 50 | CES31 = 96 | CES56 = 91 | CES81 = 81 |
| CES07 = 41 | CES32 = 92 | CES57 = 89 | CES82 = 97 |
| CES08 = 40 | CES33 = 94 | CES58 = 89 | CES83 = 95 |
| CES09 = 29 | CES34 = 94 | CES59 = 96 | CES84 = 93 |
| CES10 = 73 | CES35 = 96 | CES60 = 90 | CES85 = 82 |
| CES11 = 56 | CES36 = 76 | CES61 = 90 | CES86 = 85 |
| CES12 = 62 | CES37 = 95 | CES62 = 80 | CES87 = 93 |
| CES13 = 42 | CES38 = 79 | CES63 = 90 | CES88 = 97 |
| CES14 = 74 | CES39 = 98 | CES64 = 86 | CES89 = 87 |
| CES15 = 71 | CES40 = 99 | CES65 = 87 | CES90 = 94 |
| CES16 = 47 | CES41 = 93 | CES66 = 83 | CES91 = 70 |
| CES17 = 48 | CES42 = 94 | CES67 = 82 | CES92 = 78 |
| CES18 = 56 | CES43 = 95 | CES68 = 85 | CES93 = 86 |
| CES19 = 70 | CES44 = 99 | CES69 = 86 | CES94 = 79 |
| CES20 = 65 | CES45 = 99 | CES70 = 84 | CES95 = 83 |
| CES21 = 85 | CES46 = 97 | CES71 = 76 | CES96 = 93 |
| CES22 = 77 | CES47 = 93 | CES72 = 92 | CES97 = 96 |
| CES23 = 91 | CES48 = 86 | CES73 = 80 | CES98 = 95 |
| CES24 = 90 | CES49 = 98 | CES74 = 89 | CES99 = 93 |
| CES25 = 70 | CES50 = 96 | CES75 = 79 |            |



Color Rendition by Hue-Angle Bin



**Measure Comparisons**



(END OF REPORT)