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**Report No. 103732488CRT-001**

## Shanghai Nanhua Electronics Co., Ltd.

Building #9  
1755 Wenbei Rd  
Jiadingqu  
Shanghai 201802, China

### Standards

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

<i>Test Purpose</i>	Performance Verification Testing - Type B and C Medium Intensity Obstacle Light
<i>Test Dates</i>	November 16, 2018 to December 14, 2018 / April 3, 2019

*Revision 4/9/2019: Added testing for sample modification*



Jennifer Barnoski  
Project Engineer  
Lighting



Christopher W. Metcalf  
Engineering Supervisor  
Lighting

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Test Plan and Datasheets			
Client	Shanghai Nanhua Electronics Co., Ltd.	Engineer	Jennifer Barnoski
Report #	103732488CRT-001	Reviewer	Christopher W. Metcalf
Product	Obstacle Light	Model(s)	LM102
Standard	ICAO Annex 14, dated July 2018		

Spec	Test name	Clause	Pass Fail NA
ICAO	Photometry Medium Intensity Type A (White)	Table 6-3W	NA
ICAO	Photometry Medium Intensity Type B (Red) - 20 FPM	Table 6-3R	Pass
ICAO	Photometry Medium Intensity Type B (Red) - 30 FPM	Table 6-3R	NT
ICAO	Photometry Medium Intensity Type B (Red) - 40 FPM	Table 6-3R	Pass
ICAO	Photometry Medium Intensity Type B (Red) - 60 FPM	Table 6-3R	Pass
ICAO	Photometry Medium Intensity Type C (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

Sample Information				
Date Rec.	Intertek ID	Description	Condition	Model No.
11/12/18	CRT1811121319-001	Type B or C Medium Intensity Light	Production	LM102
3/25/19	CRT1903251300-001	Type B or C Medium Intensity Light	Production	LM102

Further Sample Description	
Type:	B or C Medium Intensity Obstruction Light
Options:	NA
Light Source:	Red LED: (18), Osram GA
Lens:	PC (Clear), S3000UR, Mitsubishi
Approx Size:	7" ø x 4.5"
Electrical Input:	100-240VAC
LED Supply Location:	Internal to Flash Head
Cable:	NA
Min Cable Length:	NA
Max Cable Length:	NA
Casting Material:	Aluminum Alloy
Mounting:	(4) through holes on base

Sample Modification Log	
Date	Modification description
3/25/19	Increased current for all modes

**Picture(s)**



**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  $\pm 10\%$  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 meters. The horizontal beam spread is 360 degrees.

**Results**

**ICAO Medium-Intensity, Type B (Red Night) - 20 FPM**

**Table 6-3 Minimum Requirements**

Mode	Parameter	Requirement	Measured		Result
Red Night	Flash Rate (FPM)	20-60 FPM	20.0	FPM	Pass
	Min. Avg. Intensity	2,000 cd at 0°	2446	cd	Pass
	Min. Peak Intensity	1,500 cd at 0°	2138	cd	Pass
	Min. Peak Intensity	750 cd at -1°	1422	cd	Pass
	Beam Spread	$\geq 3^\circ$ at each vertical slice (min 750cd)	3.5	degrees	Pass




**Table 6-3 Recommendations**

Mode	Parameter	Requirement	Measured		Result
Red Night	Max. Intensity	2,500 cd at 0°	2817	cd	Fail
	Max. Intensity	1,125 cd at -1°	2032	cd	Fail
	Max. Intensity	75 cd at -10°	0	cd	Pass

Voltage Variation		Voltage	Position	Measured	Factor	Minimum Cable Length				
						Min. Avg. Int. 2,000cd @ 0°	Min. Peak Int. 1,500cd @ 0°			
Input Voltage		120.1	0, 0	9520	NA	2446 cd	Result 2138 cd	Result	2138 cd	Result
Input Voltage +10%		264.1	0, 0	9520	100%	2446 cd	Pass	2138 cd	cd	Pass
Input Voltage -10%		90.1	0, 0	9510	100%	2444 cd	Pass	2135 cd	cd	Pass

