

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: P1357026

Luminaire Tested: 3ASL4-20HE-2-35-UNV

Issue Date: 2/17/2026

**Test Information**

Test Method: LM-79-2019  
Report Number: P1357026  
TEST IS SCALED FROM IESNA LM-79-08 TEST DATA (G2-2511-597-7)  
Test Lab: INNOVATION CENTER  
Issue Date: 2/17/2026  
Manufacturer: COOPER LIGHTING SOLUTIONS  
Product Line: FAIL-SAFE  
Catalog Number: 3ASL4-20HE-2-35-UNV  
Description: 3FT 2000 LUMEN PER FOOT 4ASL LED LUMINAIRE WITH OPL LENS AND 3500K LEDS 2 ROW  
Light Source: -  
Ballast/Driver: -

**Summary**

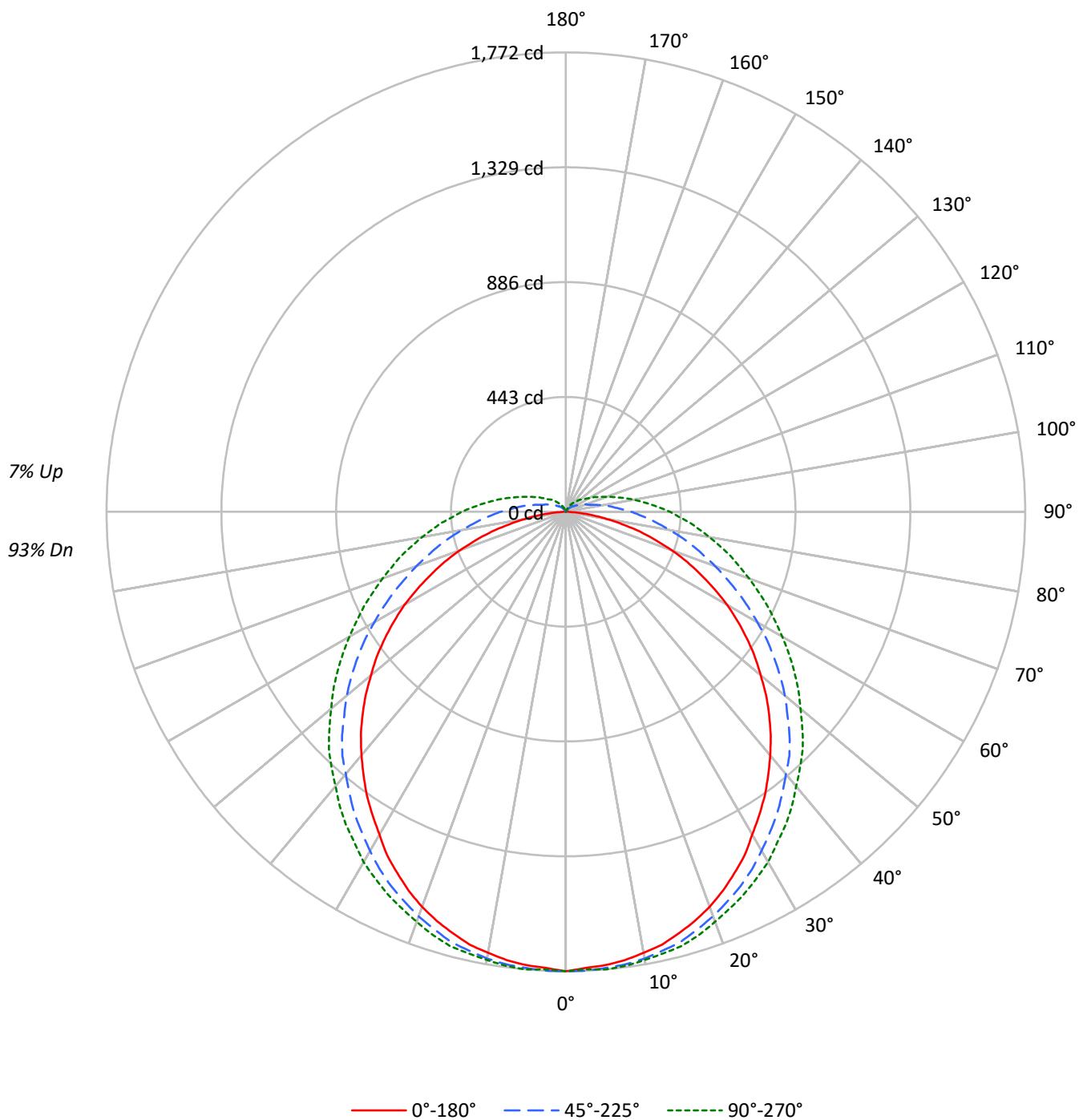
Lumens per Lamp: N/A  
Luminaire Lumens: 6084.0 lumens  
Efficiency: N/A  
Efficacy: 113.3 lumens/watt  
Spacing Criteria (0/90/45): 1.21 / 1.3 / 1.4  
Luminous Opening: Rectangular w/ Sides (W: 0.33' x L: 2.98' x H: 0.1')  
CIE Type: Direct

Input Watts (W): 53.7  
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: 3ASL4-20HE-2-35-UNV

### Luminous Intensity Polar Plot



TEST NUMBER: P1357026

CATALOG NUMBER: 3ASL4-20HE-2-35-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 | 50 | 30 | 10 |
| RCR |     |     |     |     |     |     |     |     |     |     |     |     |     |     |    |    |    |    |    |    |
| 0   | 117 | 117 | 117 | 117 | 114 | 114 | 114 | 114 | 107 | 107 | 107 | 101 | 101 | 101 | 95 | 95 | 95 | 95 | 95 | 93 |
| 1   | 105 | 100 | 95  | 90  | 102 | 97  | 92  | 88  | 91  | 87  | 84  | 86  | 83  | 80  | 81 | 79 | 77 | 77 | 77 | 74 |
| 2   | 95  | 86  | 79  | 72  | 92  | 84  | 77  | 71  | 79  | 73  | 68  | 74  | 70  | 65  | 70 | 66 | 63 | 63 | 63 | 60 |
| 3   | 86  | 75  | 66  | 59  | 83  | 73  | 65  | 58  | 69  | 62  | 56  | 65  | 59  | 55  | 62 | 57 | 53 | 53 | 53 | 50 |
| 4   | 79  | 66  | 57  | 50  | 76  | 64  | 56  | 49  | 61  | 54  | 48  | 58  | 51  | 46  | 55 | 49 | 45 | 45 | 45 | 42 |
| 5   | 72  | 59  | 50  | 43  | 70  | 57  | 49  | 42  | 54  | 47  | 41  | 52  | 45  | 40  | 49 | 43 | 39 | 39 | 39 | 36 |
| 6   | 67  | 53  | 44  | 37  | 64  | 52  | 43  | 37  | 49  | 41  | 36  | 47  | 40  | 35  | 44 | 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  | 34  | 29  | 41  | 33  | 28  | 39  | 32  | 28  | 37 | 31 | 27 | 27 | 27 | 25 |
| 9   | 54  | 40  | 32  | 26  | 52  | 39  | 31  | 26  | 37  | 30  | 25  | 36  | 29  | 25  | 34 | 29 | 24 | 24 | 24 | 22 |
| 10  | 50  | 37  | 29  | 24  | 49  | 36  | 28  | 23  | 35  | 28  | 23  | 33  | 27  | 22  | 32 | 26 | 22 | 22 | 22 | 20 |

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

|     | 0°    | 45°   | 90°   |
|-----|-------|-------|-------|
| 0°  | 19209 | 19209 | 19209 |
| 5°  | 19043 | 18817 | 18770 |
| 10° | 18898 | 18461 | 18313 |
| 15° | 18711 | 18072 | 17947 |
| 20° | 18471 | 17584 | 17431 |
| 25° | 18100 | 17103 | 16987 |
| 30° | 17640 | 16555 | 16545 |
| 35° | 17275 | 16044 | 16033 |
| 40° | 16854 | 15494 | 15494 |
| 45° | 16426 | 15019 | 15100 |
| 50° | 15878 | 14392 | 14517 |
| 55° | 15348 | 13720 | 14054 |
| 60° | 14695 | 12967 | 13560 |
| 65° | 13695 | 12264 | 13179 |
| 70° | 12569 | 11598 | 12830 |
| 75° | 10943 | 11079 | 12713 |
| 80° | 8418  | 10609 | 12674 |
| 85° | 4949  | 10555 | 13038 |

