3933 US Rt 11
Cortland, NY, 13045
www.intertek.com

Issue Date:May 02, 2019
Project No. G103734065
Quote No.:Qu-00933407

Contact: Stella Su
Email: stella@nanhua.com
Phone No. 8602139126868-850

**Report No. 103734065CRT-001**

# Shanghai Nanhua Electronics Co., Ltd.

Building#9
1755 Wenbei Road, Jiading
Shanghai 201802 China

| Standards |
|---|
| *International Civil Aviation Organization (ICAO), Aerodromes, Annex 14, Volume 1, Eighth Edition, dated July 2018* |

| | |
|---|---|
| *Test Purpose* | Performance testing of a Medium Intensity Obstacle Light |
| *Test Dates* | November 28, 2018 through May 1, 2019 |

Christopher W. Metcalf
Engineering Supervisor
Lighting

Jeremy N. Downs, P.E.
Staff Engineer
Lighting

| Test Plan and Datasheets | | | |
|---|---|---|---|
| Client | Shanghai Nanhua Electronics Co., Ltd. | Engineer | Christopher W. Metcalf |
| Report # | 103734065CRT-001 | Reviewer | Jeremy N. Downs, P.E. |
| Product | Obstruction Light | Model(s) | LM403A |
| Standard | ICAO Annex 14, dated July 2018 | | |

| Spec | Test name | Clause | Pass Fail NA |
|---|---|---|---|
| ICAO | Photometry Medium Intensity Type A (White) | Table 6-3W | Pass |
| ICAO | Photometry Medium Intensity Type B (Red) | Table 6-3R | Pass |
| ICAO | Chromaticity ICAO App. 1 | 2.3.1 | Pass |
| ICAO | Photometry High Intensity Type A | Table 6-3A | NA |
| ICAO | Photometry High Intensity Type B | Table 6-3B | NA |
| ICAO | Chromaticity ICAO App. 1 | 2.3.1H | NA |
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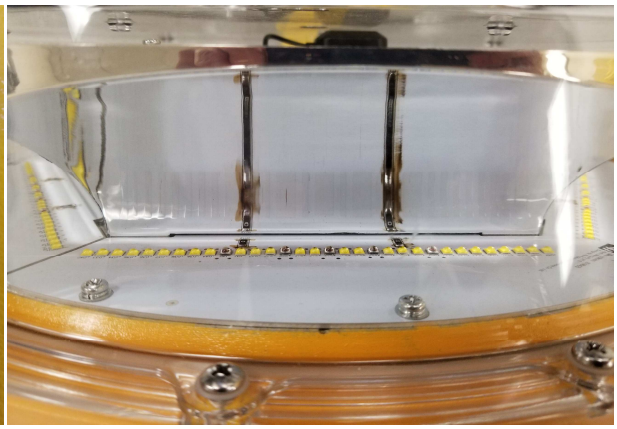
| Sample Information | | | | |
|---|---|---|---|---|
| **Date Rec.** | **Intertek ID** | **Description** | **Condition** | **Model No.** |
| 11/12/18 | CRT1811121319-002 | Medium Intensity Obstruction | Production | LM403A |
| 3/25/19 | CRT1903251300-002 | Medium Intensity Obstruction | Production | LM403A |
| | | | | |

| Further Sample Description | |
|---|---|
| Type: | A |
| Options: | None |
| Light Source: | white Osram P8 total 162pcs, red CREE XPE total 30pcs |
| Lens: | Polycarbonate, PC S3000UR |
| Approx Size: | Diameter: 17" Height: 9" |
| Electrical Input: | 220Vac |
| LED Supply Location: | In Flash Head |
| Cable: | NA |
| Min Cable Length: | NA |
| Max Cable Length: | NA |
| Casting Material: | Aluminum |
| Mounting: | (4) 11mm through holes |

| Sample Modification Log | |
|---|---|
| Date | Modification description |
| 3/26/19 | Changed the white LED chip bin number to correct color. |

**Picture(s)**

## Photometry Medium Intensity Type A (White)

Energize the light by the system power supply and control unit and test for compliance with the photometric requirements in Table 6-3. Vary the input voltage to the light ± 10% from nominal voltage and measure the effective intensity at the input extremes. Make the effective intensity measurements using an integrating photometer whose calibration is traceable to an NIST steady state source. The test distance is 100 feet. The horizontal beam spread is 360 degrees.