Cable Length (ft.):	3 ft	Calibration Factor:	2.48x10-12	Input:	120.1 Vac							
Flash Duration (sec.):	0.672	Neutral Density Filter:	NA									
Flash Period (sec.):	3.0	Calculated Effective Intensity Data (candela)										
Vertical Position	Horizontal Position (deg.)											
	0	30	60	90	120	150	180	210	240	270	300	330
3U	711	537	624	165	461	65	470	49	406	82	466	275
2U	1367	1876	1385	1578	1083	1204	1007	1188	1083	1323	1183	1495
1.5U	1672	2489	1771	2518	1509	2154	1356	2025	1408	1943	1509	2213
1U	2124	2803	2200	2725	1929	2555	1805	2530	1695	2372	1821	2523
0	2154	2479	2216	2560	2307	2766	2291	2817	2257	2718	2138	2654
1D	1571	1422	1709	1862	1853	2011	2032	1885	2007	1817	1995	1569
1.5D	947	1248	1167	1544	1372	1569	1358	1603	1252	1514	1101	1289
2D	729	1021	803	1181	1030	1183	979	1236	966	1261	803	1050
3D	498	234	378	451	615	537	612	516	610	617	573	432
10D	0	0	0	0	0	0	0	0	0	0	0	0

Complies:  YES  NO

Tested By:	Brittany James	Signature or initials:	
Engineer:	Jennifer Barnoski	Signature or initials:	
Reviewed By:	cwm	Signature or initials:	
Test Equipment Used:	1, 2, 4, 7, 15, 16, 17, 18	Sample No:	CRT1903251300-001
Amb (°C):	26.1 RH% 16.8	Completion Date:	4/3/2019

**ICAO Medium-Intensity, Type B (Red Night) - 40 FPM**

**Table 6-3 Minimum Requirements**

Mode	Parameter	Requirement	Measured		Result
Red Night	Flash Rate (FPM)	20-60 FPM	40.0	FPM	Pass
	Min. Avg. Intensity	2,000 cd at 0°	2324	cd	Pass
	Min. Peak Intensity	1,500 cd at 0°	2023	cd	Pass
	Min. Peak Intensity	750 cd at -1°	1325	cd	Pass
	Beam Spread	≥3° at each vertical slice (min 750cd)	3.5	degrees	Pass

**Table 6-3 Recommendations**

Mode	Parameter	Requirement	Measured		Result
Red Night	Max. Intensity	2,500 cd at 0°	2654	cd	Fail
	Max. Intensity	1,125 cd at -1°	1858	cd	Fail
	Max. Intensity	75 cd at -10°	12	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	120.1	0, 0	8950	NA	2324	cd	Result	2023	cd	Result
Input Voltage +10%	264.1	0, 0	8930	100%	2319	cd	Pass	2018	cd	Pass
Input Voltage -10%	90.2	0, 0	8950	100%	2324	cd	Pass	2023	cd	Pass

Cable Length (ft.): 3 ft  
 Flash Duration (sec): 0.674  
 Flash Period (sec.): 1.5




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

Input: 120.1 Vac

**Calculated Effective Intensity Data (candela)**

Vertical Position	Horizontal Position (deg.)											
	0	30	60	90	120	150	180	210	240	270	300	330
3U	689	542	609	179	443	96	457	60	393	90	451	276
2U	1284	1815	1311	1515	1034	1178	973	1151	1039	1304	1128	1437
1.5U	1570	2339	1680	2348	1439	2062	1307	1950	1350	1867	1435	2124
1U	2039	2616	2085	2659	1835	2410	1739	2398	1673	2270	1721	2380
0	2064	2332	2108	2444	2204	2634	2204	2654	2130	2574	2023	2515
1D	1465	1325	1604	1709	1709	1840	1838	1769	1815	1698	1858	1483
1.5D	897	1165	1082	1442	1277	1469	1238	1506	1229	1430	1034	1220
2D	691	957	762	1108	957	1105	913	1172	902	1185	762	1002
3D	478	235	352	437	586	529	584	524	586	600	549	417
10D	11	11	12	12	11	11	10	10	11	11	11	10

