

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: P1357033

Luminaire Tested: 3ASL4-20VHE-3-27-UNV

Issue Date: 2/17/2026

**Test Information**

Test Method: LM-79-2019  
Report Number: P1357033  
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: 3ASL4-20VHE-3-27-UNV  
Description: 3FT 2000 LUMEN PER FOOT 4ASL LED LUMINAIRE WITH OPL LENS AND 2700K LEDS 3 ROW  
Light Source: -  
Ballast/Driver: -

**Summary**

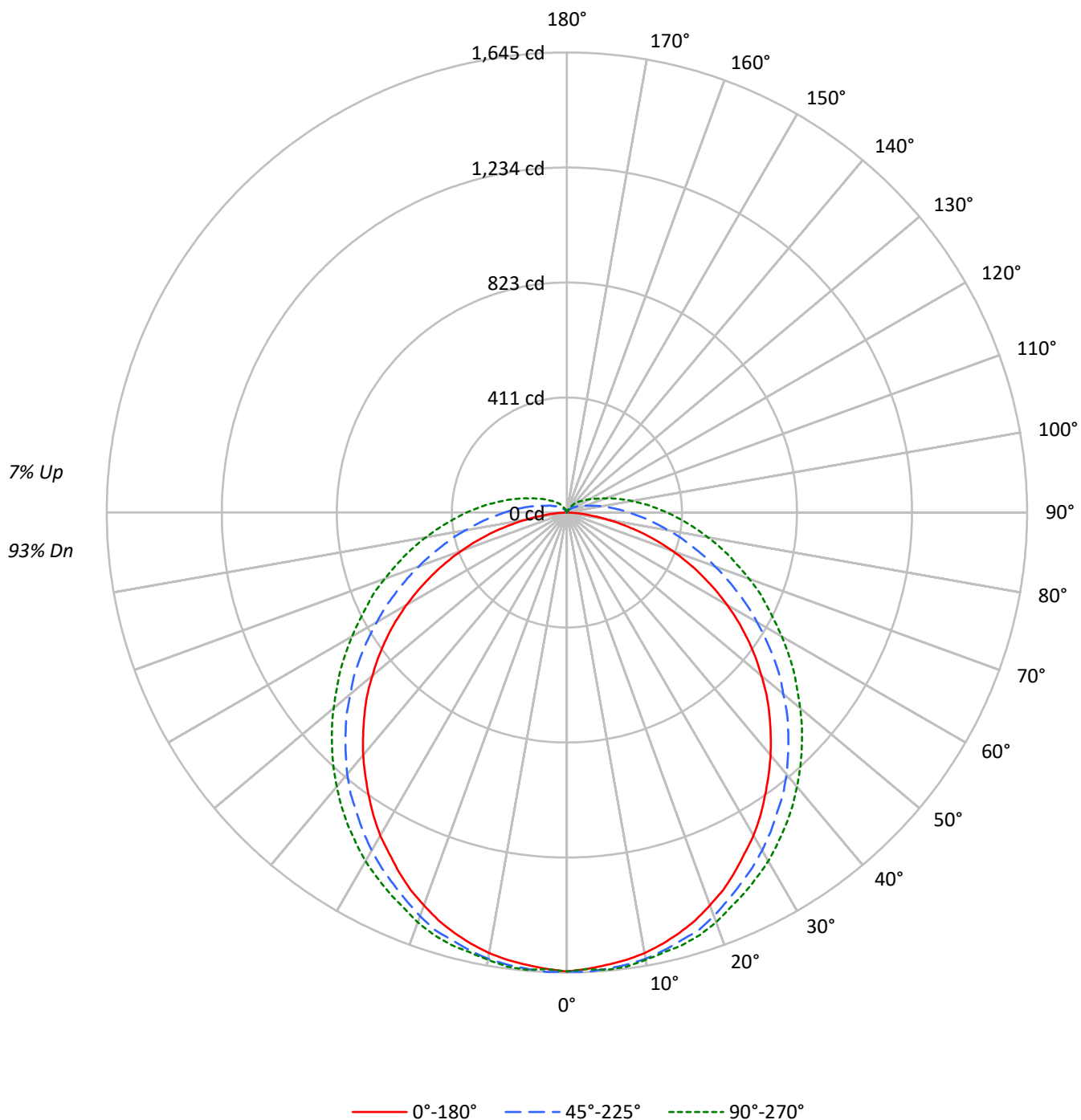
Lumens per Lamp: N/A  
Luminaire Lumens: 5580.0 lumens  
Efficiency: N/A  
Efficacy: 110.7 lumens/watt  
Spacing Criteria (0/90/45): 1.21 / 1.3 / 1.39  
Luminous Opening: Rectangular w/ Sides (W: 0.33' x L: 2.98' x H: 0.1')  
CIE Type: Direct

Input Watts (W): 50.4  
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: 3ASL4-20VHE-3-27-UNV

### Luminous Intensity Polar Plot



TEST NUMBER: P1357033

CATALOG NUMBER: 3ASL4-20VHE-3-27-UNV

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

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

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

|     | 0°    | 45°   | 90°   |
|-----|-------|-------|-------|
| 0°  | 17789 | 17789 | 17789 |
| 5°  | 17617 | 17444 | 17382 |
| 10° | 17505 | 17098 | 16942 |
| 15° | 17298 | 16668 | 16569 |
| 20° | 17021 | 16257 | 16150 |
| 25° | 16703 | 15743 | 15672 |
| 30° | 16367 | 15296 | 15266 |
| 35° | 15953 | 14792 | 14817 |
| 40° | 15572 | 14330 | 14343 |
| 45° | 15161 | 13771 | 13868 |
| 50° | 14693 | 13173 | 13373 |
| 55° | 14187 | 12601 | 12929 |
| 60° | 13530 | 11934 | 12477 |
| 65° | 12700 | 11291 | 12104 |
| 70° | 11641 | 10652 | 11810 |
| 75° | 10113 | 10063 | 11609 |
| 80° | 7819  | 9611  | 11524 |
| 85° | 4549  | 9470  | 11694 |

**MAXIMUM LUMINANCE 45°-90°:**

Horizontal Angle: 0°

Vertical Angle: 45°

Luminance: 15161 cd/sqm

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**ZONAL LUMENS:**

| Zone      | Lumens | % Fixture |
|-----------|--------|-----------|
| 0°-10°    | 155.6  | 2.8       |
| 10°-20°   | 446.8  | 8.0       |
| 20°-30°   | 675.6  | 12.1      |
| 30°-40°   | 818.0  | 14.7      |
| 40°-50°   | 859.2  | 15.4      |
| 50°-60°   | 801.6  | 14.4      |
| 60°-70°   | 662.4  | 11.9      |
| 70°-80°   | 477.0  | 8.5       |
| 80°-90°   | 296.4  | 5.3       |
| 90°-100°  | 173.7  | 3.1       |
| 100°-110° | 99.3   | 1.8       |
| 110°-120° | 56.1   | 1.0       |
| 120°-130° | 32.3   | 0.6       |
| 130°-140° | 17.4   | 0.3       |
| 140°-150° | 7.3    | 0.1       |
| 150°-160° | 1.3    | 0.0       |
| 160°-170° | 0.0    | 0.0       |
| 170°-180° | 0.0    | 0.0       |
| 0°-30°    | 1278.0 | 22.9      |
| 0°-40°    | 2096.0 | 37.6      |
| 0°-60°    | 3756.7 | 67.3      |
| 0°-90°    | 5192.5 | 93.1      |
| 90°-120°  | 329.1  | 5.9       |
| 90°-150°  | 386.1  | 6.9       |
| 90°-180°  | 387.0  | 6.9       |
| 0°-180°   | 5580.0 | 100.0     |