### Results

**ICAO Medium-Intensity, Type A (White Day) - 30FPM**

| Flash / Min. Variation | Voltage | Position | Measured | Factor |
|---|---|---|---|---|
| 20 | 220.0 | (0, 0) | 26200 | 101% |
| 30 | | | 25900 | NA* |
| 40 | | | 26100 | 101% |
| 60 | | | 25800 | 100% |

flash energy measurements are relative  * Test flash rate

**Table 6-3 Minimum Requirements**

| Mode | Parameter | Requirement | Measured | | Result |
|---|---|---|---|---|---|
| White Day | Flash Rate (FPM) | 20-60 FPM | 30.0 | FPM | Pass |
| | Min. Avg. Intensity | 20,000 cd at 0° | 24343 | cd | Pass |
| | Min. Peak Intensity | 15,000 cd at 0° | 23643 | cd | Pass |
| | Min. Peak Intensity | 7,500 cd at -1° | 15649 | cd | Pass |
| | Beam Spread | ≥3° at each vertical slice (min 7,500cd) | 4 | degrees | Pass |

**Table 6-3 Recommendations**

| Mode | Parameter | Requirement | Measured | | Result |
|---|---|---|---|---|---|
| White Day | Max. Intensity | 25,000 cd at 0° | 25472 | cd | Fail |
| | Max. Intensity | 11,250 cd at -1° | 21611 | cd | Fail |
| | Max. Intensity | 750 cd at -10° | 206 | cd | Pass |

| | | | | | Minimum Cable Length | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Voltage Variation | Voltage | Position | Measured | Factor | Min. Avg. Int. 20,000cd @ 0° | | | Min. Peak Int. 15,000cd @ 0° | | |
| Input Voltage | 220.1 | 0, 0 | 37200 | NA | 24343 | cd | Result | 23643 | cd | Result |
| Input Voltage +10% | 242.0 | 0, 0 | 37200 | 100% | 24343 | cd | Pass | 23643 | cd | Pass |
| Input Voltage -10% | 198.3 | 0, 0 | 37200 | 100% | 24343 | cd | Pass | 23643 | cd | Pass |

Cable Length (ft.): NA
Flash Duration (sec): 0.0952
Flash Period (sec.): 2.0

Calibration Factor: 2.48*10^-12
Neutral Density Filter: NA

Input: 220.1 Vac

Calculated Effective Intensity Data (candela)

| Vertical Position | Horizontal Position (deg.) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 30 | 60 | 90 | 120 | 150 | 180 | 210 | 240 | 270 | 300 | 330 |
| 3U | 9484 | 8428 | 10013 | 8475 | 11043 | 8834 | 9132 | 7066 | 9356 | 8184 | 8658 | 6768 |
| 2U | 14159 | 13197 | 14362 | 14159 | 15717 | 14227 | 13515 | 12797 | 14227 | 12939 | 13095 | 11984 |
| 1.5U | 17275 | 17072 | 17478 | 17953 | 19308 | 18224 | 16598 | 16191 | 17411 | 16869 | 15853 | 15446 |
| 1U | 21001 | 20527 | 21001 | 21543 | 22966 | 21611 | 20053 | 20053 | 21001 | 20662 | 19579 | 19443 |
| 0 | 25269 | 24253 | 23643 | 24050 | 25201 | 23914 | 23711 | 23847 | 25472 | 24727 | 23914 | 24118 |
| 1D | 21611 | 17749 | 18698 | 15785 | 18833 | 15649 | 19511 | 17004 | 20866 | 17953 | 20730 | 18698 |
| 1.5D | 14836 | 10270 | 11544 | 10189 | 11165 | 9064 | 13007 | 12770 | 14362 | 10819 | 14498 | 13407 |
| 2D | 7649 | 4532 | 5142 | 5725 | 4810 | 4268 | 6734 | 8746 | 7879 | 5318 | 7411 | 8522 |
| 3D | 1253 | 744 | 822 | 1175 | 913 | 816 | 1163 | 2561 | 1484 | 913 | 974 | 2120 |
| 10D | 175 | 177 | 192 | 195 | 206 | 177 | 159 | 152 | 157 | 146 | 154 | 162 |