**MAXIMUM LUMINANCE 45°-90°:**

Horizontal Angle: 0°

Vertical Angle: 45°

Luminance: 16426 cd/sqm

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**ZONAL LUMENS:**

| Zone      | Lumens | % Fixture |
|-----------|--------|-----------|
| 0°-10°    | 168.1  | 2.8       |
| 10°-20°   | 483.1  | 7.9       |
| 20°-30°   | 732.0  | 12.0      |
| 30°-40°   | 885.4  | 14.6      |
| 40°-50°   | 933.4  | 15.3      |
| 50°-60°   | 871.2  | 14.3      |
| 60°-70°   | 719.2  | 11.8      |
| 70°-80°   | 521.8  | 8.6       |
| 80°-90°   | 329.7  | 5.4       |
| 90°-100°  | 196.8  | 3.2       |
| 100°-110° | 112.8  | 1.9       |
| 110°-120° | 64.1   | 1.1       |
| 120°-130° | 36.5   | 0.6       |
| 130°-140° | 19.8   | 0.3       |
| 140°-150° | 8.7    | 0.1       |
| 150°-160° | 1.6    | 0.0       |
| 160°-170° | 0.0    | 0.0       |
| 170°-180° | 0.0    | 0.0       |
| 0°-30°    | 1383.2 | 22.7      |
| 0°-40°    | 2268.6 | 37.3      |
| 0°-60°    | 4073.1 | 66.9      |
| 0°-90°    | 5643.8 | 92.8      |
| 90°-120°  | 373.6  | 6.1       |
| 90°-150°  | 438.6  | 7.2       |
| 90°-180°  | 440.0  | 7.2       |
| 0°-180°   | 6084.0 | 100.0     |

**CANDELA DISTRIBUTION:**

|      | 0°   | 22.5° | 45°  | 67.5° | 90°  | Flux |
|------|------|-------|------|-------|------|------|
| 0°   | 1772 | 1772  | 1772 | 1772  | 1772 |      |
| 5°   | 1756 | 1772  | 1767 | 1767  | 1772 | 167  |
| 15°  | 1683 | 1705  | 1716 | 1722  | 1733 | 475  |
| 25°  | 1538 | 1560  | 1594 | 1616  | 1627 | 709  |
| 35°  | 1338 | 1371  | 1421 | 1460  | 1477 | 836  |
| 45°  | 1109 | 1154  | 1220 | 1271  | 1293 | 855  |
| 55°  | 853  | 903   | 981  | 1048  | 1076 | 762  |
| 65°  | 574  | 635   | 730  | 819   | 858  | 570  |
| 75°  | 295  | 373   | 507  | 613   | 658  | 311  |
| 85°  | 56   | 173   | 323  | 435   | 479  | 68   |
| 90°  | 0    | 106   | 251  | 357   | 401  | 2    |
| 95°  | 0    | 67    | 190  | 290   | 329  | 0    |
| 105° | 0    | 22    | 106  | 184   | 212  | 0    |
| 115° | 0    | 11    | 61   | 112   | 134  | 0    |
| 125° | 0    | 6     | 39   | 72    | 84   | 0    |
| 135° | 0    | 0     | 22   | 45    | 56   | 0    |
| 145° | 0    | 0     | 11   | 28    | 33   | 0    |
| 155° | 0    | 0     | 0    | 6     | 11   | 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°     | 1772.2 | 1772.2 | 1772.2 | 1772.2 | 1772.2 |
| 2.5°   | 1761.1 | 1777.8 | 1772.2 | 1766.6 | 1766.6 |
| 5°     | 1755.5 | 1772.2 | 1766.6 | 1766.6 | 1772.2 |
| 7.5°   | 1744.3 | 1761.1 | 1761.1 | 1761.1 | 1766.6 |
| 10°    | 1727.6 | 1749.9 | 1749.9 | 1749.9 | 1755.5 |
| 12.5°  | 1710.9 | 1727.6 | 1733.2 | 1738.8 | 1744.3 |
| 15°    | 1683.0 | 1705.3 | 1716.5 | 1722.0 | 1733.2 |
| 17.5°  | 1655.2 | 1671.9 | 1688.6 | 1705.3 | 1710.9 |
| 20°    | 1621.7 | 1644.0 | 1660.7 | 1677.5 | 1683.0 |
| 22.5°  | 1582.7 | 1605.0 | 1627.3 | 1644.0 | 1655.2 |
| 25°    | 1538.1 | 1560.4 | 1593.9 | 1616.2 | 1627.3 |
| 27.5°  | 1493.6 | 1515.8 | 1554.9 | 1582.7 | 1593.9 |
| 30°    | 1437.8 | 1471.3 | 1510.3 | 1543.7 | 1560.4 |
| 32.5°  | 1387.7 | 1421.1 | 1465.7 | 1504.7 | 1515.8 |
| 35°    | 1337.5 | 1371.0 | 1421.1 | 1460.1 | 1476.8 |
| 37.5°  | 1281.8 | 1320.8 | 1371.0 | 1415.5 | 1432.3 |
| 40°    | 1226.1 | 1265.1 | 1320.8 | 1371.0 | 1382.1 |
| 42.5°  | 1170.3 | 1209.3 | 1276.2 | 1320.8 | 1337.5 |
| 45°    | 1109.0 | 1153.6 | 1220.5 | 1270.6 | 1292.9 |
| 47.5°  | 1047.7 | 1092.3 | 1159.2 | 1214.9 | 1237.2 |
| 50°    | 980.8  | 1031.0 | 1103.4 | 1159.2 | 1181.5 |
| 52.5°  | 919.5  | 969.7  | 1042.1 | 1103.4 | 1131.3 |
| 55°    | 852.7  | 902.8  | 980.8  | 1047.7 | 1075.6 |
| 57.5°  | 785.8  | 835.9  | 919.5  | 992.0  | 1019.9 |
| 60°    | 718.9  | 769.1  | 852.7  | 936.3  | 964.1  |
| 62.5°  | 646.5  | 702.2  | 791.4  | 875.0  | 908.4  |
| 65°    | 574.0  | 635.3  | 730.1  | 819.2  | 858.2  |
| 67.5°  | 507.1  | 568.4  | 668.8  | 769.1  | 802.5  |
| 70°    | 434.7  | 501.6  | 613.0  | 713.3  | 752.4  |
| 72.5°  | 362.2  | 434.7  | 557.3  | 663.2  | 702.2  |
| 75°    | 295.4  | 373.4  | 507.1  | 613.0  | 657.6  |
| 77.5°  | 222.9  | 317.7  | 457.0  | 568.4  | 607.5  |
| 80°    | 161.6  | 261.9  | 406.8  | 523.9  | 562.9  |
| 82.5°  | 105.9  | 211.8  | 362.2  | 479.3  | 518.3  |
| 85°    | 55.7   | 172.8  | 323.2  | 434.7  | 479.3  |
| 87.5°  | 16.7   | 133.8  | 284.2  | 395.7  | 434.7  |
| 90°    | 0.0    | 105.9  | 250.8  | 356.7  | 401.3  |
| 92.5°  | 0.0    | 83.6   | 217.3  | 323.2  | 362.2  |
| 95°    | 0.0    | 66.9   | 189.5  | 289.8  | 328.8  |
| 97.5°  | 0.0    | 55.7   | 167.2  | 261.9  | 295.4  |
| 100°   | 0.0    | 44.6   | 144.9  | 234.1  | 267.5  |
| 102.5° | 0.0    | 33.4   | 122.6  | 206.2  | 239.6  |
| 105°   | 0.0    | 22.3   | 105.9  | 183.9  | 211.8  |
| 107.5° | 0.0    | 16.7   | 89.2   | 161.6  | 189.5  |
| 110°   | 0.0    | 16.7   | 83.6   | 139.3  | 167.2  |