**CANDELA DISTRIBUTION:**

|      | 0°   | 22.5° | 45°  | 67.5° | 90°  | Flux |
|------|------|-------|------|-------|------|------|
| 0°   | 1641 | 1641  | 1641 | 1641  | 1641 |      |
| 5°   | 1624 | 1638  | 1638 | 1638  | 1641 | 154  |
| 15°  | 1556 | 1576  | 1583 | 1593  | 1600 | 439  |
| 25°  | 1419 | 1443  | 1467 | 1488  | 1501 | 654  |
| 35°  | 1235 | 1269  | 1310 | 1348  | 1365 | 773  |
| 45°  | 1024 | 1061  | 1119 | 1167  | 1187 | 790  |
| 55°  | 788  | 832   | 901  | 966   | 990  | 704  |
| 65°  | 532  | 583   | 672  | 758   | 788  | 527  |
| 75°  | 273  | 341   | 461  | 560   | 600  | 289  |
| 85°  | 51   | 154   | 290  | 392   | 430  | 63   |
| 90°  | 0    | 92    | 222  | 317   | 358  | 2    |
| 95°  | 0    | 58    | 167  | 256   | 293  | 0    |
| 105° | 0    | 20    | 92   | 160   | 188  | 0    |
| 115° | 0    | 10    | 55   | 99    | 116  | 0    |
| 125° | 0    | 7     | 34   | 65    | 75   | 0    |
| 135° | 0    | 0     | 20   | 41    | 51   | 0    |
| 145° | 0    | 0     | 10   | 24    | 27   | 0    |
| 155° | 0    | 0     | 0    | 7     | 10   | 0    |
| 165° | 0    | 0     | 0    | 0     | 0    | 0    |
| 175° | 0    | 0     | 0    | 0     | 0    | 0    |
| 180° | 0    | 0     | 0    | 0     | 0    | 0    |

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**CANDELA DISTRIBUTION (FULL):**

|        | 0°     | 22.5°  | 45°    | 67.5°  | 90°    |
|--------|--------|--------|--------|--------|--------|
| 0°     | 1641.2 | 1641.2 | 1641.2 | 1641.2 | 1641.2 |
| 2.5°   | 1634.3 | 1644.6 | 1644.6 | 1634.3 | 1634.3 |
| 5°     | 1624.1 | 1637.7 | 1637.7 | 1637.7 | 1641.2 |
| 7.5°   | 1613.9 | 1630.9 | 1630.9 | 1630.9 | 1637.7 |
| 10°    | 1600.2 | 1617.3 | 1620.7 | 1620.7 | 1624.1 |
| 12.5°  | 1579.7 | 1600.2 | 1603.6 | 1607.0 | 1610.4 |
| 15°    | 1555.9 | 1576.3 | 1583.1 | 1593.4 | 1600.2 |
| 17.5°  | 1528.6 | 1552.4 | 1566.1 | 1576.3 | 1583.1 |
| 20°    | 1494.4 | 1518.3 | 1535.4 | 1549.0 | 1559.3 |
| 22.5°  | 1460.3 | 1480.8 | 1501.3 | 1518.3 | 1528.6 |
| 25°    | 1419.4 | 1443.3 | 1467.1 | 1487.6 | 1501.3 |
| 27.5°  | 1375.0 | 1402.3 | 1433.0 | 1456.9 | 1470.6 |
| 30°    | 1334.1 | 1361.4 | 1395.5 | 1426.2 | 1439.8 |
| 32.5°  | 1286.3 | 1317.0 | 1354.5 | 1385.3 | 1402.3 |
| 35°    | 1235.1 | 1269.2 | 1310.2 | 1347.7 | 1364.8 |
| 37.5°  | 1184.0 | 1218.1 | 1269.2 | 1306.8 | 1323.8 |
| 40°    | 1132.8 | 1166.9 | 1221.5 | 1262.4 | 1279.5 |
| 42.5°  | 1078.2 | 1112.3 | 1170.3 | 1214.7 | 1235.1 |
| 45°    | 1023.6 | 1061.1 | 1119.1 | 1166.9 | 1187.4 |
| 47.5°  | 969.0  | 1006.5 | 1067.9 | 1119.1 | 1139.6 |
| 50°    | 907.6  | 948.5  | 1009.9 | 1067.9 | 1088.4 |
| 52.5°  | 849.6  | 890.5  | 958.8  | 1016.8 | 1037.2 |
| 55°    | 788.2  | 832.5  | 900.8  | 965.6  | 989.5  |
| 57.5°  | 726.7  | 771.1  | 842.8  | 911.0  | 938.3  |
| 60°    | 661.9  | 709.7  | 784.8  | 856.4  | 887.1  |
| 62.5°  | 597.1  | 648.3  | 730.2  | 805.2  | 835.9  |
| 65°    | 532.3  | 583.4  | 672.2  | 757.5  | 788.2  |
| 67.5°  | 467.4  | 522.0  | 617.6  | 706.3  | 743.8  |
| 70°    | 402.6  | 460.6  | 563.0  | 655.1  | 692.6  |
| 72.5°  | 337.8  | 399.2  | 511.8  | 607.3  | 644.9  |
| 75°    | 273.0  | 341.2  | 460.6  | 559.6  | 600.5  |
| 77.5°  | 208.1  | 286.6  | 416.3  | 515.2  | 556.1  |
| 80°    | 150.1  | 238.8  | 368.5  | 470.9  | 511.8  |
| 82.5°  | 95.5   | 191.1  | 327.5  | 429.9  | 470.9  |
| 85°    | 51.2   | 153.5  | 290.0  | 392.4  | 429.9  |
| 87.5°  | 17.1   | 119.4  | 252.5  | 354.8  | 392.4  |
| 90°    | 0.0    | 92.1   | 221.8  | 317.3  | 358.3  |
| 92.5°  | 0.0    | 71.7   | 194.5  | 286.6  | 324.1  |
| 95°    | 0.0    | 58.0   | 167.2  | 255.9  | 293.4  |
| 97.5°  | 0.0    | 47.8   | 146.7  | 228.6  | 262.7  |
| 100°   | 0.0    | 37.5   | 126.2  | 204.7  | 235.4  |
| 102.5° | 0.0    | 30.7   | 109.2  | 180.8  | 211.5  |
| 105°   | 0.0    | 20.5   | 92.1   | 160.4  | 187.7  |
| 107.5° | 0.0    | 17.1   | 78.5   | 143.3  | 167.2  |
| 110°   | 0.0    | 13.6   | 71.7   | 122.8  | 146.7  |



TEST NUMBER: P1357033

CATALOG NUMBER: 3ASL4-20VHE-3-27-UNV

**CANDELA DISTRIBUTION (continued):**

|        | 0°  | 22.5° | 45°  | 67.5° | 90°   |
|--------|-----|-------|------|-------|-------|
| 112.5° | 0.0 | 10.2  | 64.8 | 109.2 | 133.1 |
| 115°   | 0.0 | 10.2  | 54.6 | 98.9  | 116.0 |
| 117.5° | 0.0 | 10.2  | 47.8 | 88.7  | 105.8 |
| 120°   | 0.0 | 6.8   | 44.4 | 78.5  | 95.5  |
| 122.5° | 0.0 | 6.8   | 37.5 | 71.7  | 85.3  |
| 125°   | 0.0 | 6.8   | 34.1 | 64.8  | 75.1  |
| 127.5° | 0.0 | 3.4   | 30.7 | 58.0  | 68.2  |
| 130°   | 0.0 | 3.4   | 27.3 | 51.2  | 61.4  |
| 132.5° | 0.0 | 3.4   | 23.9 | 47.8  | 58.0  |
| 135°   | 0.0 | 0.0   | 20.5 | 40.9  | 51.2  |
| 137.5° | 0.0 | 0.0   | 17.1 | 37.5  | 44.4  |
| 140°   | 0.0 | 0.0   | 13.6 | 30.7  | 40.9  |
| 142.5° | 0.0 | 0.0   | 10.2 | 27.3  | 34.1  |
| 145°   | 0.0 | 0.0   | 10.2 | 23.9  | 27.3  |
| 147.5° | 0.0 | 0.0   | 6.8  | 17.1  | 23.9  |
| 150°   | 0.0 | 0.0   | 3.4  | 13.6  | 17.1  |
| 152.5° | 0.0 | 0.0   | 0.0  | 10.2  | 13.6  |
| 155°   | 0.0 | 0.0   | 0.0  | 6.8   | 10.2  |
| 157.5° | 0.0 | 0.0   | 0.0  | 0.0   | 3.4   |
| 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: P1357033

