SAE Aerospace
An SAE International Group

AEROSPACE STANDARD

SAE AS8037 | REV. C

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Superseding AS8037B

(R) Minimum Performance Standard for Aircraft Position Lights

RATIONALE

This document establishes minimum performance levels for aircraft position lights including chromaticity, and light intensity in support of TSO and system certification. Information contained herein has been expanded from AS8037A in the areas of measurement conditions, lumen maintenance, and the inclusion of specific information relative to the use of Light Emitting Diode source technology. It provides minimum requirements for night operation not addressed in CFR Title 14. Position lights shall be capable of daytime operation as well. FAR references have been revised for clarity and test laboratory temperature range has been reduced for accuracy.

1. SCOPE

This SAE Aerospace Standard (AS) establishes minimum performance standards for new equipment position lights.

This Aerospace Standard defines minimum light intensity in terms of candelas in vertical and horizontal directions about the longitudinal, vertical, and lateral axes of the aircraft. It also defines color tolerances in terms of limiting chromaticities for the light emitted from the position lights. It is not intended that this standard require the use of any particular light source such as quartz-halogen, incandescent, or any other specific design of lamp.

2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

J1330 Photometry Laboratory Accuracy Guidelines

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
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SAE WEB ADDRESS: http://www.sae.org

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AS8037C

2.2 RTCA Publication

Available from RTCA, Inc., 1150 18th Street, NW, Suite 910, Washington, DC 20036, Tel: 202-833-9339, www.rtca.org.

Radio Technical Commission for Aeronautics (RTCA) Document No. 160, Environmental Conditions and Test Procedures for Airborne Equipment

2.3 U.S. Government Publications

Available from DLA Document Services, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6396, http://quicksearch.dla.mil/.

MIL-DTL-7989C Covers, Light-Transmitting, for Aeronautical Lights, General Specification for

2.3.1 Other Publications

Code of Federal Regulations Title 14, Part 23, 25, 27, 29

Some applicable sections may include, but are not limited to the following:

§23, 25, 27, 29-.1385 Position light system installation.

§23, 25, 27, 29-.1387 Position light system dihedral angles.

§23, 25, 27, 29-.1389 Position light distribution and intensities.

§23-.1391 Minimum intensities in the horizontal plane of position lights

§25, 27, 29-.1391 Minimum intensities in the horizontal plane of forward and rear position lights.

§23-.1393 Minimum intensities in any vertical plane of position lights.

§25, 27, 29-.1393 Minimum intensities in any vertical plane of forward and rear position lights.

§23-.1395 Maximum intensities in overlapping beams of position lights

§25, 27, 29-.1395 Maximum intensities in overlapping beams of forward and rear position lights.

§23, 25, 27, 29-.1397 Color specifications.

Department of Transportation, Federal Aviation Administration, Aircraft Certification Service, Washington, DC

TSO-C30c, AIRCRAFT POSITION LIGHTS

AC20-74 Aircraft Position and Anticollision Light Measurements

3. GENERAL STANDARDS

3.1 Dihedral Angle Coverage, Forward Position Lights, Types I and II, and Rear Position Lights, Type III

When mounted on the aircraft in accordance with manufacturer's instructions, the forward and rear lights shall show unbroken light within the dihedral angles specified in Figure 1, and defined in 3.1.1.

Position Light Type	Dihedral Angle
Type I (forward, red)	L (left)
Type II (forward, green)	R (right)
Type III (rear, white)	A (aft)