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**CANDELA DISTRIBUTION (continued):**

|        | 0°  | 22.5° | 45°  | 67.5° | 90°   |
|--------|-----|-------|------|-------|-------|
| 112.5° | 0.0 | 11.1  | 72.4 | 128.2 | 150.5 |
| 115°   | 0.0 | 11.1  | 61.3 | 111.5 | 133.8 |
| 117.5° | 0.0 | 11.1  | 55.7 | 100.3 | 122.6 |
| 120°   | 0.0 | 11.1  | 50.2 | 89.2  | 105.9 |
| 122.5° | 0.0 | 5.6   | 44.6 | 78.0  | 94.7  |
| 125°   | 0.0 | 5.6   | 39.0 | 72.4  | 83.6  |
| 127.5° | 0.0 | 5.6   | 33.4 | 66.9  | 78.0  |
| 130°   | 0.0 | 5.6   | 33.4 | 61.3  | 72.4  |
| 132.5° | 0.0 | 0.0   | 27.9 | 55.7  | 66.9  |
| 135°   | 0.0 | 0.0   | 22.3 | 44.6  | 55.7  |
| 137.5° | 0.0 | 0.0   | 22.3 | 39.0  | 50.2  |
| 140°   | 0.0 | 0.0   | 16.7 | 39.0  | 44.6  |
| 142.5° | 0.0 | 0.0   | 11.1 | 33.4  | 39.0  |
| 145°   | 0.0 | 0.0   | 11.1 | 27.9  | 33.4  |
| 147.5° | 0.0 | 0.0   | 5.6  | 22.3  | 27.9  |
| 150°   | 0.0 | 0.0   | 5.6  | 16.7  | 22.3  |
| 152.5° | 0.0 | 0.0   | 0.0  | 11.1  | 16.7  |
| 155°   | 0.0 | 0.0   | 0.0  | 5.6   | 11.1  |
| 157.5° | 0.0 | 0.0   | 0.0  | 0.0   | 5.6   |
| 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   |

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**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 | 19.57            | 21.10 | 20.04 | 21.57 | 22.06 | 21.60          | 23.14 | 22.07 | 23.60 | 24.09 |
|                 | 3H   | 21.07            | 22.47 | 21.56 | 22.94 | 23.47 | 24.04          | 25.44 | 24.53 | 25.91 | 26.44 |
|                 | 4H   | 21.55            | 22.88 | 22.06 | 23.37 | 23.91 | 25.24          | 26.57 | 25.75 | 27.05 | 27.60 |
|                 | 6H   | 21.83            | 23.07 | 22.35 | 23.57 | 24.13 | 26.49          | 27.73 | 27.01 | 28.23 | 28.79 |
|                 | 8H   | 21.88            | 23.07 | 22.41 | 23.59 | 24.16 | 27.14          | 28.32 | 27.67 | 28.85 | 29.41 |
|                 | 12H  | 21.90            | 23.03 | 22.44 | 23.55 | 24.15 | 27.85          | 28.98 | 28.38 | 29.50 | 30.10 |
| 4H              | 2H   | 20.44            | 21.77 | 20.95 | 22.26 | 22.80 | 22.03          | 23.36 | 22.54 | 23.85 | 24.39 |
|                 | 3H   | 22.19            | 23.32 | 22.71 | 23.85 | 24.42 | 24.70          | 25.83 | 25.22 | 26.37 | 26.93 |
|                 | 4H   | 22.80            | 23.83 | 23.33 | 24.37 | 24.97 | 26.08          | 27.11 | 26.62 | 27.65 | 28.25 |
|                 | 6H   | 23.20            | 24.11 | 23.76 | 24.68 | 25.29 | 27.53          | 28.44 | 28.09 | 29.01 | 29.62 |
|                 | 8H   | 23.30            | 24.16 | 23.86 | 24.72 | 25.35 | 28.28          | 29.14 | 28.85 | 29.71 | 30.34 |
|                 | 12H  | 23.34            | 24.13 | 23.93 | 24.72 | 25.35 | 29.11          | 29.90 | 29.70 | 30.49 | 31.12 |
| 8H              | 4H   | 23.48            | 24.35 | 24.05 | 24.91 | 25.54 | 26.30          | 27.16 | 26.86 | 27.73 | 28.35 |
|                 | 6H   | 24.07            | 24.80 | 24.67 | 25.41 | 26.04 | 27.93          | 28.66 | 28.52 | 29.26 | 29.90 |
|                 | 8H   | 24.26            | 24.92 | 24.87 | 25.54 | 26.18 | 28.82          | 29.48 | 29.43 | 30.10 | 30.75 |
|                 | 12H  | 24.38            | 24.97 | 24.99 | 25.58 | 26.29 | 29.84          | 30.43 | 30.45 | 31.04 | 31.75 |
| 12H             | 4H   | 23.68            | 24.46 | 24.27 | 25.06 | 25.69 | 26.31          | 27.09 | 26.89 | 27.68 | 28.32 |
|                 | 6H   | 24.37            | 25.03 | 24.98 | 25.65 | 26.29 | 27.96          | 28.63 | 28.57 | 29.24 | 29.89 |
|                 | 8H   | 24.66            | 25.25 | 25.27 | 25.86 | 26.57 | 28.93          | 29.52 | 29.54 | 30.13 | 30.84 |



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

Report Prepared for

Cooper Lighting Solutions

Fail-Safe

Report Number: SP1-2511-597-1

Test Date: 11/17/2025

Luminaire Tested: 4ASL-2-35-UNV-OPL-1\_600mA

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

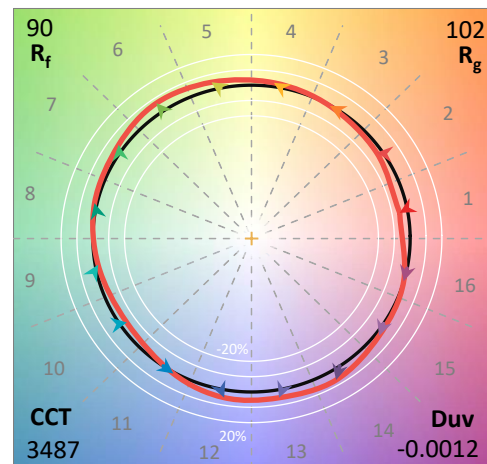
### Test Information

Test Method: LM-79-2019  
 Report Number: SP1-2511-597-1  
 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-2-35-UNV-OPL-1\_600mA**  
 Description: 2foot 4ASL LED LUMINAIRE WITH OPL LENS AND 3500K LEDS with 1 rows at 600mA

### Spectral Parameters

CCT (K): 3487  
 CIE  $u'$ : 0.2366  
 CIE  $v'$ : 0.5099  
 Duv: -0.0012  
 CIE x: 0.4047  
 CIE y: 0.3876  
 CIE z: 0.2077  
 Peak Wavelength (nm): 630  
 Dominant Wavelength (nm): 581  
 Purity: 37.79273  
 R<sub>f</sub>: 90  
 R<sub>g</sub>: 102.4

CRI (Ra): 92.5  
 R1: 94.7  
 R2: 94.3  
 R3: 92.9  
 R4: 93.3  
 R5: 93.9  
 R6: 93.4  
 R7: 92.5  
 R8: 85.2  
 R9: 61.3  
 R10: 85.5  
 R11: 93.7  
 R12: 80.8  
 R13: 94.3  
 R14: 95.1  
 R15: 90.9



### Test Conditions

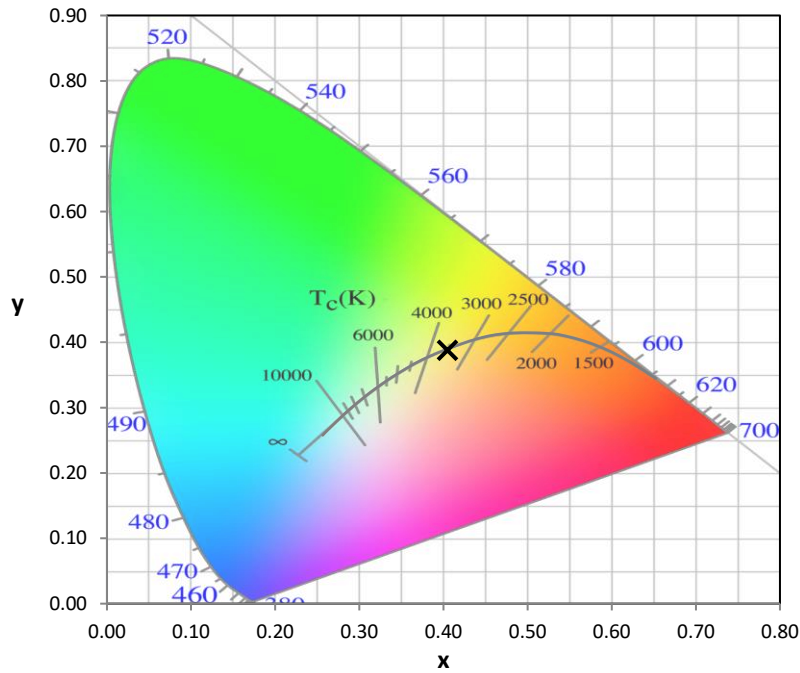
Stabilization Time: 31M  
 Operation Time: 1H 31M  
 Sphere Temperature (°C): 24.1