CATALOG NUMBER: 3ASL4-20VHE-3-27-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 | 19.32            | 20.86 | 19.79 | 21.32 | 21.80 | 21.32          | 22.86 | 21.79 | 23.32 | 23.80 |
|                 | 3H   | 20.82            | 22.23 | 21.30 | 22.69 | 23.21 | 23.77          | 25.18 | 24.25 | 25.64 | 26.17 |
|                 | 4H   | 21.30            | 22.63 | 21.80 | 23.12 | 23.65 | 24.96          | 26.29 | 25.46 | 26.77 | 27.31 |
|                 | 6H   | 21.58            | 22.82 | 22.09 | 23.31 | 23.87 | 26.20          | 27.44 | 26.71 | 27.93 | 28.48 |
|                 | 8H   | 21.63            | 22.82 | 22.16 | 23.34 | 23.90 | 26.83          | 28.02 | 27.36 | 28.54 | 29.10 |
|                 | 12H  | 21.64            | 22.78 | 22.18 | 23.30 | 23.89 | 27.52          | 28.66 | 28.05 | 29.17 | 29.76 |
| 4H              | 2H   | 20.19            | 21.53 | 20.70 | 22.01 | 22.55 | 21.76          | 23.09 | 22.26 | 23.57 | 24.11 |
|                 | 3H   | 21.93            | 23.07 | 22.45 | 23.59 | 24.15 | 24.43          | 25.57 | 24.95 | 26.09 | 26.66 |
|                 | 4H   | 22.53            | 23.57 | 23.07 | 24.11 | 24.70 | 25.79          | 26.83 | 26.33 | 27.37 | 27.96 |
|                 | 6H   | 22.93            | 23.85 | 23.49 | 24.41 | 25.02 | 27.22          | 28.14 | 27.78 | 28.70 | 29.31 |
|                 | 8H   | 23.03            | 23.89 | 23.59 | 24.45 | 25.07 | 27.96          | 28.82 | 28.52 | 29.38 | 30.00 |
|                 | 12H  | 23.07            | 23.86 | 23.65 | 24.45 | 25.07 | 28.77          | 29.56 | 29.35 | 30.15 | 30.77 |
| 8H              | 4H   | 23.21            | 24.07 | 23.77 | 24.63 | 25.25 | 26.01          | 26.87 | 26.57 | 27.44 | 28.05 |
|                 | 6H   | 23.79            | 24.52 | 24.38 | 25.12 | 25.75 | 27.61          | 28.34 | 28.20 | 28.94 | 29.57 |
|                 | 8H   | 23.97            | 24.63 | 24.57 | 25.25 | 25.88 | 28.49          | 29.15 | 29.09 | 29.76 | 30.40 |
|                 | 12H  | 24.09            | 24.68 | 24.69 | 25.28 | 25.98 | 29.49          | 30.08 | 30.09 | 30.68 | 31.38 |
| 12H             | 4H   | 23.40            | 24.18 | 23.98 | 24.77 | 25.40 | 26.02          | 26.80 | 26.60 | 27.39 | 28.02 |
|                 | 6H   | 24.08            | 24.74 | 24.68 | 25.35 | 25.99 | 27.65          | 28.31 | 28.25 | 28.92 | 29.56 |
|                 | 8H   | 24.36            | 24.95 | 24.96 | 25.55 | 26.25 | 28.60          | 29.19 | 29.20 | 29.79 | 30.49 |



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

Report Prepared for

Cooper Lighting Solutions

Fail-Safe

Report Number: SP1-2511-597-2

Test Date: 11/17/2025

Luminaire Tested: 4ASL-2-27-UNV-OPL-1\_600mA

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

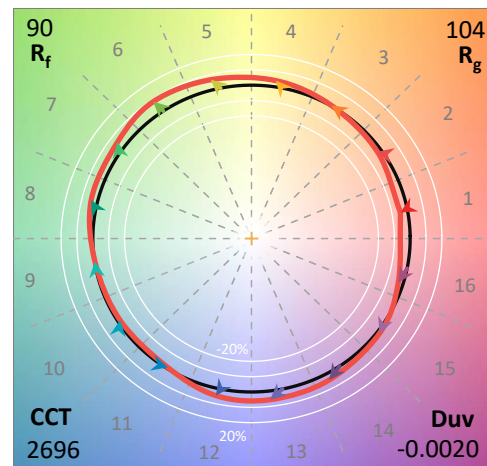
### Test Information

Test Method: LM-79-2019  
 Report Number: SP1-2511-597-2  
 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-2-27-UNV-OPL-1\_600mA**  
 Description: 2foot 4ASL LED LUMINAIRE WITH OPL LENS AND 2700K LEDS with 1 rows at 600mA

### Spectral Parameters

CCT (K): 2696  
 CIE  $u'$ : 0.2632  
 CIE  $v'$ : 0.5245  
 Duv: -0.0020  
 CIE x: 0.4568  
 CIE y: 0.4045  
 CIE z: 0.1387  
 Peak Wavelength (nm): 630  
 Dominant Wavelength (nm): 584  
 Purity: 58.52757  
 R<sub>f</sub>: 90.1  
 R<sub>g</sub>: 103.5

CRI (Ra): 94.4  
 R1: 97.5  
 R2: 97.8  
 R3: 96.9  
 R4: 95.3  
 R5: 97.2  
 R6: 96.5  
 R7: 91.2  
 R8: 83.2  
 R9: 61.8  
 R10: 93.6  
 R11: 93.7  
 R12: 94.1  
 R13: 97.6  
 R14: 96.8  
 R15: 91.9



### Test Conditions

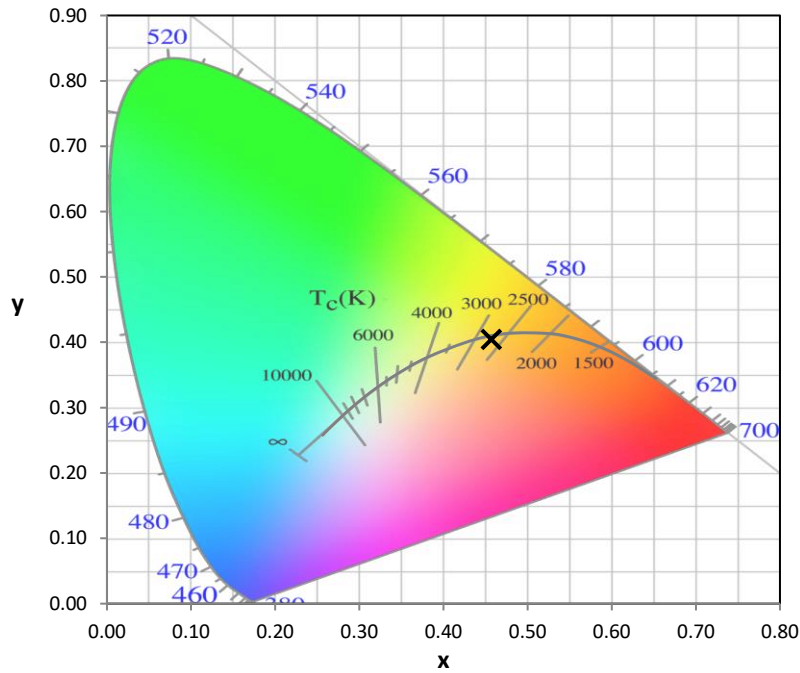
Stabilization Time: 32M  
 Operation Time: 1H 32M  
 Sphere Temperature (°C): 24.1