## ICAO Medium-Intensity, Type A (White Night) - 30FPM

| Flash / Min. Variation | Voltage | Position | Measured | Factor |
|---|---|---|---|---|
| 20 | 220.0 | (0, 0) | 12590 | 101% |
| 30 | | | 12500 | NA* |
| 40 | | | 12460 | 99.7% |
| 60 | | | 12500 | 100% |

flash energy measurements are relative  * Test flash rate

| Table 6-3 Minimum Requirements | | | | | |
|---|---|---|---|---|---|
| Mode | Parameter | Requirement | Measured | | Result |
| White Night | Flash Rate (FPM) | 20-60 FPM | 30.0 | FPM | Pass |
| | Min. Avg. Intensity | 2,000 cd at 0° | 4044 | cd | Pass |
| | Min. Peak Intensity | 1,500 cd at 0° | 3881 | cd | Pass |
| | Min. Peak Intensity | 750 cd at -1° | 2576 | cd | Pass |
| | Beam Spread | ≥3° at each vertical slice (min 750cd) | >5 | degrees | Pass |

| Table 6-3 Recommendations | | | | | |
|---|---|---|---|---|---|
| Mode | Parameter | Requirement | Measured | | Result |
| White Night | Max. Intensity | 2,500 cd at 0° | 4232 | cd | Fail |
| | Max. Intensity | 1,125 cd at -1° | 3612 | cd | Fail |
| | Max. Intensity | 75 cd at -10° | 58 | cd | Pass |

| | | | | | Minimum Cable Length | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Voltage Variation | Voltage | Position | Measured | Factor | Min. Avg. Int. 2,000cd @ 0° | | | Min. Peak Int. 1,500cd @ 0° | | |
| Input Voltage | 220.1 | 0, 0 | 18350 | NA | 4044 | cd | Result | 3881 | cd | Result |
| Input Voltage +10% | 242.0 | 0, 0 | 18340 | 100% | 4041 | cd | Pass | 3879 | cd | Pass |
| Input Voltage -10% | 198.0 | 0, 0 | 18350 | 100% | 4044 | cd | Pass | 3881 | cd | Pass |

Cable Length: NA
Flash Duration (sec): 0.672
Flash Period (sec.): 2.00

Calibration Factor: 2.48*10^-12
Neutral Density Filter: NA

Input: 220.1 Vac

Calculated Effective Intensity Data (candela)

| Vertical Position | Horizontal Position (deg.) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 30 | 60 | 90 | 120 | 150 | 180 | 210 | 240 | 270 | 300 | 330 |
| 3U | 1562 | 1374 | 1624 | 1383 | 1814 | 1461 | 1491 | 1154 | 1537 | 1362 | 1445 | 1151 |
| 2U | 2344 | 2154 | 2339 | 2326 | 2601 | 2344 | 2225 | 2096 | 2337 | 2144 | 2193 | 2014 |
| 1.5U | 2869 | 2807 | 2862 | 2966 | 3204 | 3018 | 2734 | 2665 | 2867 | 2800 | 2663 | 2599 |
| 1U | 3493 | 3388 | 3431 | 3583 | 3807 | 3596 | 3307 | 3314 | 3459 | 3431 | 3291 | 3278 |
| 0 | 4232 | 4028 | 3881 | 3998 | 4202 | 3979 | 3908 | 3938 | 4186 | 4094 | 4018 | 4060 |
| 1D | 3612 | 2894 | 3034 | 2580 | 3119 | 2576 | 3195 | 2752 | 3411 | 2929 | 3468 | 3140 |
| 1.5D | 2486 | 1670 | 1878 | 1656 | 1846 | 1502 | 2131 | 2069 | 2339 | 1768 | 2422 | 2282 |
| 2D | 1291 | 736 | 837 | 931 | 796 | 713 | 1108 | 1424 | 1291 | 876 | 1259 | 1468 |
| 3D | 216 | 129 | 141 | 199 | 160 | 143 | 201 | 431 | 259 | 165 | 184 | 378 |
| 10D | 54 | 53 | 55 | 55 | 58 | 53 | 50 | 49 | 49 | 47 | 49 | 50 |

**Complies:** ☑ YES ☐ NO

| | | | | | |
|---|---|---|---|---|---|
| Tested By: | Brittany James | | | Signature or initials: | |
| Engineer: | cwm | | | Signature or initials: | |
| Reviewed By: | JND | | | Signature or initials: | |
| Test Equipment Used: | 1, 2, 3, 5, 16, 17, 18 | | | Sample No: | CRT1903251300-002 |
| Amb (ºC): | 24.6 | RH% | 38.9 | Completion Date: | 5/1/2019 |

## Photometry Medium Intensity Type B (Red)

Energize the light by the system power supply and control unit and test for compliance with the photometric requirements in Table 6-3. Vary the input voltage to the light ± 10% from nominal voltage and measure the effective intensity at the input extremes. Make the effective intensity measurements using an integrating photometer whose calibration is traceable to an NIST steady state source. The test distance is 25 meters. The horizontal beam spread is 360 degrees.