REPORT NUMBER: SP1-2511-597-1

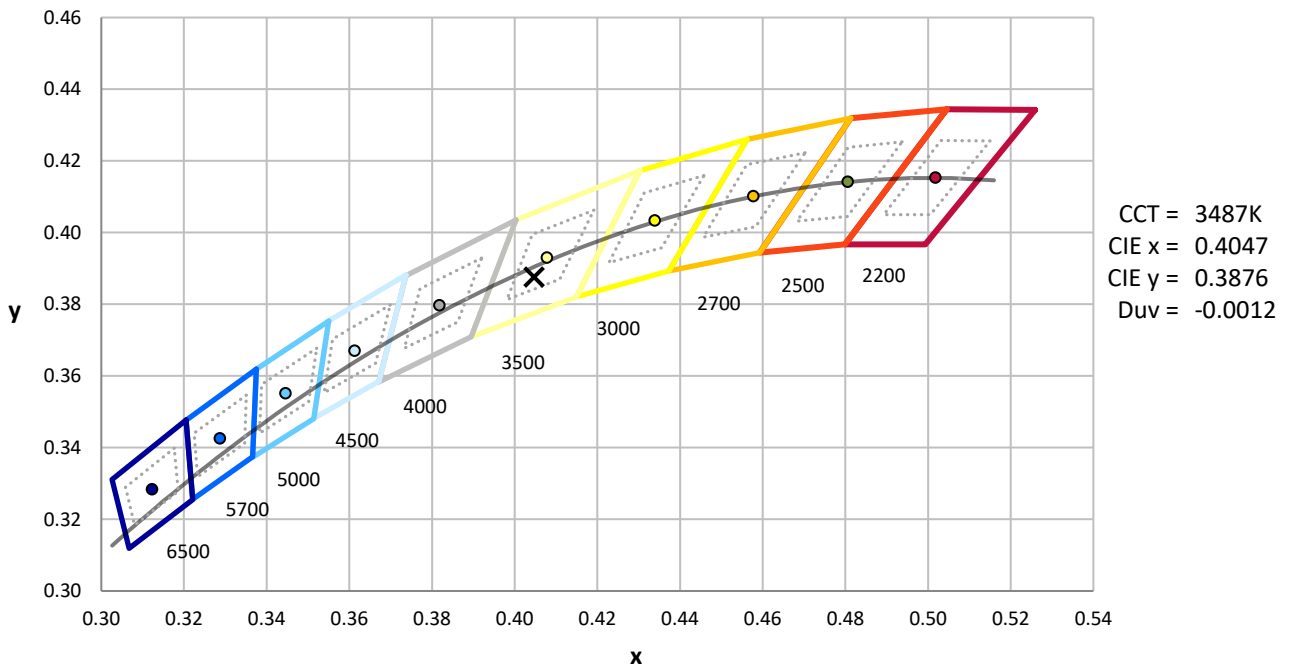
| Measurement and Test Equipment |                       |                  |                      |
|--------------------------------|-----------------------|------------------|----------------------|
| Instrument                     | Identification Number | Calibration Date | Calibration Due Date |
| 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: SP1-2511-597-1

**CIE 1931 Chromaticity Diagram**



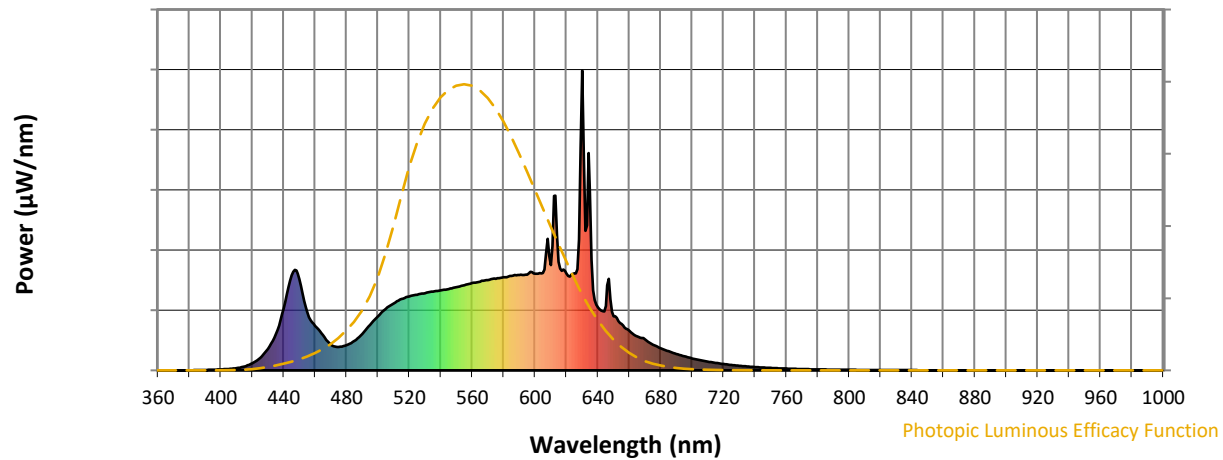
**CIE 1931 Chromaticity Diagram with 2017 ANSI 7-Step and 4-Step Quadrangles**



Point lies inside the ANSI 3500K 4-step quadrangle

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### Photopic Flux vs. Wavelength