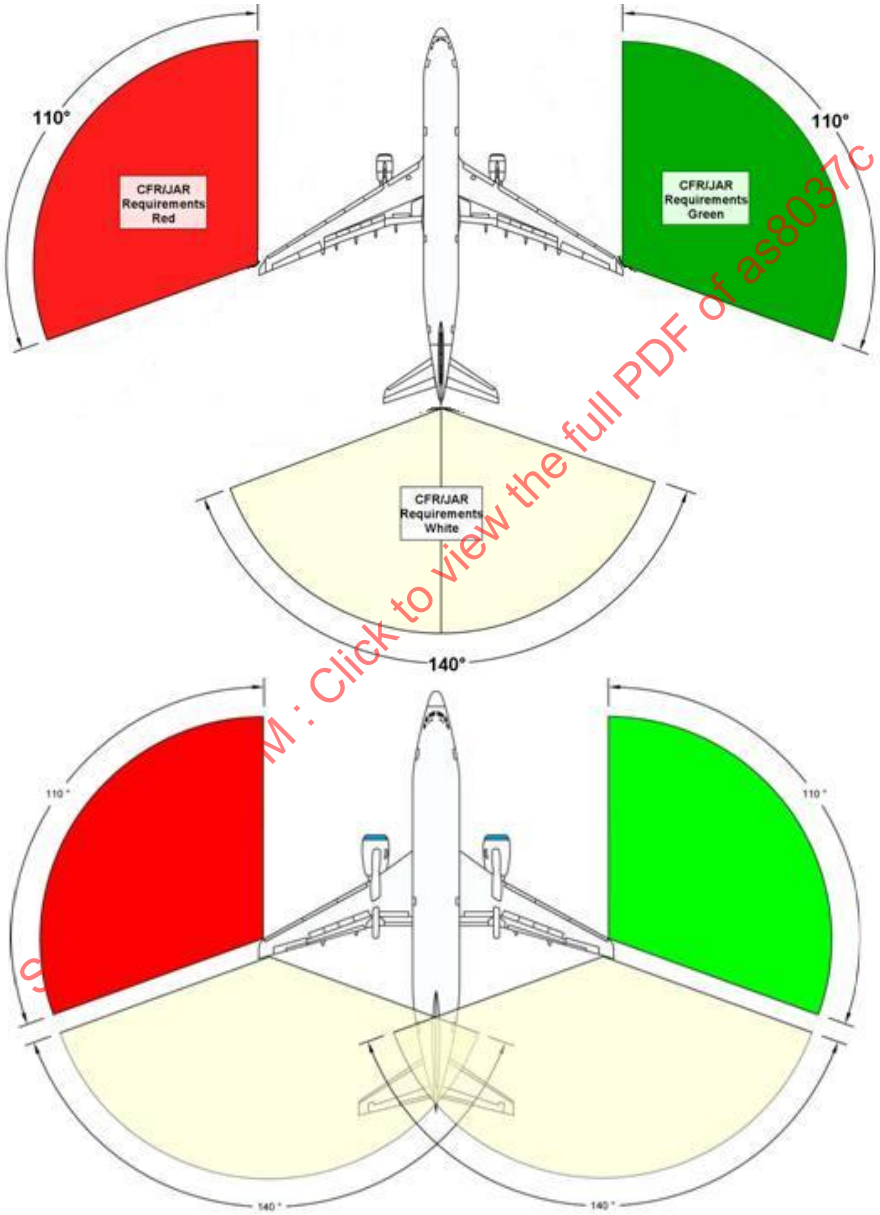

FIGURE 1 - DIHEDRAL ANGLE COVERAGE, FORWARD AND REAR POSITION LIGHTS, SHOWING BOTH SINGLE AND DUAL AFT INSTALLATIONS

3.1.1 Definitions of Dihedral Angles

a. Dihedral Angle L (Left): The dihedral angle formed by two intersecting vertical planes, one parallel to the longitudinal axis of the airplane, and the other at 110 degrees to the left of the first when looking forward along the longitudinal axis (Figure 2).

b. Dihedral Angle R (Right): The dihedral angle formed by two intersecting vertical planes, one parallel to the longitudinal axis of the airplane, and the other at 110 degrees to the right of the first when looking forward along the longitudinal axis (Figure 2).

c. Dihedral Angle A (Aft): The dihedral angle formed by two intersecting vertical planes making angles of 70 degrees to the right and 70 degrees to the left, respectively, looking aft along the longitudinal axis, to a vertical plane passing through the longitudinal axis (Figure 3).