Complies:  YES  NO

Tested By:	Brittany James	Signature or initials:	
Engineer:	Jennifer Barnoski	Signature or initials:	
Reviewed By:	cwm	Signature or initials:	
Test Equipment Used:	1, 2, 4, 7, 15, 16, 17, 18	Sample No:	CRT1903251300-001
Amb (°C):	24.5	RH%	19.6
		Completion Date:	4/3/2019

**ICAO Medium-Intensity, Type B (Red Night) - 60 FPM**

**Table 6-3 Minimum Requirements**

Mode	Parameter	Requirement	Measured	Result
Red Night	Flash Rate (FPM)	20-60 FPM	60.0 FPM	Pass
	Min. Avg. Intensity	2,000 cd at 0°	2073 cd	Fail
	Min. Peak Intensity	1,500 cd at 0°	1817 cd	Pass
	Min. Peak Intensity	750 cd at -1°	1179 cd	Pass
	Beam Spread	≥3° at each vertical slice (min 750cd)	4 degrees	Pass

**Table 6-3 Recommendations**

Mode	Parameter	Requirement	Measured	Result
Red Night	Max. Intensity	2,500 cd at 0°	2351 cd	Pass
	Max. Intensity	1,125 cd at -1°	1663 cd	Fail
	Max. Intensity	75 cd at -10°	6 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	120.1	0, 0	8000	NA	2073 cd	1817 cd
Input Voltage +10%	264.0	0, 0	8000	100%	2073 cd	1817 cd
Input Voltage -10%	90.1	0, 0	7990	100%	2070 cd	1814 cd

Cable Length (ft.): 3 ft  
 Flash Duration (sec): 0.672  
 Flash Period (sec.): 1.00




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

Input: 120.0 Vac

**Calculated Effective Intensity Data (candela)**

Vertical Position	Horizontal Position (deg.)											
	0	30	60	90	120	150	180	210	240	270	300	330
3U	633	505	567	207	398	82	411	51	354	85	409	265
2U	1161	1683	1193	1459	954	1252	901	1112	972	1291	1032	1333
1.5U	1420	2135	1537	2144	1328	1938	1211	1837	1268	1764	1310	1947
1U	1867	2363	1920	2337	1700	2415	1596	2186	1571	2106	1567	2181
0	1817	2060	1890	2188	1929	2342	1986	2351	1945	2284	1853	2232
1D	1328	1179	1463	1498	1532	1628	1624	1585	1523	1654	1663	1319
1.5D	800	1039	945	1287	1128	1305	1094	1337	1016	1275	1011	1213
2D	622	851	681	982	858	991	810	1046	791	1046	688	899
3D	437	207	304	387	528	472	525	475	534	539	544	374
10D	4	5	5	6	5	5	5	4	5	5	6	5

Complies:  YES  NO

Tested By:	Brittany James	Signature or initials:	
Engineer:	Jennifer Barnoski	Signature or initials:	
Reviewed By:	cwm	Signature or initials:	
Test Equipment Used:	1, 2, 4, 7, 15, 16, 17, 18	Sample No:	CRT1903251300-001
Amb (°C):	24.9	RH%	19.2
		Completion Date:	4/2/2019

**Photometry Medium Intensity Type C (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  $\pm 10\%$  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 meters. The horizontal beam spread is 360 degrees.

**Results**

**ICAO Medium-Intensity, Type C (Red Night)**

Table 6-3 Minimum Requirements					
Mode	Parameter	Requirement	Measured		Result
Red Night	Min. Avg. Intensity	2,000 cd at 0°	2368	cd	Pass
	Min. Peak Intensity	1,500 cd at 0°	2131	cd	Pass
	Min. Peak Intensity	750 cd at -1°	1363	cd	Pass
	Beam Spread	$\geq 3^\circ$ at each vertical slice (min 750cd)	3.5	degrees	Pass




Table 6-3 Recommendations					
Mode	Parameter	Requirement	Measured		Result
White Night	Max. Intensity	2,500 cd at 0°	2672	cd	Fail
	Max. Intensity	1,125 cd at -1°	1878	cd	Fail
	Max. Intensity	75 cd at -10°	6	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	120.1	0, 0	2110	NA	2368	cd	Result	2131	cd	Result
Input Voltage +10%	264.1	0, 0	2110	100%	2368	cd	Pass	2131	cd	Pass
Input Voltage -10%	90.2	0, 0	2100	100%	2357	cd	Pass	2121	cd	Pass