**Results**

| Flash / Min. Variation | Voltage | Position | Measured | Factor |
|---|---|---|---|---|
| 20 | 220Vac | (0, 0) | 16660 | 100% |
| 30 | | | 16660 | NA* |
| 40 | | | 16660 | 100% |
| 60 | | | 16370 | 98% |

* Test flash rate

### ICAO Medium-Intensity, Type B (Red Night) - 30FPM

**Table 6-3 Minimum Requirements**

| Mode | Parameter | Requirement | Measured | | Result |
|---|---|---|---|---|---|
| Red Night | Flash Rate (FPM) | 20-60 FPM | 30.2 | FPM | Pass |
| | Min. Avg. Intensity | 2,000 cd at 0° | 3730 | cd | Pass |
| | Min. Peak Intensity | 1,500 cd at 0° | 3041 | cd | Pass |
| | Min. Peak Intensity | 750 cd at -1° | 1096 | cd | Pass |
| | Beam Spread | ≥3° at each vertical slice (min 750cd) | 3 | degrees | Pass |

**Table 6-3 Recommendations**

| Mode | Parameter | Requirement | Measured | | Result |
|---|---|---|---|---|---|
| Red Night | Max. Intensity | 2,500 cd at 0° | 4165 | cd | Fail |
| | Max. Intensity | 1,125 cd at -1° | 2927 | cd | Fail |
| | Max. Intensity | 75 cd at -10° | 14 | cd | Pass |

| | | | | | Minimum Cable Length | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Voltage Variation | Voltage | Position | Measured | Factor | Min. Avg. Int. 2,000cd @ 0° | | | Min. Peak Int. 1,500cd @ 0° | | |
| Input Voltage | 220.2Vac | 0, 0 | 16660 | NA | 3730 | cd | Result | 3041 | cd | Result |
| Input Voltage +10% | 242.6Vac | 0, 0 | 16680 | 100% | 3735 | cd | Pass | 3045 | cd | Pass |
| Input Voltage -10% | 197.8Vac | 0, 0 | 16640 | 100% | 3726 | cd | Pass | 3038 | cd | Pass |

Cable Length (ft.): NA
Flash Duration (sec): 0.672
Flash Period (sec.): 2.0

Calibration Factor: 2.48x10-12
Neutral Density Filter: NA

Input: 220 Vac

Calculated Effective Intensity Data (candela)

| Vertical Position | Horizontal Position (deg.) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 30 | 60 | 90 | 120 | 150 | 180 | 210 | 240 | 270 | 300 | 330 |
| 3U | 885 | 1055 | 1404 | 1227 | 1452 | 972 | 557 | 331 | 450 | 759 | 461 | 555 |
| 2U | 2053 | 1950 | 2477 | 2087 | 2532 | 1732 | 1821 | 1248 | 1583 | 1310 | 1755 | 1507 |
| 1.5U | 2534 | 2622 | 2807 | 2858 | 3085 | 2599 | 2381 | 2064 | 2064 | 1853 | 2287 | 2243 |
| 1U | 3282 | 3433 | 3450 | 3697 | 3865 | 3622 | 3222 | 2839 | 2844 | 2959 | 2970 | 3053 |
| 0 | 3821 | 3436 | 3339 | 3041 | 3486 | 3567 | 3993 | 3931 | 4055 | 4048 | 4165 | 3878 |
| 1D | 2005 | 1580 | 1720 | 1190 | 1096 | 1491 | 2245 | 2415 | 2927 | 2339 | 2514 | 2282 |
| 1.5D | 743 | 633 | 548 | 461 | 252 | 441 | 959 | 1479 | 1296 | 796 | 1080 | 1222 |
| 2D | 185 | 158 | 130 | 130 | 81 | 113 | 288 | 665 | 386 | 159 | 312 | 448 |
| 3D | 40 | 48 | 31 | 35 | 37 | 51 | 51 | 60 | 50 | 53 | 57 | 64 |
| 10D | 13 | 11 | 9 | 11 | 11 | 10 | 12 | 11 | 12 | 14 | 14 | 13 |

**Complies:** ☑ YES ☐ NO

| | | | |
|---|---|---|---|
| Tested By: | Rudy Sporman | Signature or initials: | RS |
| Engineer: | cwm | Signature or initials: | cwm |
| Reviewed By: | JND | Signature or initials: | JND |
| Test Equipment Used: | 1, 2, 3, 5, 6, 7, 8 | Sample No: | CRT1811121319-002 |
| Amb (ºC): | 24.3 RH% 21 | Completion Date: | 11/28/2018 |

## Chromaticity ICAO

Test the fixture with the lamp, filter and optical system for color of light emitted. Chromaticity Coordinates are to be calculated from a spectral distribution measured in 2nm increments for LEDs, and 5nm increments for incandescent. Measure the color after stabilization at rated input at the main beam center and beam extremes.