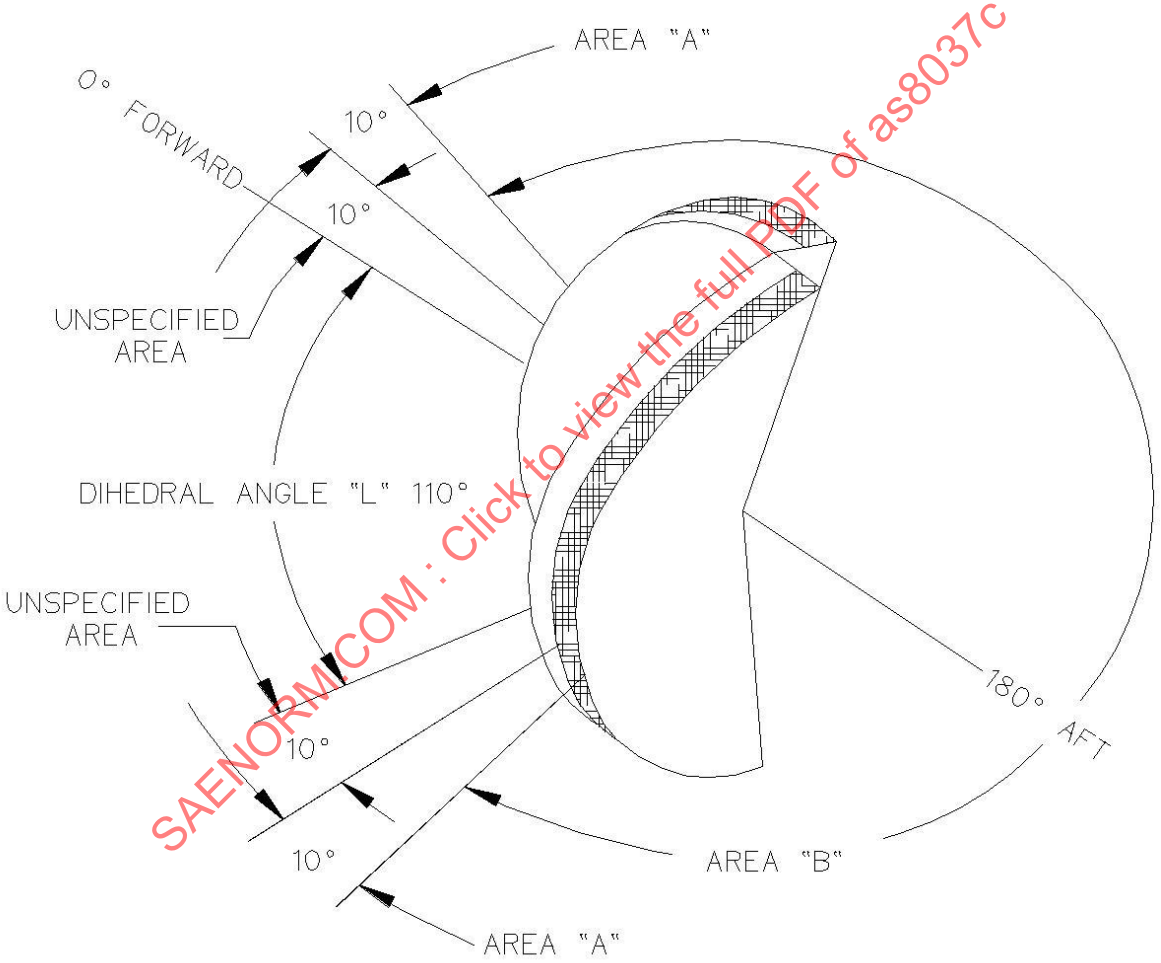

FIGURE 2 - REPRESENTATION OF ANGLES FOR LEFT FORWARD POSITION LIGHT

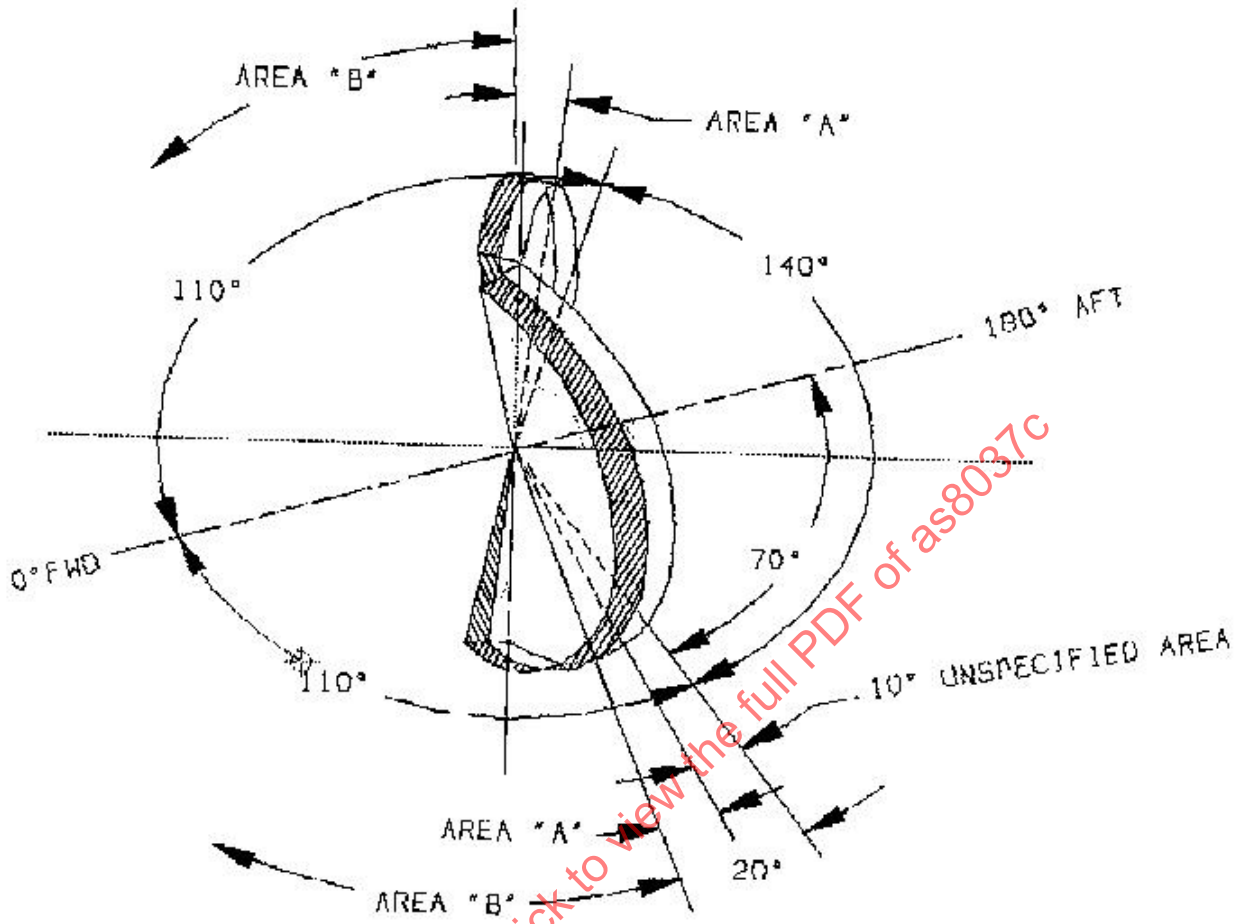

FIGURE 3 - REPRESENTATION OF ANGLES FOR AFT POSITION LIGHT

3.2 Position Light Intensity Distribution

3.2.1 General

The intensities specified in this section shall be provided by new equipment, with all light covers and color filters in place, when mounted on aircraft in accordance with the manufacturer's instructions. Luminous intensity can be measured at nominal input voltage. If the luminous intensity varies with the input voltage, it should be shown that the light assembly meets the minimum intensity requirements over the rated (assembly) input voltage range.

3.2.2 Minimum Intensities in the Horizontal Plane

The intensities in the horizontal plane shall not be less than the values given in Figure 4. The horizontal plane is defined as the plane containing the longitudinal axis of the airplane and is perpendicular to the plane of symmetry of the aircraft.

Position Light Considered	Angle (x) from Right or Left of Longitudinal Axis measured from dead ahead (0°)	Minimum Intensity (candelas)
Type I (forward, red)	0° ≤ x ≤ 10°	40
Type II (forward, green)	10° < x ≤ 20°	30
	20° < x ≤ 110°	5
Type III (rear, white)	110° ≤ x ≤ 180°	20

FIGURE 4 - MINIMUM INTENSITIES IN THE HORIZONTAL PLANE, FORWARD AND REAR POSITION LIGHTS

3.2.2.1 Minimum Intensities Above and Below the Horizontal Plane

The intensities in any vertical plane shall not be less than the appropriate value given in Figure 5 when I is the minimum intensity specified in Figure 4 for the corresponding angles in the horizontal plane. Vertical planes are defined as planes perpendicular to the horizontal plane.