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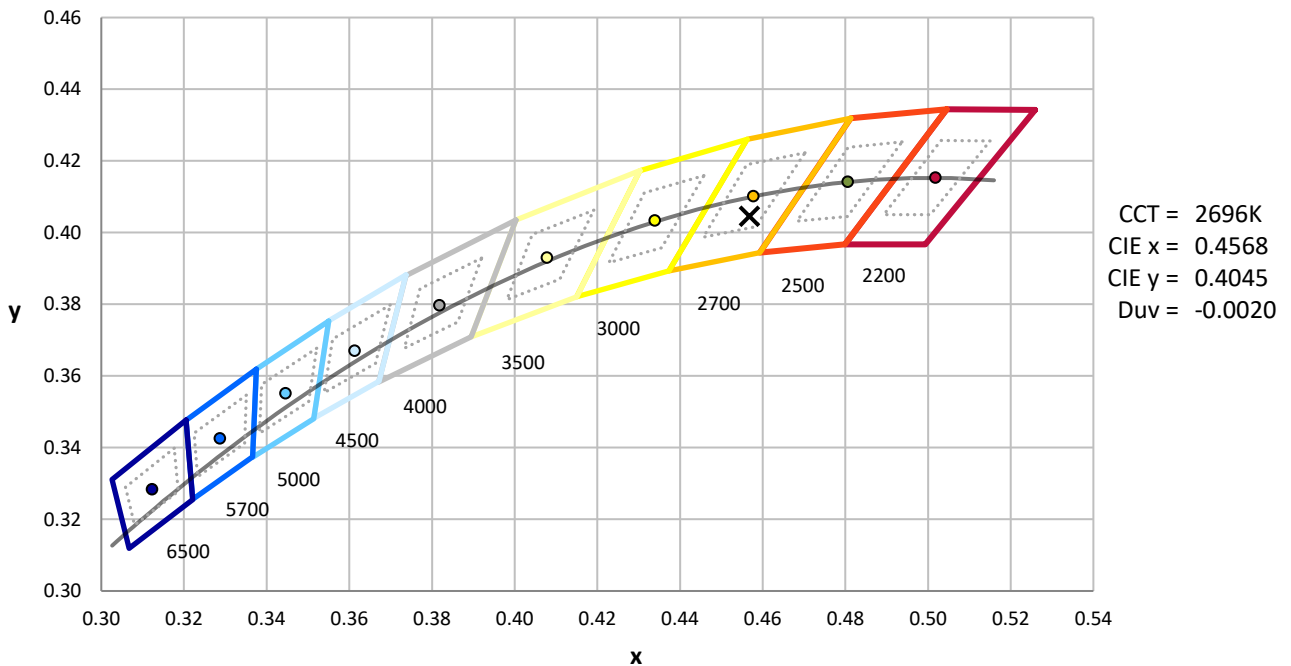
| Measurement and Test Equipment |                       |                  |                      |
|--------------------------------|-----------------------|------------------|----------------------|
| Instrument                     | Identification Number | Calibration Date | Calibration Due Date |
| 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: SP1-2511-597-2

**CIE 1931 Chromaticity Diagram**

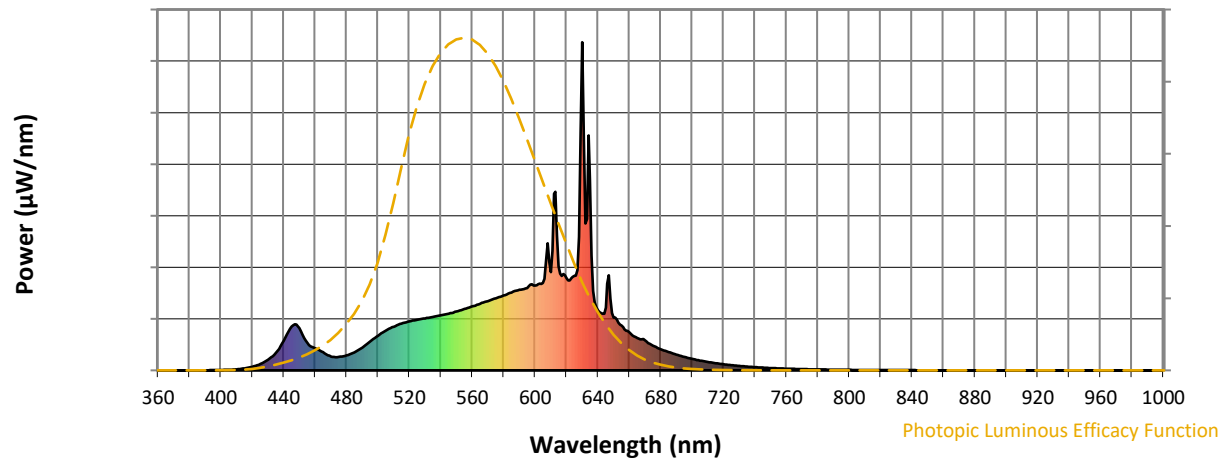


**CIE 1931 Chromaticity Diagram with 2017 ANSI 7-Step and 4-Step Quadrangles**



REPORT NUMBER: SP1-2511-597-2

### Photopic Flux vs. Wavelength

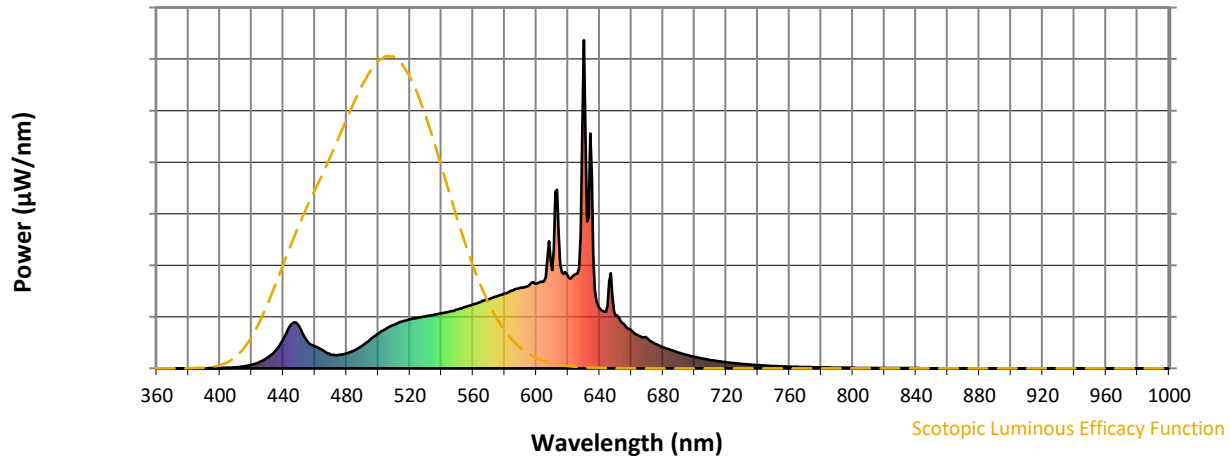


### Photopic Lumens: NR

| λ<br>(nm) | Power<br>W <sup>λ</sup> /nm | Lumens<br>(φ/nm) | λ<br>(nm) | Power<br>W <sup>λ</sup> /nm | Lumens<br>(φ/nm) | λ<br>(nm) | Power<br>W <sup>λ</sup> /nm | Lumens<br>(φ/nm) | λ<br>(nm) | Power<br>W <sup>λ</sup> /nm | Lumens<br>(φ/nm) | λ<br>(nm) | Power<br>W <sup>λ</sup> /nm | Lumens<br>(φ/nm) |
|-----------|-----------------------------|------------------|-----------|-----------------------------|------------------|-----------|-----------------------------|------------------|-----------|-----------------------------|------------------|-----------|-----------------------------|------------------|
| 360       | 0                           | NR               | 490       | 70                          | NR               | 620       | 281                         | NR               | 750       | 7                           | NR               | 880       | 0                           | NR               |
| 365       | 0                           | NR               | 495       | 88                          | NR               | 625       | 288                         | NR               | 755       | 6                           | NR               | 885       | 0                           | NR               |
| 370       | 0                           | NR               | 500       | 106                         | NR               | 630       | 1000                        | NR               | 760       | 5                           | NR               | 890       | 0                           | NR               |
| 375       | 0                           | NR               | 505       | 121                         | NR               | 635       | 581                         | NR               | 765       | 5                           | NR               | 895       | 0                           | NR               |
| 380       | 0                           | NR               | 510       | 133                         | NR               | 640       | 184                         | NR               | 770       | 4                           | NR               | 900       | 0                           | NR               |
| 385       | 0                           | NR               | 515       | 143                         | NR               | 645       | 191                         | NR               | 775       | 3                           | NR               | 905       | 0                           | NR               |
| 390       | 0                           | NR               | 520       | 149                         | NR               | 650       | 161                         | NR               | 780       | 3                           | NR               | 910       | 0                           | NR               |
| 395       | 1                           | NR               | 525       | 155                         | NR               | 655       | 136                         | NR               | 785       | 2                           | NR               | 915       | 0                           | NR               |
| 400       | 1                           | NR               | 530       | 158                         | NR               | 660       | 116                         | NR               | 790       | 2                           | NR               | 920       | 0                           | NR               |
| 405       | 2                           | NR               | 535       | 163                         | NR               | 665       | 99                          | NR               | 795       | 2                           | NR               | 925       | 0                           | NR               |
| 410       | 3                           | NR               | 540       | 168                         | NR               | 670       | 92                          | NR               | 800       | 2                           | NR               | 930       | 0                           | NR               |
| 415       | 6                           | NR               | 545       | 173                         | NR               | 675       | 75                          | NR               | 805       | 1                           | NR               | 935       | 0                           | NR               |
| 420       | 11                          | NR               | 550       | 179                         | NR               | 680       | 65                          | NR               | 810       | 1                           | NR               | 940       | 0                           | NR               |
| 425       | 19                          | NR               | 555       | 187                         | NR               | 685       | 56                          | NR               | 815       | 1                           | NR               | 945       | 0                           | NR               |
| 430       | 32                          | NR               | 560       | 195                         | NR               | 690       | 48                          | NR               | 820       | 1                           | NR               | 950       | 0                           | NR               |
| 435       | 54                          | NR               | 565       | 203                         | NR               | 695       | 41                          | NR               | 825       | 1                           | NR               | 955       | 0                           | NR               |
| 440       | 90                          | NR               | 570       | 211                         | NR               | 700       | 35                          | NR               | 830       | 1                           | NR               | 960       | 0                           | NR               |
| 445       | 134                         | NR               | 575       | 219                         | NR               | 705       | 30                          | NR               | 835       | 1                           | NR               | 965       | 0                           | NR               |
| 450       | 128                         | NR               | 580       | 228                         | NR               | 710       | 26                          | NR               | 840       | 1                           | NR               | 970       | 0                           | NR               |
| 455       | 83                          | NR               | 585       | 237                         | NR               | 715       | 22                          | NR               | 845       | 0                           | NR               | 975       | 0                           | NR               |
| 460       | 67                          | NR               | 590       | 246                         | NR               | 720       | 19                          | NR               | 850       | 0                           | NR               | 980       | 0                           | NR               |
| 465       | 55                          | NR               | 595       | 251                         | NR               | 725       | 16                          | NR               | 855       | 0                           | NR               | 985       | 0                           | NR               |
| 470       | 42                          | NR               | 600       | 259                         | NR               | 730       | 13                          | NR               | 860       | 0                           | NR               | 990       | 0                           | NR               |
| 475       | 41                          | NR               | 605       | 266                         | NR               | 735       | 11                          | NR               | 865       | 0                           | NR               | 995       | 0                           | NR               |
| 480       | 46                          | NR               | 610       | 299                         | NR               | 740       | 10                          | NR               | 870       | 0                           | NR               | 1000      | 0                           | NR               |
| 485       | 55                          | NR               | 615       | 317                         | NR               | 745       | 8                           | NR               | 875       | 0                           | NR               |           |                             |                  |