### Results - ICAO LED Red

| Sample | Color | Input | Location | x | y | z | (P/F) |
|---|---|---|---|---|---|---|---|
| CRT1811121319-002 | Red | 218.07 | (0,0) | 0.701 | 0.298 | 0.000 | P |

| Boundary | Line Equation | Calc. |
|---|---|---|
| Purple Boundary | y ≥ 0.980 - x | 0.279 |
| Yellow Boundary | y ≤ 0.335 | 0.298 |

**Complies:** ☑ YES ☐ NO

| | | | | | |
|---|---|---|---|---|---|
| Tested By: | Craig Small | | | Signature or initials: | |
| Engineer: | cwm | | | Signature or initials: | |
| Reviewed By: | JND | | | Signature or initials: | |
| Test Equipment Used: | 9,10,11,12,13,14,15 | | | Sample No: | above |
| Amb (ºC): | 23.1 | RH% | 17 | Completion Date: | 12/5/2018 |

## Chromaticity ICAO

Test the fixture with the lamp, filter and optical system for color of light emitted. Chromaticity Coordinates are to be calculated from a spectral distribution measured in 2nm increments for LEDs, and 5nm increments for incandescent. Measure the color after stabilization at rated input at the main beam center and beam extremes.

### Results - ICAO LED White

| Sample | Color | Input | Location | x | y | z | (P/F) |
|---|---|---|---|---|---|---|---|
| CRT1903251300-002 | White | 220.1 | (0,0) | 0.320 | 0.334 | 0.346 | P |

| Boundary | Line Equation | Calc. | (P/F) |
|---|---|---|---|
| Yellow Boundary | x ≤ 0.440 | 0.320 | P |
| Blue Boundary | x ≥ 0.320 | 0.320 | P |
| Green Boundary | y ≤ 0.150 + 0.643x | 0.356 | P |
| Purple Boundary | y ≥ 0.050 + 0.757x | 0.293 | P |

**Complies:** ☑ YES ☐ NO

| | | | | | |
|---|---|---|---|---|---|
| Tested By: | Matthew Benninger | | | Signature or initials: | |
| Engineer: | cwm | | | Signature or initials: | |
| Reviewed By: | JND | | | Signature or initials: | |
| Test Equipment Used: | 4,19,20,21 | | | Sample No: | above |
| Amb (ºC): | 22 | RH% | 31 | Completion Date: | 4/12/2019 |

**Equipment list**

| # | Intertek ID No. | Description | Manufacturer | Calibration Due |
|---|---|---|---|---|
| 1 | N1311 | Level | Starrett | 10-Sep-2019 |
| 2 | M308 | Stopwatch | Traceable | 03-Nov-2019 |
| 3 | L178 | Goniophotometer | Labsphere | 18-Apr-2019 |
| 4 | T1555 | Hygro-Thermometer | Extech | 03-Jun-2019 |
| 5 | L061 | IL1700 | International Light | 13-May-2019 |
| 6 | M211 | Multimeter | Fluke | 25-Jan-2019 |
| 7 | E466 | Oscilloscope | Tektronix | 06-Aug-2019 |
| 8 | 45173188 | Hygro-Thermometer | Testo | 16-Nov-2019 |
| 9 | E288 | OL-750 Spectroradiometer | Optronic Laboratories | 19-Dec-2018 |
| 10 | M282 | Hygrometer | Testo | 18-Apr-2019 |
| 11 | E536 | Digital Power Meter | Yokogowa | 19-Jan-2019 |
| 12 | A208 | Current Transformer | Pearson Electric | 27-Jun-2019 |
| 13 | N721 | Steel Ruler | Products Engineering Corp | 12-Jul-2019 |
| 14 | E499 | Smart Tool | M-D Building Products | 29-Jun-2019 |
| 15 | N1335 | Tape Measure | Stanley | 19-Jan-2019 |
| 16 | M245 | Multimeter | Fluke | 07-May-2019 |
| 17 | M310 | Hygro-Thermometer | Testo | 16-Nov-2019 |
| 18 | E538 | Oscilloscope | Tektronix | 07-Sep-2019 |
| 19 | O109 | Goniometer | Optroniks | 10-Apr-2019 |
| 20 | M292 | Spectroradiometer | Gooch and Housego | 27-Mar-2019 |
| 21 | M135 | Multimeter | Fluke | 12-Apr-2019 |
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Note: For measurement uncertainty, refer to the calibration certificates for all the test equipment located in the equipment files