Angle (y) above or below Horizontal, in any Vertical Plane	Minimum Intensity (I)
0°	1.00 x I
0° < y ≤ 5°	0.90 x I
5° < y ≤ 10°	0.80 x I
10° < y ≤ 15°	0.70 x I
15° < y ≤ 20°	0.50 x I
20° < y ≤ 30°	0.30 x I
30° < y ≤ 40°	0.10 x I
40° < y ≤ 90°	0.05 x I

FIGURE 5 - MINIMUM INTENSITIES IN ANY VERTICAL PLANE, FORWARD AND REAR POSITION LIGHTS

3.2.3 Maximum Intensities in Overlap Regions, Forward Position Lights, Types I and II, and Rear Position Lights, Type III

The intensities in the overlap regions between any forward or rear position lights shall not exceed the values given in Figure 6. Area A includes all directions in the adjacent dihedral angle which pass through the light source and which intercept the common boundary plane at more than 10 degrees but less than 20 degrees. Area B includes all directions in the adjacent dihedral angle which pass through the light source and which intercept the common boundary plane at more than 20 degrees (Figures 2 and 3).

	Maximum (Candelas)	
	Area A	Area B
Type I (fwd, red) in dihedral angle R	10	1
Type I (fwd, red) in dihedral angle A	5	1
Type II (fwd, green) in dihedral angle L	10	1
Type II (fwd, green) in dihedral angle A	5	1
Type III (rear, white) in dihedral angle L	5	1
Type III (rear, white) in dihedral angle R	5	1

FIGURE 6 - MAXIMUM INTENSITIES IN OVERLAPS BETWEEN FORWARD AND REAR POSITION LIGHTS

3.2.3.1 When the peak intensity is greater than 100 candelas, the maximum overlap intensity may exceed the values given in Figure 6, provided the overlap intensity in Area A is not greater than 10% of the peak position light intensity and the overlap intensity in Area B is not greater than 2.5% of the peak position light intensity.

3.3 Position Light Colors

The colors of the position light shall be in accordance with Figure 7 and shall conform to 3.3.1.

Type	Dihedral Angle
Type I (forward, red)	Aviation Red
Type II (forward, green)	Aviation Green
Type III (rear, white)	Aviation White

FIGURE 7 - POSITION LIGHT COLORS

3.3.1 Position Light Color Specifications

The colors of the position lights shall have the (CIE 1931, 2 degrees observer) International Commission on Illumination chromaticity coordinates per color definitions reported in this section.

Color definitions that have been practiced by industry's TSO and certification programs.

a. Aviation Red

Purple Boundary	y = 0.980 - x
Yellow Boundary	y = 0.335

b. Aviation Green

Yellow Boundary	x = 0.360 - 0.080y
White Boundary	x = 0.650y
Blue Boundary	y = 0.390 - 0.171x

c. Aviation White

Yellow Boundary	x = 0.500
Red Boundary	y = 0.382
Purple Boundary	y = 0.047 + 0.762x
Blue Boundary	x = 0.285
Green Boundary	y = 0.150 + 0.640x
and	y = 0.440