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### Scotopic Flux vs. Wavelength



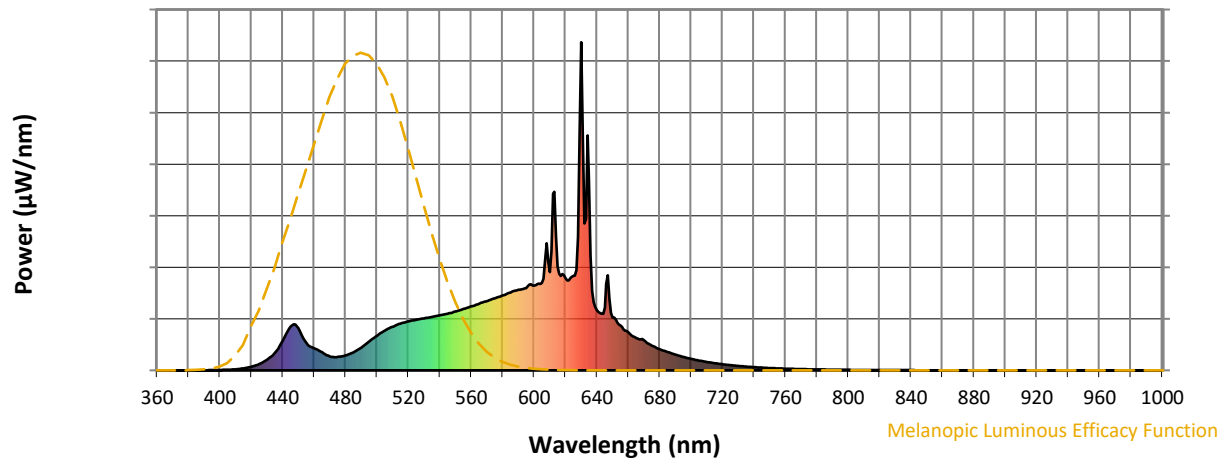
Scotopic Lumens: NR

S/P: 1.29

| λ (nm) | Power W <sup>^</sup> /nm | Lumens (Φ/nm) | λ (nm) | Power W <sup>^</sup> /nm | Lumens (Φ/nm) | λ (nm) | Power W <sup>^</sup> /nm | Lumens (Φ/nm) | λ (nm) | Power W <sup>^</sup> /nm | Lumens (Φ/nm) | λ (nm) | Power W <sup>^</sup> /nm | Lumens (Φ/nm) |
|--------|--------------------------|---------------|--------|--------------------------|---------------|--------|--------------------------|---------------|--------|--------------------------|---------------|--------|--------------------------|---------------|
| 360    | 0                        | NR            | 490    | 70                       | NR            | 620    | 281                      | NR            | 750    | 7                        | NR            | 880    | 0                        | NR            |
| 365    | 0                        | NR            | 495    | 88                       | NR            | 625    | 288                      | NR            | 755    | 6                        | NR            | 885    | 0                        | NR            |
| 370    | 0                        | NR            | 500    | 106                      | NR            | 630    | 1000                     | NR            | 760    | 5                        | NR            | 890    | 0                        | NR            |
| 375    | 0                        | NR            | 505    | 121                      | NR            | 635    | 581                      | NR            | 765    | 5                        | NR            | 895    | 0                        | NR            |
| 380    | 0                        | NR            | 510    | 133                      | NR            | 640    | 184                      | NR            | 770    | 4                        | NR            | 900    | 0                        | NR            |
| 385    | 0                        | NR            | 515    | 143                      | NR            | 645    | 191                      | NR            | 775    | 3                        | NR            | 905    | 0                        | NR            |
| 390    | 0                        | NR            | 520    | 149                      | NR            | 650    | 161                      | NR            | 780    | 3                        | NR            | 910    | 0                        | NR            |
| 395    | 1                        | NR            | 525    | 155                      | NR            | 655    | 136                      | NR            | 785    | 2                        | NR            | 915    | 0                        | NR            |
| 400    | 1                        | NR            | 530    | 158                      | NR            | 660    | 116                      | NR            | 790    | 2                        | NR            | 920    | 0                        | NR            |
| 405    | 2                        | NR            | 535    | 163                      | NR            | 665    | 99                       | NR            | 795    | 2                        | NR            | 925    | 0                        | NR            |
| 410    | 3                        | NR            | 540    | 168                      | NR            | 670    | 92                       | NR            | 800    | 2                        | NR            | 930    | 0                        | NR            |
| 415    | 6                        | NR            | 545    | 173                      | NR            | 675    | 75                       | NR            | 805    | 1                        | NR            | 935    | 0                        | NR            |
| 420    | 11                       | NR            | 550    | 179                      | NR            | 680    | 65                       | NR            | 810    | 1                        | NR            | 940    | 0                        | NR            |
| 425    | 19                       | NR            | 555    | 187                      | NR            | 685    | 56                       | NR            | 815    | 1                        | NR            | 945    | 0                        | NR            |
| 430    | 32                       | NR            | 560    | 195                      | NR            | 690    | 48                       | NR            | 820    | 1                        | NR            | 950    | 0                        | NR            |
| 435    | 54                       | NR            | 565    | 203                      | NR            | 695    | 41                       | NR            | 825    | 1                        | NR            | 955    | 0                        | NR            |
| 440    | 90                       | NR            | 570    | 211                      | NR            | 700    | 35                       | NR            | 830    | 1                        | NR            | 960    | 0                        | NR            |
| 445    | 134                      | NR            | 575    | 219                      | NR            | 705    | 30                       | NR            | 835    | 1                        | NR            | 965    | 0                        | NR            |
| 450    | 128                      | NR            | 580    | 228                      | NR            | 710    | 26                       | NR            | 840    | 1                        | NR            | 970    | 0                        | NR            |
| 455    | 83                       | NR            | 585    | 237                      | NR            | 715    | 22                       | NR            | 845    | 0                        | NR            | 975    | 0                        | NR            |
| 460    | 67                       | NR            | 590    | 246                      | NR            | 720    | 19                       | NR            | 850    | 0                        | NR            | 980    | 0                        | NR            |
| 465    | 55                       | NR            | 595    | 251                      | NR            | 725    | 16                       | NR            | 855    | 0                        | NR            | 985    | 0                        | NR            |
| 470    | 42                       | NR            | 600    | 259                      | NR            | 730    | 13                       | NR            | 860    | 0                        | NR            | 990    | 0                        | NR            |
| 475    | 41                       | NR            | 605    | 266                      | NR            | 735    | 11                       | NR            | 865    | 0                        | NR            | 995    | 0                        | NR            |
| 480    | 46                       | NR            | 610    | 299                      | NR            | 740    | 10                       | NR            | 870    | 0                        | NR            | 1000   | 0                        | NR            |
| 485    | 55                       | NR            | 615    | 317                      | NR            | 745    | 8                        | NR            | 875    | 0                        | NR            |        |                          |               |