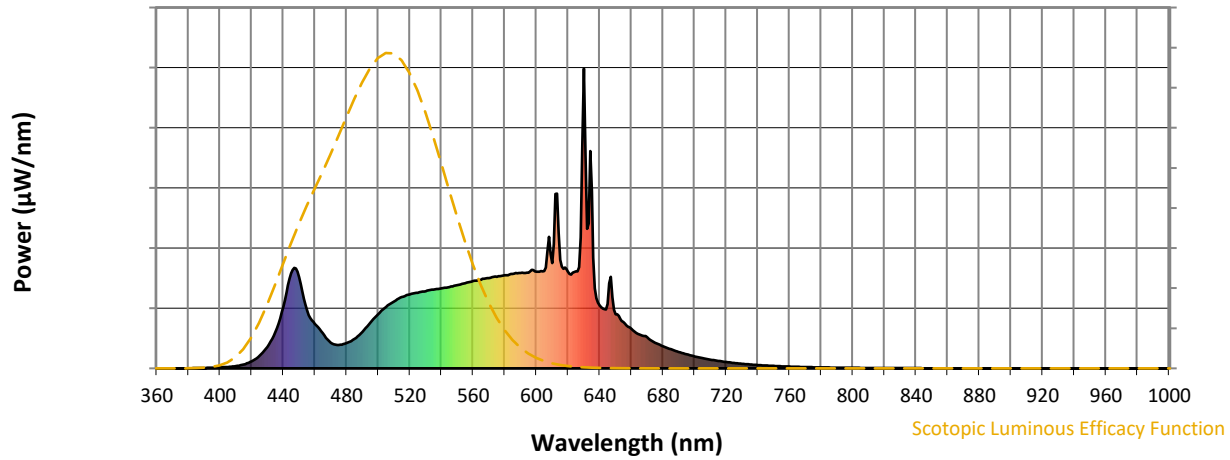


### Photopic Lumens: NR

| 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       | 122                         | NR               | 620       | 322                         | NR               | 750       | 8                           | NR               | 880       | 0                           | NR               |
| 365       | 0                           | NR               | 495       | 152                         | NR               | 625       | 323                         | NR               | 755       | 7                           | NR               | 885       | 0                           | NR               |
| 370       | 0                           | NR               | 500       | 180                         | NR               | 630       | 1000                        | NR               | 760       | 6                           | NR               | 890       | 0                           | NR               |
| 375       | 0                           | NR               | 505       | 205                         | NR               | 635       | 589                         | NR               | 765       | 5                           | NR               | 895       | 0                           | NR               |
| 380       | 0                           | NR               | 510       | 223                         | NR               | 640       | 210                         | NR               | 770       | 4                           | NR               | 900       | 0                           | NR               |
| 385       | 1                           | NR               | 515       | 238                         | NR               | 645       | 214                         | NR               | 775       | 4                           | NR               | 905       | 0                           | NR               |
| 390       | 1                           | NR               | 520       | 247                         | NR               | 650       | 181                         | NR               | 780       | 3                           | NR               | 910       | 0                           | NR               |
| 395       | 2                           | NR               | 525       | 252                         | NR               | 655       | 155                         | NR               | 785       | 3                           | NR               | 915       | 0                           | NR               |
| 400       | 3                           | NR               | 530       | 258                         | NR               | 660       | 133                         | NR               | 790       | 2                           | NR               | 920       | 0                           | NR               |
| 405       | 5                           | NR               | 535       | 262                         | NR               | 665       | 113                         | NR               | 795       | 2                           | NR               | 925       | 0                           | NR               |
| 410       | 7                           | NR               | 540       | 267                         | NR               | 670       | 104                         | NR               | 800       | 2                           | NR               | 930       | 0                           | NR               |
| 415       | 13                          | NR               | 545       | 271                         | NR               | 675       | 86                          | NR               | 805       | 2                           | NR               | 935       | 0                           | NR               |
| 420       | 24                          | NR               | 550       | 277                         | NR               | 680       | 74                          | NR               | 810       | 1                           | NR               | 940       | 0                           | NR               |
| 425       | 42                          | NR               | 555       | 284                         | NR               | 685       | 64                          | NR               | 815       | 1                           | NR               | 945       | 0                           | NR               |
| 430       | 72                          | NR               | 560       | 291                         | NR               | 690       | 55                          | NR               | 820       | 1                           | NR               | 950       | 0                           | NR               |
| 435       | 122                         | NR               | 565       | 296                         | NR               | 695       | 47                          | NR               | 825       | 1                           | NR               | 955       | 0                           | NR               |
| 440       | 207                         | NR               | 570       | 301                         | NR               | 700       | 40                          | NR               | 830       | 1                           | NR               | 960       | 0                           | NR               |
| 445       | 317                         | NR               | 575       | 306                         | NR               | 705       | 34                          | NR               | 835       | 1                           | NR               | 965       | 0                           | NR               |
| 450       | 304                         | NR               | 580       | 310                         | NR               | 710       | 29                          | NR               | 840       | 1                           | NR               | 970       | 0                           | NR               |
| 455       | 193                         | NR               | 585       | 315                         | NR               | 715       | 25                          | NR               | 845       | 1                           | NR               | 975       | 0                           | NR               |
| 460       | 149                         | NR               | 590       | 318                         | NR               | 720       | 21                          | NR               | 850       | 0                           | NR               | 980       | 0                           | NR               |
| 465       | 117                         | NR               | 595       | 320                         | NR               | 725       | 18                          | NR               | 855       | 0                           | NR               | 985       | 0                           | NR               |
| 470       | 85                          | NR               | 600       | 322                         | NR               | 730       | 15                          | NR               | 860       | 0                           | NR               | 990       | 0                           | NR               |
| 475       | 78                          | NR               | 605       | 325                         | NR               | 735       | 13                          | NR               | 865       | 0                           | NR               | 995       | 0                           | NR               |
| 480       | 84                          | NR               | 610       | 351                         | NR               | 740       | 11                          | NR               | 870       | 0                           | NR               | 1000      | 0                           | NR               |
| 485       | 98                          | NR               | 615       | 362                         | NR               | 745       | 10                          | NR               | 875       | 0                           | NR               |           |                             |                  |

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### Scotopic Flux vs. Wavelength



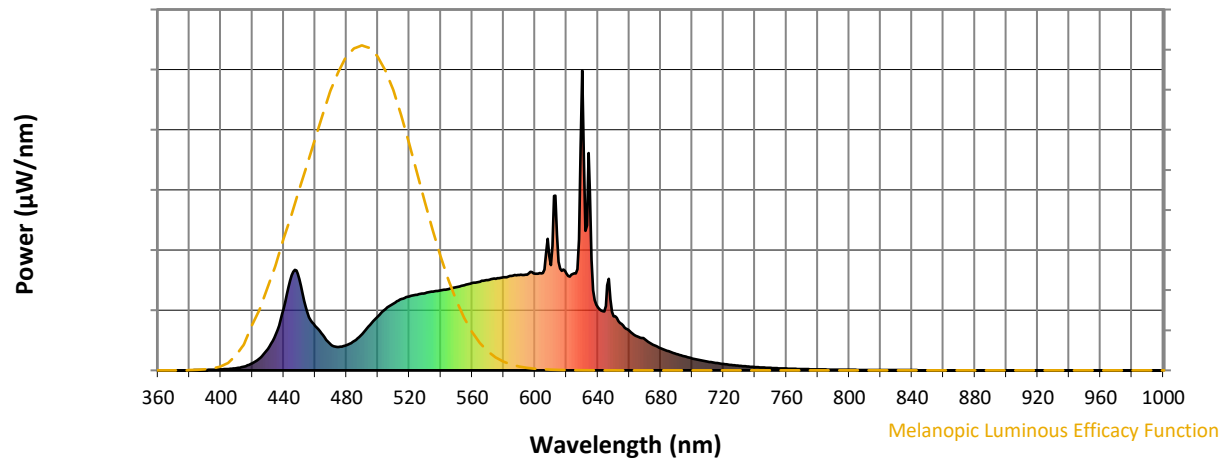
Scotopic Lumens: NR

S/P: 1.58

| $\lambda$<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               | 122                                  | NR                             | 620               | 322                                  | NR                             | 750               | 8                                    | NR                             | 880               | 0                                    | NR                             |
| 365               | 0                                    | NR                             | 495               | 152                                  | NR                             | 625               | 323                                  | NR                             | 755               | 7                                    | NR                             | 885               | 0                                    | NR                             |
| 370               | 0                                    | NR                             | 500               | 180                                  | NR                             | 630               | 1000                                 | NR                             | 760               | 6                                    | NR                             | 890               | 0                                    | NR                             |
| 375               | 0                                    | NR                             | 505               | 205                                  | NR                             | 635               | 589                                  | NR                             | 765               | 5                                    | NR                             | 895               | 0                                    | NR                             |
| 380               | 0                                    | NR                             | 510               | 223                                  | NR                             | 640               | 210                                  | NR                             | 770               | 4                                    | NR                             | 900               | 0                                    | NR                             |
| 385               | 1                                    | NR                             | 515               | 238                                  | NR                             | 645               | 214                                  | NR                             | 775               | 4                                    | NR                             | 905               | 0                                    | NR                             |
| 390               | 1                                    | NR                             | 520               | 247                                  | NR                             | 650               | 181                                  | NR                             | 780               | 3                                    | NR                             | 910               | 0                                    | NR                             |
| 395               | 2                                    | NR                             | 525               | 252                                  | NR                             | 655               | 155                                  | NR                             | 785               | 3                                    | NR                             | 915               | 0                                    | NR                             |
| 400               | 3                                    | NR                             | 530               | 258                                  | NR                             | 660               | 133                                  | NR                             | 790               | 2                                    | NR                             | 920               | 0                                    | NR                             |
| 405               | 5                                    | NR                             | 535               | 262                                  | NR                             | 665               | 113                                  | NR                             | 795               | 2                                    | NR                             | 925               | 0                                    | NR                             |
| 410               | 7                                    | NR                             | 540               | 267                                  | NR                             | 670               | 104                                  | NR                             | 800               | 2                                    | NR                             | 930               | 0                                    | NR                             |
| 415               | 13                                   | NR                             | 545               | 271                                  | NR                             | 675               | 86                                   | NR                             | 805               | 2                                    | NR                             | 935               | 0                                    | NR                             |
| 420               | 24                                   | NR                             | 550               | 277                                  | NR                             | 680               | 74                                   | NR                             | 810               | 1                                    | NR                             | 940               | 0                                    | NR                             |
| 425               | 42                                   | NR                             | 555               | 284                                  | NR                             | 685               | 64                                   | NR                             | 815               | 1                                    | NR                             | 945               | 0                                    | NR                             |
| 430               | 72                                   | NR                             | 560               | 291                                  | NR                             | 690               | 55                                   | NR                             | 820               | 1                                    | NR                             | 950               | 0                                    | NR                             |
| 435               | 122                                  | NR                             | 565               | 296                                  | NR                             | 695               | 47                                   | NR                             | 825               | 1                                    | NR                             | 955               | 0                                    | NR                             |
| 440               | 207                                  | NR                             | 570               | 301                                  | NR                             | 700               | 40                                   | NR                             | 830               | 1                                    | NR                             | 960               | 0                                    | NR                             |
| 445               | 317                                  | NR                             | 575               | 306                                  | NR                             | 705               | 34                                   | NR                             | 835               | 1                                    | NR                             | 965               | 0                                    | NR                             |
| 450               | 304                                  | NR                             | 580               | 310                                  | NR                             | 710               | 29                                   | NR                             | 840               | 1                                    | NR                             | 970               | 0                                    | NR                             |
| 455               | 193                                  | NR                             | 585               | 315                                  | NR                             | 715               | 25                                   | NR                             | 845               | 1                                    | NR                             | 975               | 0                                    | NR                             |
| 460               | 149                                  | NR                             | 590               | 318                                  | NR                             | 720               | 21                                   | NR                             | 850               | 0                                    | NR                             | 980               | 0                                    | NR                             |
| 465               | 117                                  | NR                             | 595               | 320                                  | NR                             | 725               | 18                                   | NR                             | 855               | 0                                    | NR                             | 985               | 0                                    | NR                             |
| 470               | 85                                   | NR                             | 600               | 322                                  | NR                             | 730               | 15                                   | NR                             | 860               | 0                                    | NR                             | 990               | 0                                    | NR                             |
| 475               | 78                                   | NR                             | 605               | 325                                  | NR                             | 735               | 13                                   | NR                             | 865               | 0                                    | NR                             | 995               | 0                                    | NR                             |
| 480               | 84                                   | NR                             | 610               | 351                                  | NR                             | 740               | 11                                   | NR                             | 870               | 0                                    | NR                             | 1000              | 0                                    | NR                             |
| 485               | 98                                   | NR                             | 615               | 362                                  | NR                             | 745               | 10                                   | NR                             | 875               | 0                                    | NR                             |                   |                                      |                                |