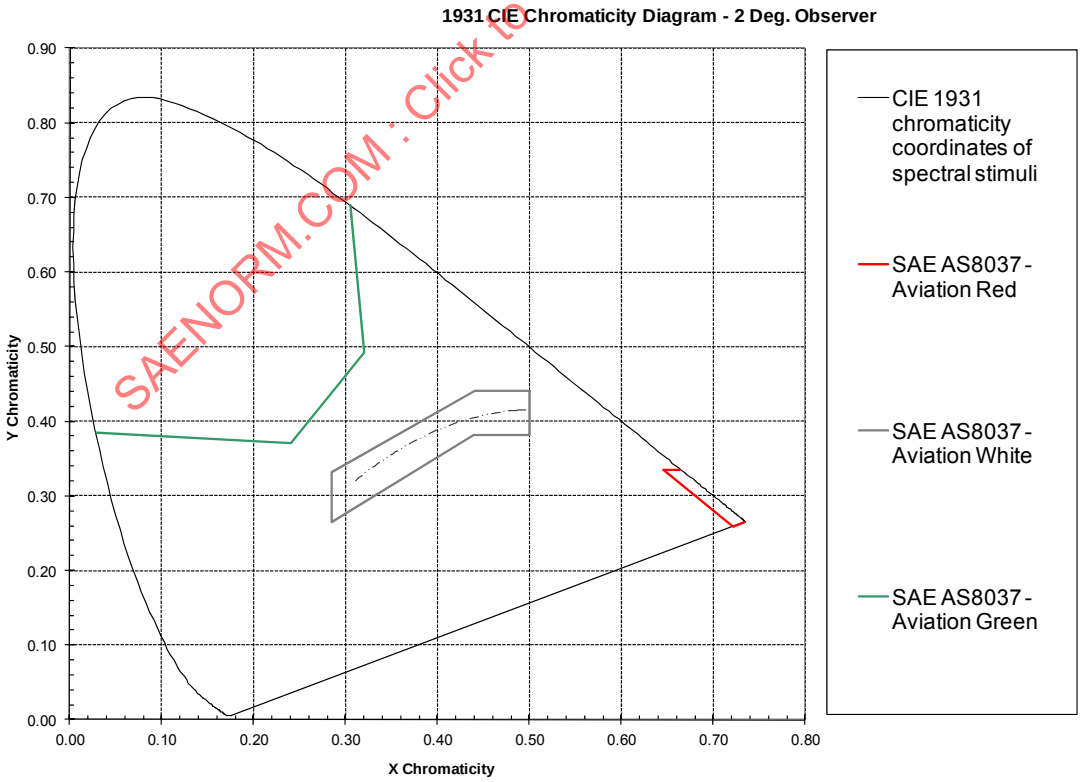

FIGURE 8 - AVIATION COLOR DEFINITIONS IN CIE1931 COLOR DIAGRAM

3.4 Light Covers, Color Filters, and Light Emitting Diodes (LED)

For all position lights, the light covers or color filters used shall not readily support combustion and shall be constructed so that they will not change shape or permanently change color or shape or suffer any appreciable loss of light transmission during normal use.

3.4.1 Red Filters

Red color filters commonly used have a characteristic where the color changes and luminous transmission decreases with temperature rise. Therefore, both the color and intensity distribution testing shall be performed under standard ambient temperature conditions of 25 °C ± 5 °C. This requirement is intended to produce results which will be more representative of actual aircraft installation and in-flight temperature environment.

3.4.2 LEDs

LEDs commonly used have a characteristic where the color (slightly) changes and luminous intensity decreases with temperature rise. Therefore, both the color and intensity distribution testing shall be performed under standard ambient temperature conditions of 25 °C ± 5 °C. This requirement is intended to produce results which will be more representative of actual aircraft installation and in-flight temperature environment.

3.5 Multiple Installations

If the lighting distribution for any one type of position light is supplied by two or more lights which are located immediately adjacent to each other (generally 2 feet or less), the intensity distribution shall be determined with both lights operating and mounted in the same relationship to each other as they would be on the aircraft. If the lights are not located immediately adjacent to each other, intensity distributions shall be determined individually for each light and the minimum intensity in any direction shall be provided by either one or the other light. Additive intensity cannot be used to demonstrate compliance with the minimum required intensity for non-adjacent lights.

3.6 Measurements

3.6.1 Laboratory ambient temperature shall be 25 °C ± 5 °C.

3.6.2 Input Power

Intensity measurements should be performed at nominal input voltage. Compliance shall be demonstrated by testing or other means at the lower and higher normal voltage limits to show compliance for all normal input voltages.

3.6.3 Forced Air Cooling

There should be no external forced air cooling (fans and other drafts) during measurements, except in cases where their use is required to simulate the aircraft's operating environment.