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### Melanopic Flux vs. Wavelength



Melanopic Lumens: NR

M/P: 2.45

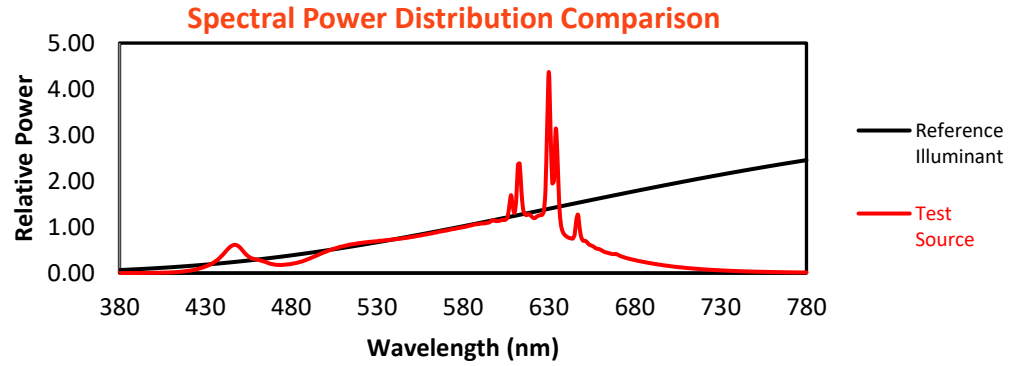
| $\lambda$<br>(nm) | Power<br>$\text{W}^{\wedge}/\text{nm}$ | Lumens<br>( $\phi/\text{nm}$ ) | $\lambda$<br>(nm) | Power<br>$\text{W}^{\wedge}/\text{nm}$ | Lumens<br>( $\phi/\text{nm}$ ) | $\lambda$<br>(nm) | Power<br>$\text{W}^{\wedge}/\text{nm}$ | Lumens<br>( $\phi/\text{nm}$ ) | $\lambda$<br>(nm) | 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               | 70                                     | NR                             | 620               | 281                                    | NR                             | 750               | 7                                      | NR                             | 880               | 0                                      | NR                             |
| 365               | 0                                      | NR                             | 495               | 88                                     | NR                             | 625               | 288                                    | NR                             | 755               | 6                                      | NR                             | 885               | 0                                      | NR                             |
| 370               | 0                                      | NR                             | 500               | 106                                    | NR                             | 630               | 1000                                   | NR                             | 760               | 5                                      | NR                             | 890               | 0                                      | NR                             |
| 375               | 0                                      | NR                             | 505               | 121                                    | NR                             | 635               | 581                                    | NR                             | 765               | 5                                      | NR                             | 895               | 0                                      | NR                             |
| 380               | 0                                      | NR                             | 510               | 133                                    | NR                             | 640               | 184                                    | NR                             | 770               | 4                                      | NR                             | 900               | 0                                      | NR                             |
| 385               | 0                                      | NR                             | 515               | 143                                    | NR                             | 645               | 191                                    | NR                             | 775               | 3                                      | NR                             | 905               | 0                                      | NR                             |
| 390               | 0                                      | NR                             | 520               | 149                                    | NR                             | 650               | 161                                    | NR                             | 780               | 3                                      | NR                             | 910               | 0                                      | NR                             |
| 395               | 1                                      | NR                             | 525               | 155                                    | NR                             | 655               | 136                                    | NR                             | 785               | 2                                      | NR                             | 915               | 0                                      | NR                             |
| 400               | 1                                      | NR                             | 530               | 158                                    | NR                             | 660               | 116                                    | NR                             | 790               | 2                                      | NR                             | 920               | 0                                      | NR                             |
| 405               | 2                                      | NR                             | 535               | 163                                    | NR                             | 665               | 99                                     | NR                             | 795               | 2                                      | NR                             | 925               | 0                                      | NR                             |
| 410               | 3                                      | NR                             | 540               | 168                                    | NR                             | 670               | 92                                     | NR                             | 800               | 2                                      | NR                             | 930               | 0                                      | NR                             |
| 415               | 6                                      | NR                             | 545               | 173                                    | NR                             | 675               | 75                                     | NR                             | 805               | 1                                      | NR                             | 935               | 0                                      | NR                             |
| 420               | 11                                     | NR                             | 550               | 179                                    | NR                             | 680               | 65                                     | NR                             | 810               | 1                                      | NR                             | 940               | 0                                      | NR                             |
| 425               | 19                                     | NR                             | 555               | 187                                    | NR                             | 685               | 56                                     | NR                             | 815               | 1                                      | NR                             | 945               | 0                                      | NR                             |
| 430               | 32                                     | NR                             | 560               | 195                                    | NR                             | 690               | 48                                     | NR                             | 820               | 1                                      | NR                             | 950               | 0                                      | NR                             |
| 435               | 54                                     | NR                             | 565               | 203                                    | NR                             | 695               | 41                                     | NR                             | 825               | 1                                      | NR                             | 955               | 0                                      | NR                             |
| 440               | 90                                     | NR                             | 570               | 211                                    | NR                             | 700               | 35                                     | NR                             | 830               | 1                                      | NR                             | 960               | 0                                      | NR                             |
| 445               | 134                                    | NR                             | 575               | 219                                    | NR                             | 705               | 30                                     | NR                             | 835               | 1                                      | NR                             | 965               | 0                                      | NR                             |
| 450               | 128                                    | NR                             | 580               | 228                                    | NR                             | 710               | 26                                     | NR                             | 840               | 1                                      | NR                             | 970               | 0                                      | NR                             |
| 455               | 83                                     | NR                             | 585               | 237                                    | NR                             | 715               | 22                                     | NR                             | 845               | 0                                      | NR                             | 975               | 0                                      | NR                             |
| 460               | 67                                     | NR                             | 590               | 246                                    | NR                             | 720               | 19                                     | NR                             | 850               | 0                                      | NR                             | 980               | 0                                      | NR                             |
| 465               | 55                                     | NR                             | 595               | 251                                    | NR                             | 725               | 16                                     | NR                             | 855               | 0                                      | NR                             | 985               | 0                                      | NR                             |
| 470               | 42                                     | NR                             | 600               | 259                                    | NR                             | 730               | 13                                     | NR                             | 860               | 0                                      | NR                             | 990               | 0                                      | NR                             |
| 475               | 41                                     | NR                             | 605               | 266                                    | NR                             | 735               | 11                                     | NR                             | 865               | 0                                      | NR                             | 995               | 0                                      | NR                             |
| 480               | 46                                     | NR                             | 610               | 299                                    | NR                             | 740               | 10                                     | NR                             | 870               | 0                                      | NR                             | 1000              | 0                                      | NR                             |
| 485               | 55                                     | NR                             | 615               | 317                                    | NR                             | 745               | 8                                      | NR                             | 875               | 0                                      | NR                             |                   |                                        |                                |