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### Melanopic Flux vs. Wavelength



Melanopic Lumens: NR

M/P: 3.15

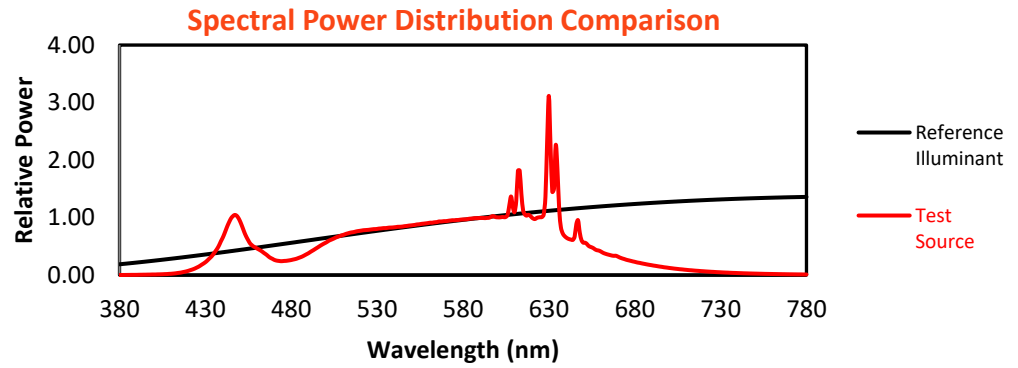
| λ<br>(nm) | Power<br>W <sup>^</sup> /nm | Lumens<br>(φ/nm) | λ<br>(nm) | Power<br>W <sup>^</sup> /nm | Lumens<br>(φ/nm) | λ<br>(nm) | Power<br>W <sup>^</sup> /nm | Lumens<br>(φ/nm) | λ<br>(nm) | Power<br>W <sup>^</sup> /nm | Lumens<br>(φ/nm) | λ<br>(nm) | Power<br>W <sup>^</sup> /nm | Lumens<br>(φ/nm) |
|-----------|-----------------------------|------------------|-----------|-----------------------------|------------------|-----------|-----------------------------|------------------|-----------|-----------------------------|------------------|-----------|-----------------------------|------------------|
| 360       | 0                           | NR               | 490       | 122                         | NR               | 620       | 322                         | NR               | 750       | 8                           | NR               | 880       | 0                           | NR               |
| 365       | 0                           | NR               | 495       | 152                         | NR               | 625       | 323                         | NR               | 755       | 7                           | NR               | 885       | 0                           | NR               |
| 370       | 0                           | NR               | 500       | 180                         | NR               | 630       | 1000                        | NR               | 760       | 6                           | NR               | 890       | 0                           | NR               |
| 375       | 0                           | NR               | 505       | 205                         | NR               | 635       | 589                         | NR               | 765       | 5                           | NR               | 895       | 0                           | NR               |
| 380       | 0                           | NR               | 510       | 223                         | NR               | 640       | 210                         | NR               | 770       | 4                           | NR               | 900       | 0                           | NR               |
| 385       | 1                           | NR               | 515       | 238                         | NR               | 645       | 214                         | NR               | 775       | 4                           | NR               | 905       | 0                           | NR               |
| 390       | 1                           | NR               | 520       | 247                         | NR               | 650       | 181                         | NR               | 780       | 3                           | NR               | 910       | 0                           | NR               |
| 395       | 2                           | NR               | 525       | 252                         | NR               | 655       | 155                         | NR               | 785       | 3                           | NR               | 915       | 0                           | NR               |
| 400       | 3                           | NR               | 530       | 258                         | NR               | 660       | 133                         | NR               | 790       | 2                           | NR               | 920       | 0                           | NR               |
| 405       | 5                           | NR               | 535       | 262                         | NR               | 665       | 113                         | NR               | 795       | 2                           | NR               | 925       | 0                           | NR               |
| 410       | 7                           | NR               | 540       | 267                         | NR               | 670       | 104                         | NR               | 800       | 2                           | NR               | 930       | 0                           | NR               |
| 415       | 13                          | NR               | 545       | 271                         | NR               | 675       | 86                          | NR               | 805       | 2                           | NR               | 935       | 0                           | NR               |
| 420       | 24                          | NR               | 550       | 277                         | NR               | 680       | 74                          | NR               | 810       | 1                           | NR               | 940       | 0                           | NR               |
| 425       | 42                          | NR               | 555       | 284                         | NR               | 685       | 64                          | NR               | 815       | 1                           | NR               | 945       | 0                           | NR               |
| 430       | 72                          | NR               | 560       | 291                         | NR               | 690       | 55                          | NR               | 820       | 1                           | NR               | 950       | 0                           | NR               |
| 435       | 122                         | NR               | 565       | 296                         | NR               | 695       | 47                          | NR               | 825       | 1                           | NR               | 955       | 0                           | NR               |
| 440       | 207                         | NR               | 570       | 301                         | NR               | 700       | 40                          | NR               | 830       | 1                           | NR               | 960       | 0                           | NR               |
| 445       | 317                         | NR               | 575       | 306                         | NR               | 705       | 34                          | NR               | 835       | 1                           | NR               | 965       | 0                           | NR               |
| 450       | 304                         | NR               | 580       | 310                         | NR               | 710       | 29                          | NR               | 840       | 1                           | NR               | 970       | 0                           | NR               |
| 455       | 193                         | NR               | 585       | 315                         | NR               | 715       | 25                          | NR               | 845       | 1                           | NR               | 975       | 0                           | NR               |
| 460       | 149                         | NR               | 590       | 318                         | NR               | 720       | 21                          | NR               | 850       | 0                           | NR               | 980       | 0                           | NR               |
| 465       | 117                         | NR               | 595       | 320                         | NR               | 725       | 18                          | NR               | 855       | 0                           | NR               | 985       | 0                           | NR               |
| 470       | 85                          | NR               | 600       | 322                         | NR               | 730       | 15                          | NR               | 860       | 0                           | NR               | 990       | 0                           | NR               |
| 475       | 78                          | NR               | 605       | 325                         | NR               | 735       | 13                          | NR               | 865       | 0                           | NR               | 995       | 0                           | NR               |
| 480       | 84                          | NR               | 610       | 351                         | NR               | 740       | 11                          | NR               | 870       | 0                           | NR               | 1000      | 0                           | NR               |
| 485       | 98                          | NR               | 615       | 362                         | NR               | 745       | 10                          | NR               | 875       | 0                           | NR               |           |                             |                  |