Cable Length (ft.):  Calibration Factor:  Input:  Vac  
 Neutral Density Filter:

Vertical Position	Intensity Data (candela)											
	Horizontal Position (deg.)											
	0	30	60	90	120	150	180	210	240	270	300	330
3U	731	592	664	210	461	95	467	61	405	94	465	294
2U	1342	1969	1385	1688	1099	1327	1057	1310	1162	1497	1196	1531
1.5U	1641	2475	1785	2491	1540	2226	1426	2140	1495	2034	1525	2229
1U	2163	2737	2213	2670	1978	2565	1871	2484	1856	2394	1805	2506
0	2131	2381	2181	2505	2194	2672	2267	2511	2224	2627	2156	2564
1D	1536	1363	1673	1724	1790	1878	1813	1819	1645	1709	1855	1515
1.5D	929	1194	1060	1486	1287	1511	1247	1535	1139	1469	1057	1266
2D	721	984	785	1125	998	1148	923	1203	891	1194	786	1033
3D	505	239	326	449	607	560	394	560	615	648	563	451
10D	2	3	2	3	3	3	6	5	1	1	3	2

Complies:  YES  NO

Tested By:	Brittany James	Signature or initials:	
Engineer:	Jennifer Barnoski	Signature or initials:	
Reviewed By:	cwm	Signature or initials:	
Test Equipment Used:	1, 4, 7, 14, 15, 17, 18	Sample No:	CRT1903251300-001
Amb (°C):	26.2	RH%	16.4
		Completion Date:	4/3/2019

**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)
CRT1811121319-001	Red	120.17	(0,0)	0.686	0.314	0.000	P

The aviation red must be per ICAO Annex 14, Volume 1, Appendix 1, Colors for Aeronautical Ground Lights, within the following chromaticity boundaries

Boundary	Line Equation	Calc.
Purple Boundary	$y \geq 0.980 - x$	0.294
Yellow Boundary	$y \leq 0.335$	0.314

**Complies:**  YES  NO

Tested By:	Craig Small	Signature or initials:	
Engineer:	Jennifer Barnoski	Signature or initials:	
Reviewed By:	cwm	Signature or initials:	
Test Equipment Used:	8,9,10,11,12,13	Sample No:	CRT1811121319-001
Amb (°C):	27.2	RH%	22.1
		Completion Date:	12/14/2018



<b>Equipment list</b>				
#	Intertek ID No.	Description	Manufacturer	Calibration Due
1	L178	100ft Lab Goniophotometer	Labsphere	18-Apr-2019
2	L061	IL1700	International Light	13-May-2019
3	M211	Multimeter	Fluke	25-Jan-2019
4	N1311	Level	Starrett	10-Sep-2019
5	E466	Oscilloscope	Tektronix	06-Apr-2019
6	T1555	Hygro-Thermometer	Extech	03-Jun-2019
7	M308	Stopwatch	Traceable	03-Nov-2019
8	E288	OL-750 Spectroradiometer	Optronic Laboratories	11-Jan-2019
9	M282	Hygrometer	Testo	18-Apr-2019
10	E536	Digital Power Meter	Yokogawa	19-Jan-2019
11	A208	Current Transformer	Pearson Electric	27-Jun-2019
12	E499	Smart Tool	M-D Building Products	29-Jun-2019
13	N1335	Tape Measure	Stanley	19-Jan-2019
14	L180	100ft Lab Photodetector	Gigahertz Optik	18-Jun-2019
15	M245	Multimeter	Fluke	07-May-2019
16	E538	Oscilloscope	Tektronix	07-Sep-2019
17	N1441	Tape Measure	Stanley	15-Jun-2021
18	M310	Hygro-Thermometer	Testo	16-Nov-2019
19				
20				

Note: For measurement uncertainty, refer to the calibration certificates for all the test equipment located in the equipment files