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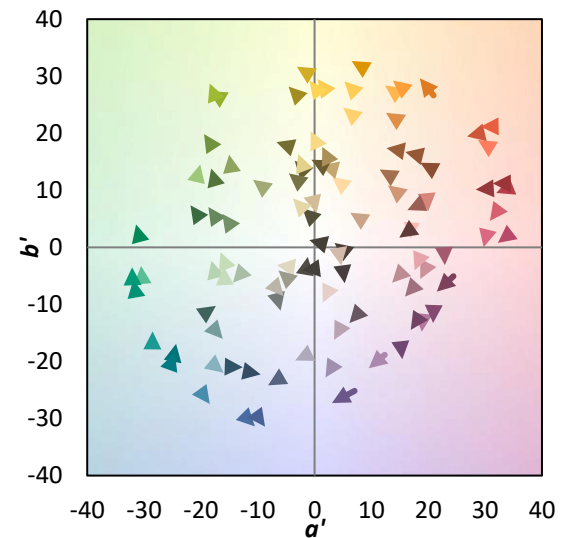
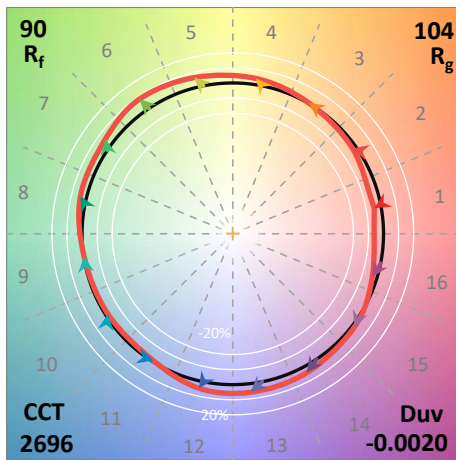
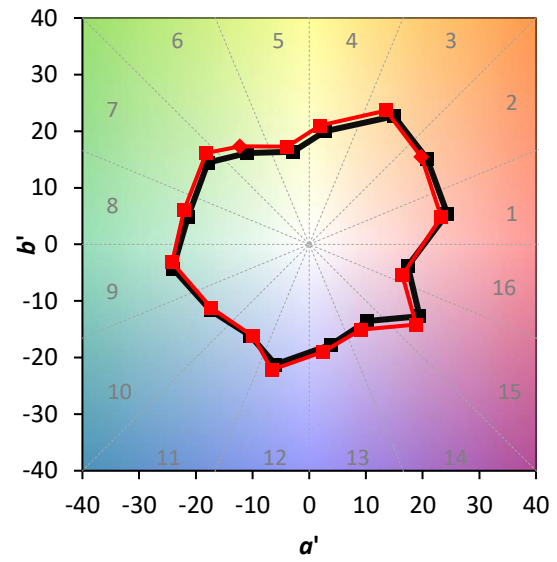
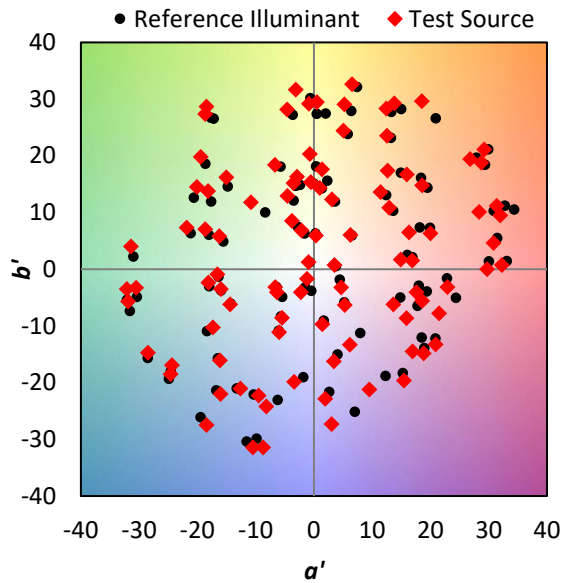
TM-30-18