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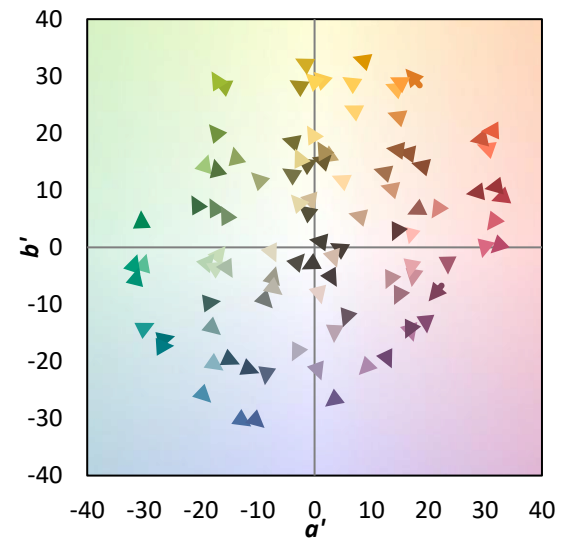
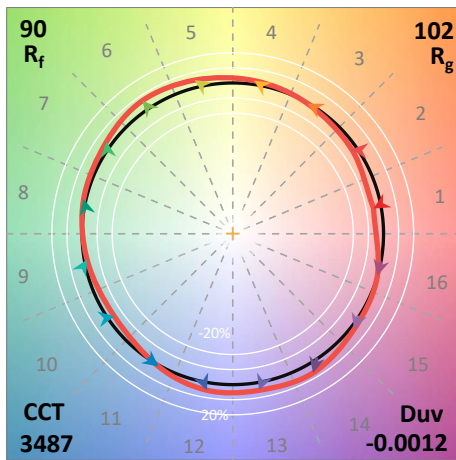
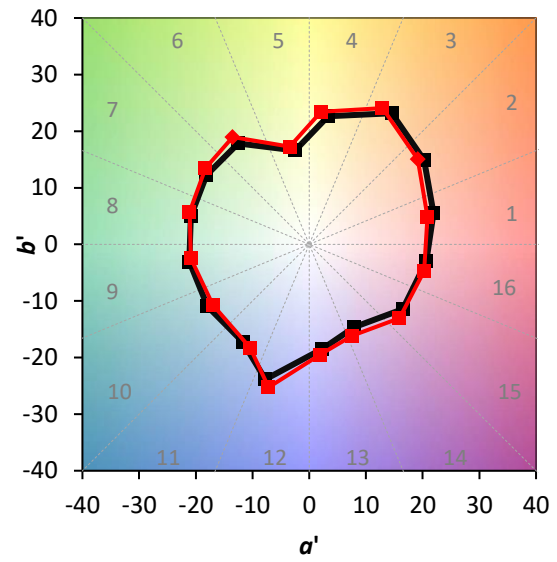
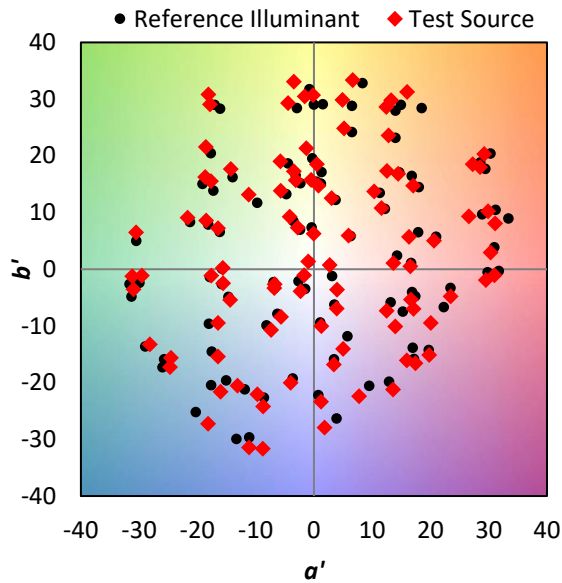
TM-30-18