### Summary

$R_f = 90.1$   
 $R_g = 103.5$   
 $CIE R_a = 94.4$   
 $R_9 = 61.8$



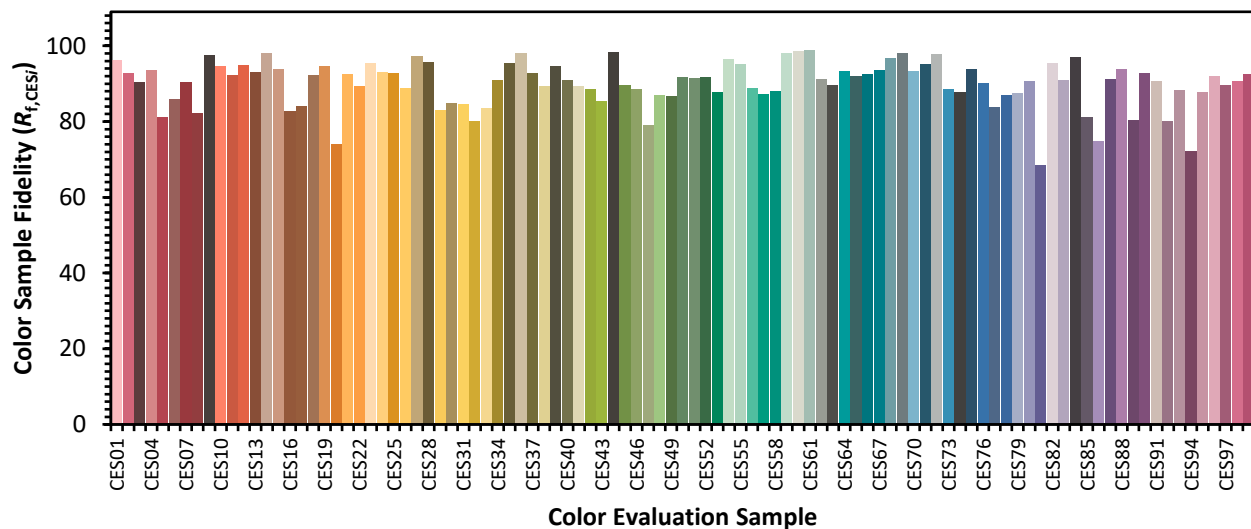
### Color Vector Graphics



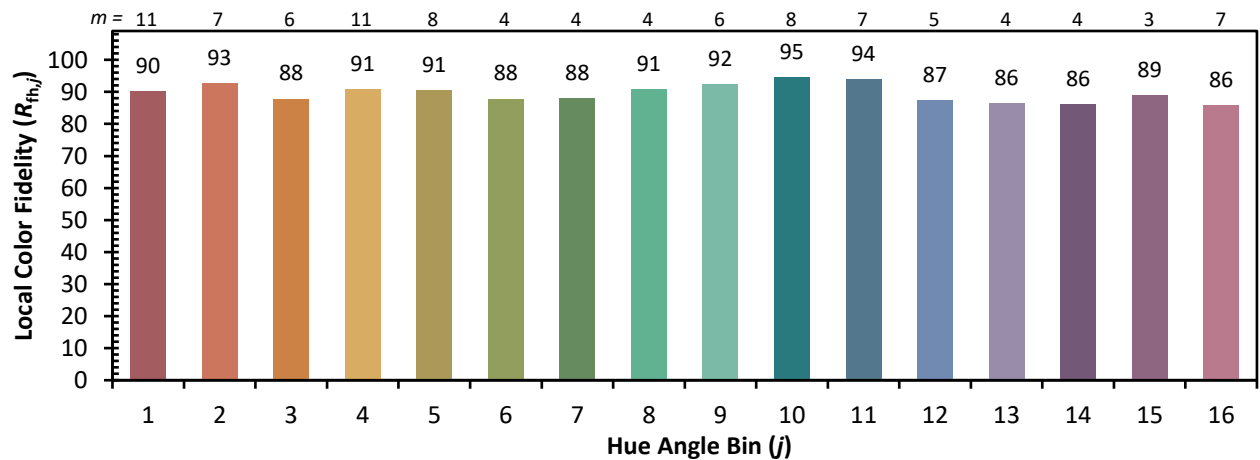
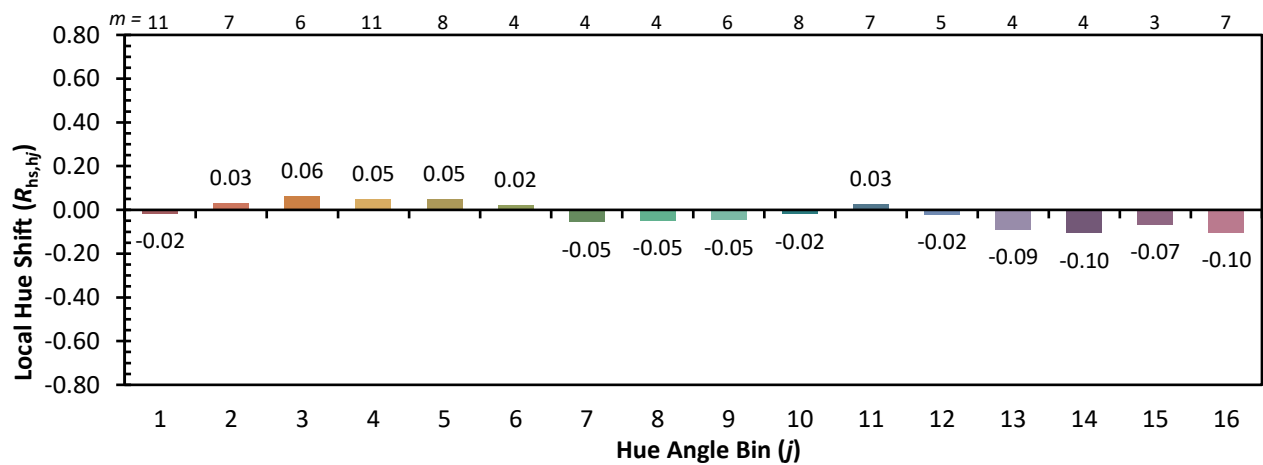
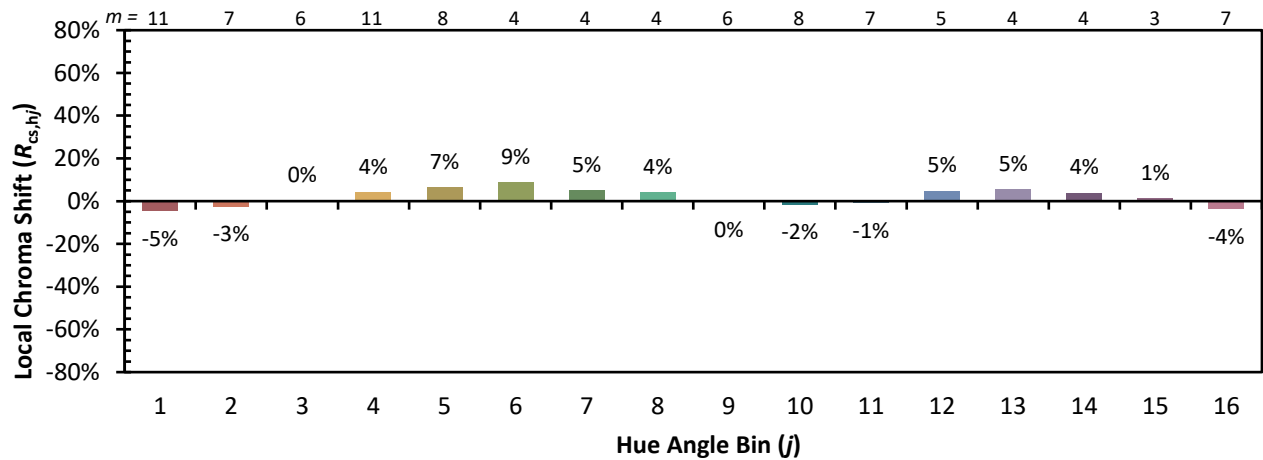


**Individual Sample Fidelity Index ( $R_{f,i}$ )**

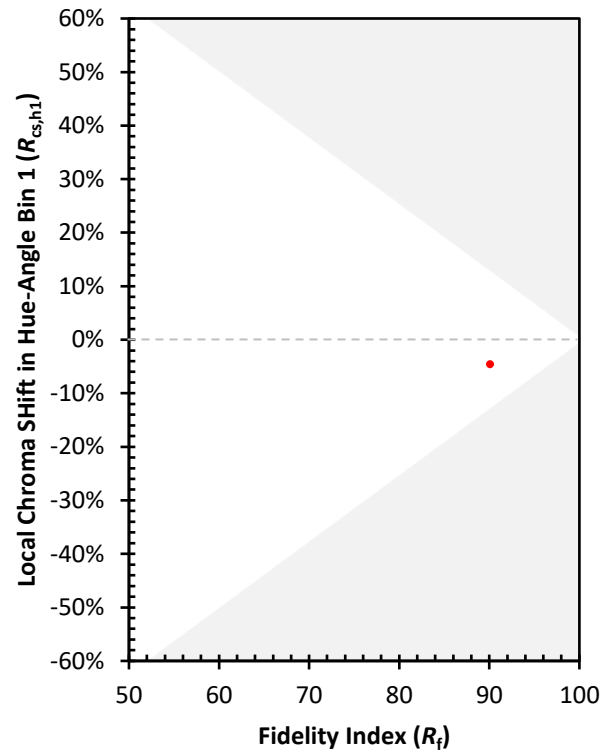
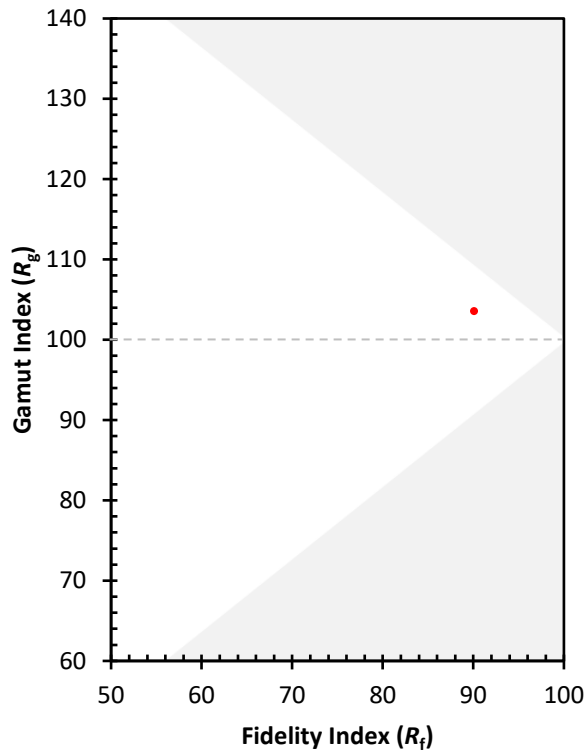
|            |            |            |            |
|------------|------------|------------|------------|
| CES01 = 86 | CES26 = 89 | CES51 = 92 | CES76 = 90 |
| CES02 = 64 | CES27 = 97 | CES52 = 92 | CES77 = 84 |
| CES03 = 32 | CES28 = 96 | CES53 = 88 | CES78 = 87 |
| CES04 = 71 | CES29 = 83 | CES54 = 97 | CES79 = 88 |
| CES05 = 51 | CES30 = 85 | CES55 = 95 | CES80 = 91 |
| CES06 = 51 | CES31 = 85 | CES56 = 89 | CES81 = 69 |
| CES07 = 44 | CES32 = 80 | CES57 = 87 | CES82 = 95 |
| CES08 = 43 | CES33 = 84 | CES58 = 88 | CES83 = 91 |
| CES09 = 29 | CES34 = 91 | CES59 = 98 | CES84 = 97 |
| CES10 = 77 | CES35 = 96 | CES60 = 99 | CES85 = 81 |
| CES11 = 59 | CES36 = 98 | CES61 = 99 | CES86 = 75 |
| CES12 = 66 | CES37 = 93 | CES62 = 91 | CES87 = 91 |
| CES13 = 45 | CES38 = 89 | CES63 = 90 | CES88 = 94 |
| CES14 = 74 | CES39 = 95 | CES64 = 93 | CES89 = 80 |
| CES15 = 72 | CES40 = 91 | CES65 = 92 | CES90 = 93 |
| CES16 = 48 | CES41 = 89 | CES66 = 92 | CES91 = 91 |
| CES17 = 50 | CES42 = 89 | CES67 = 93 | CES92 = 80 |
| CES18 = 57 | CES43 = 85 | CES68 = 97 | CES93 = 88 |
| CES19 = 72 | CES44 = 98 | CES69 = 98 | CES94 = 72 |
| CES20 = 68 | CES45 = 90 | CES70 = 93 | CES95 = 88 |
| CES21 = 87 | CES46 = 89 | CES71 = 95 | CES96 = 92 |
| CES22 = 79 | CES47 = 79 | CES72 = 98 | CES97 = 90 |
| CES23 = 92 | CES48 = 87 | CES73 = 89 | CES98 = 91 |
| CES24 = 91 | CES49 = 87 | CES74 = 88 | CES99 = 92 |
| CES25 = 72 | CES50 = 92 | CES75 = 94 |            |



Color Rendition by Hue-Angle Bin



**Measure Comparisons**



(END OF REPORT)