### Summary

$R_f = 90$   
 $R_g = 102.4$   
 $CIE R_a = 92.5$   
 $R_9 = 61.3$



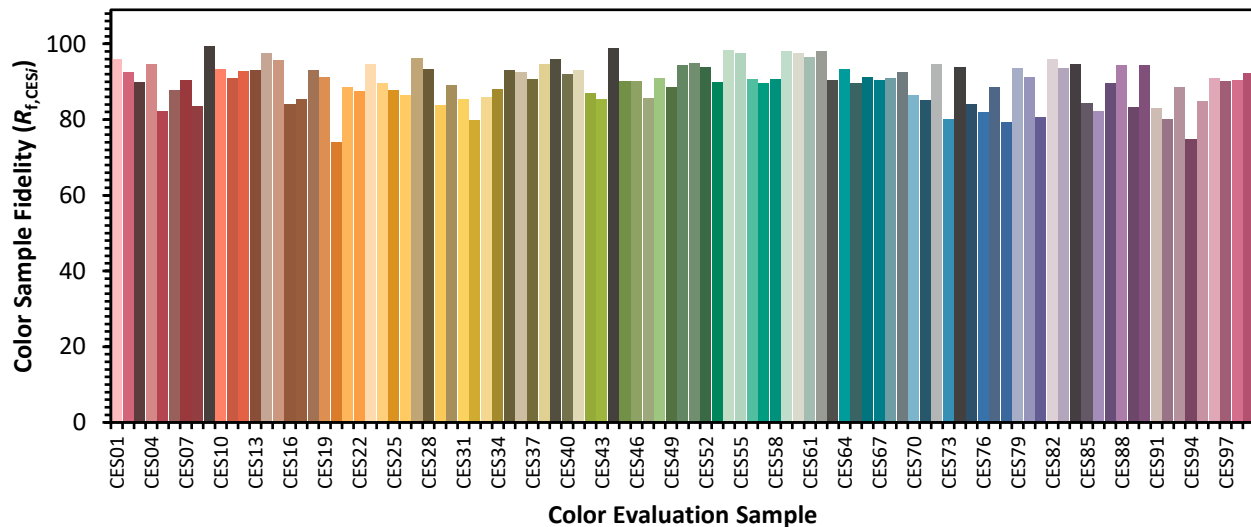
### Color Vector Graphics



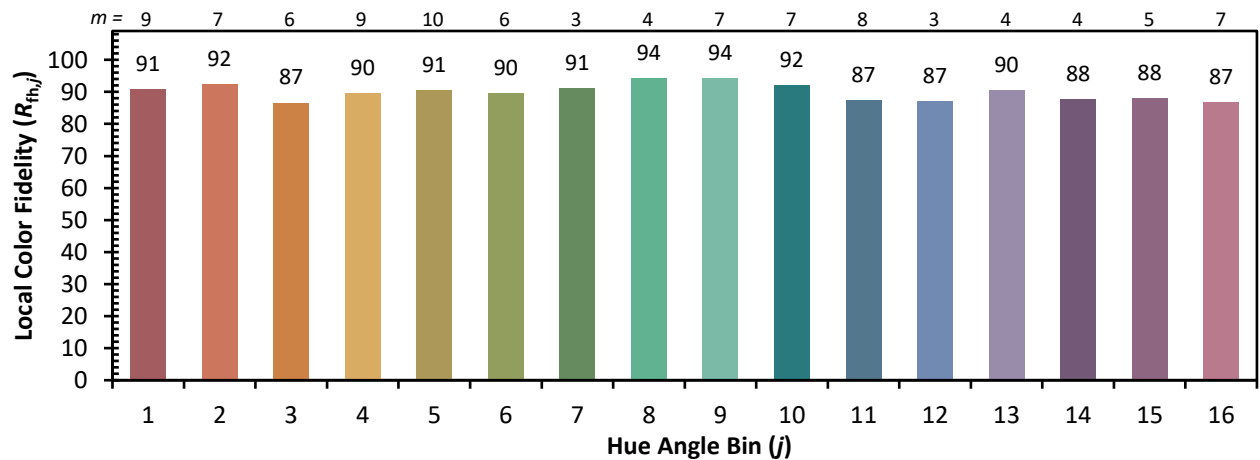
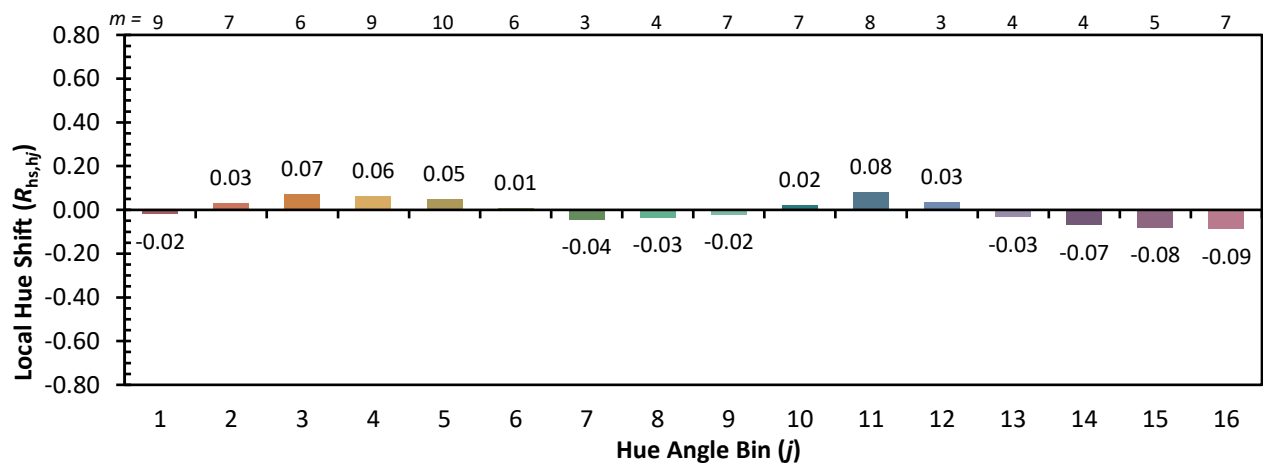
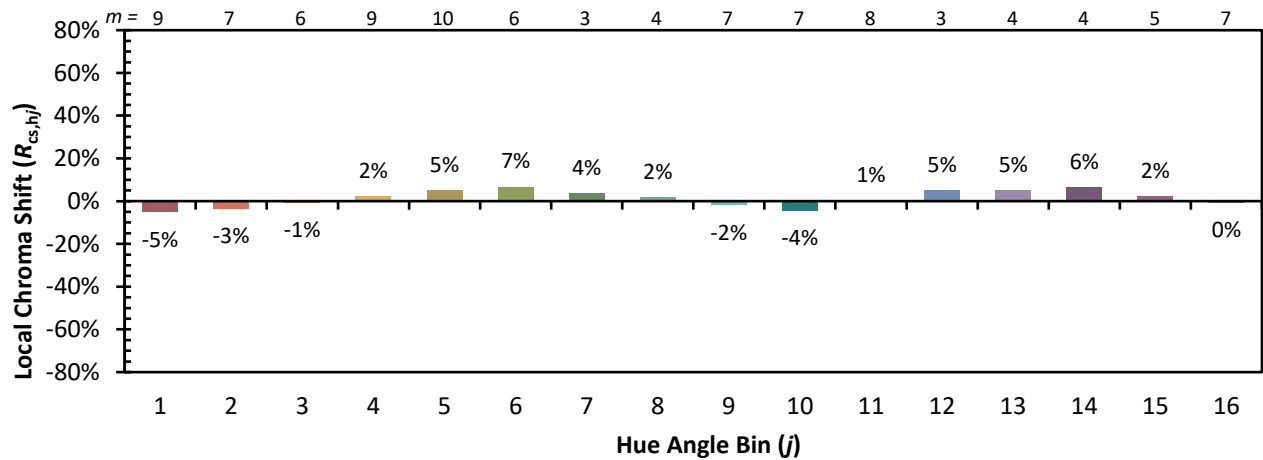


**Individual Sample Fidelity Index ( $R_{f,i}$ )**

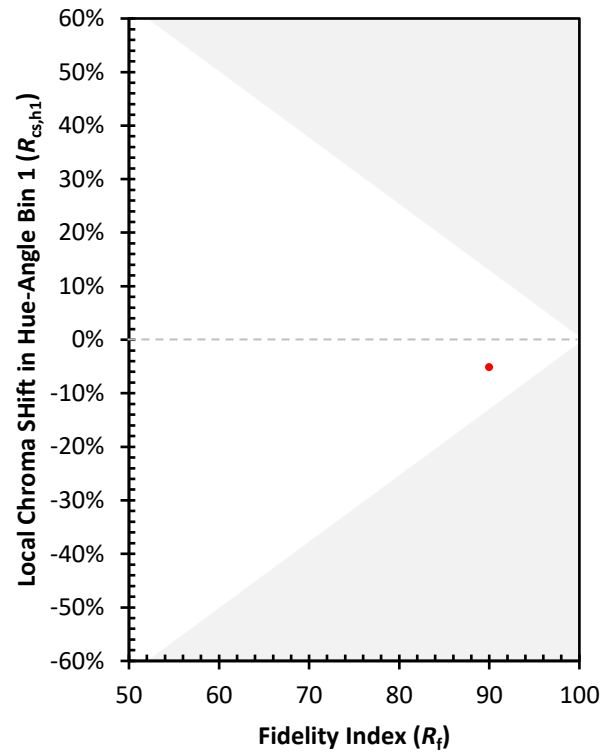
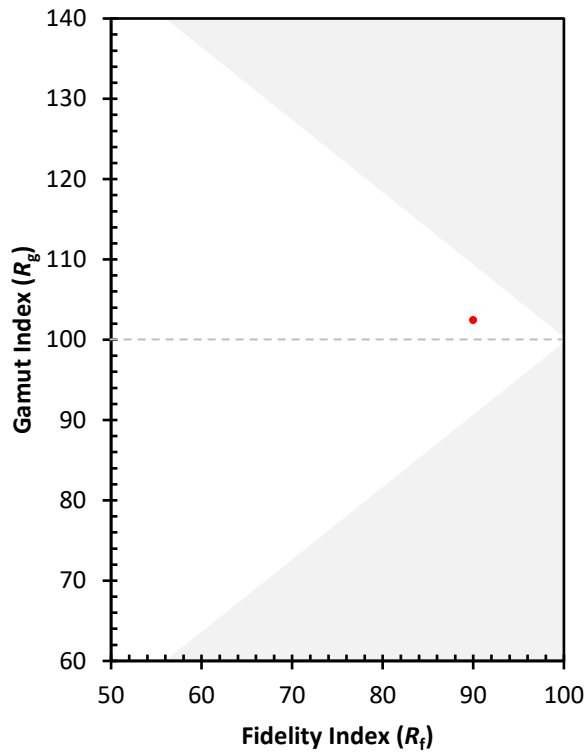
|            |            |            |            |
|------------|------------|------------|------------|
| CES01 = 86 | CES26 = 87 | CES51 = 95 | CES76 = 82 |
| CES02 = 62 | CES27 = 96 | CES52 = 94 | CES77 = 89 |
| CES03 = 31 | CES28 = 93 | CES53 = 90 | CES78 = 79 |
| CES04 = 70 | CES29 = 84 | CES54 = 98 | CES79 = 93 |
| CES05 = 50 | CES30 = 89 | CES55 = 97 | CES80 = 91 |
| CES06 = 51 | CES31 = 85 | CES56 = 91 | CES81 = 81 |
| CES07 = 43 | CES32 = 80 | CES57 = 90 | CES82 = 96 |
| CES08 = 41 | CES33 = 86 | CES58 = 91 | CES83 = 94 |
| CES09 = 29 | CES34 = 88 | CES59 = 98 | CES84 = 95 |
| CES10 = 75 | CES35 = 93 | CES60 = 97 | CES85 = 84 |
| CES11 = 58 | CES36 = 93 | CES61 = 96 | CES86 = 82 |
| CES12 = 64 | CES37 = 91 | CES62 = 98 | CES87 = 90 |
| CES13 = 43 | CES38 = 95 | CES63 = 91 | CES88 = 94 |
| CES14 = 74 | CES39 = 96 | CES64 = 93 | CES89 = 83 |
| CES15 = 71 | CES40 = 92 | CES65 = 90 | CES90 = 94 |
| CES16 = 47 | CES41 = 93 | CES66 = 91 | CES91 = 83 |
| CES17 = 49 | CES42 = 87 | CES67 = 91 | CES92 = 80 |
| CES18 = 56 | CES43 = 85 | CES68 = 91 | CES93 = 89 |
| CES19 = 71 | CES44 = 99 | CES69 = 93 | CES94 = 75 |
| CES20 = 66 | CES45 = 90 | CES70 = 87 | CES95 = 85 |
| CES21 = 86 | CES46 = 90 | CES71 = 85 | CES96 = 91 |
| CES22 = 78 | CES47 = 86 | CES72 = 95 | CES97 = 90 |
| CES23 = 91 | CES48 = 91 | CES73 = 80 | CES98 = 91 |
| CES24 = 90 | CES49 = 88 | CES74 = 94 | CES99 = 92 |
| CES25 = 71 | CES50 = 94 | CES75 = 84 |            |



Color Rendition by Hue-Angle Bin



**Measure Comparisons**



(END OF REPORT)