3.6.4 Warm Up and Stabilization

For purposes of demonstrating compliance with this specification, all photometric and color measurements for LED sources shall be made after a minimum of warm up period of 30 minutes, or after the light has reached thermal stabilization, whichever is longer. Stabilization shall be defined as the point in which light output does not change by more than 3% over a 15 minute period. The minimum warm up period for incandescent/tungsten halogen light sources is 90 seconds.

3.6.5 Cover Lens

Intensity measurements must comply with the cover lens in place. However, intensity measurements can be performed with or without the aircraft cover lens installed. When measuring without the cover lens, analyses shall be used to show compliance.

3.7 Definition of Operating Lifetime

Operating Lifetime is the duration for which the light is expected to meet the minimum intensity requirements when intensities are measured per 3.6.

Environmental and installation conditions affect Operating Lifetime. In the case of LED based lights, lumen maintenance is a function of junction temperature. Lumen maintenance for typical laboratory ambient conditions (T = 25 °C ± 5 °C) and other elevated or lower expected flight test temperatures and their exposure times (50 °C, 71 °C with a 3 knot wind for 3 hours per day, for example) can be used to help estimate actual Operating Lifetimes for particular flight patterns. This data would be used to define the aircraft's installation environment.

Continuing airworthiness can be achieved by a number of methods, some of which are:

- limiting on-wing Operating Lifetime based on an estimation of component laboratory life with adjustments which take into account actual operating conditions on-the-ground and in-flight, or;
- limiting on-wing Operating Lifetime based on active feedback from an integrated light sensor or;
- requiring Aircraft operators to measure intensity levels at regularly scheduled maintenance intervals to ensure compliance.

4. PERFORMANCE STANDARD UNDER ENVIRONMENTAL CONDITIONS

4.1 Unless otherwise specified herein, the test procedures called out in 4.2 are those set forth in Radio Technical Commission for Aeronautics (RTCA) Document No. 160.

4.1.1 The order of the tests must be in accordance with DO-160. The test procedures specified or referenced are satisfactory for use in determining the performance of position lights under normal and extreme environmental conditions. Alternate approved test procedures that provide equivalent results may be used.

4.2 Environmental Tests

In this section, the meaning of "no significant lighting degration or degradation in lighting" is that the light must stay lit without flickering or flashing during the test, and following the test, lights shall not suffer any significant loss of intensity.

4.2.1 Temperature and Altitude Tests

When lights are subjected to the tests of DO-160 as appropriate, they must operate electrically and show no significant lighting degradation.

4.2.2 Humidity

After being subjected to the tests of DO-160 Category C (or more stringent) humidity environment, the system must operate electrically and show no significant lighting degradation. Optical parts may be cleaned if necessary.

4.2.3 Vibration

When the system is tested in accordance with DO-160 Category S (or more stringent) vibration environment; there shall be no more than three incandescent light source failures during the test.

NOTE: Not applicable to other light source technologies.

4.2.4 Explosive Atmosphere

Systems which are to be marked with an explosion-proof category must be tested or an analysis performed in accordance with DO-160 Category A.

4.2.5 Waterproofness

Devices which are to be marked with a Waterproofness Category must be tested in accordance with DO-160. After being subjected to the tests, the system must operate electrically and show no significant lighting degradation. External surfaces of Optical parts (i.e., such as Lens Assemblies) may be cleaned if necessary.

4.2.6 Fluids Susceptibility

Systems which are to be marked Category F must be tested in accordance with DO-160. After being subjected to the tests, the system must operate electrically and show no significant lighting degradation. External surfaces of Optical parts (i.e., such as Lens Assemblies) may be cleaned if necessary.

4.2.7 Sand and Dust

Systems which are to be marked Sand and Dust Category D must be tested in accordance with DO-160. Following this test lights shall not suffer any loss of photometric characteristics beyond intensity minimums of 3.2.2.1 and 3.2.3. External surfaces of Optical parts (i.e., such as Lens Assemblies) may be cleaned if necessary.

4.2.8 Fungus Resistance

Systems which are to be marked Fungus Category F must be tested or an analysis must be performed in accordance with DO-160. Following testing there shall be no signs of significant corrosion of any of the parts.

4.2.9 Salt Spray

Systems which are to be marked with a Salt Spray Category must be tested in accordance with DO-160 Category S (or more stringent). Following this test there shall be no signs of significant corrosion of any of the parts.

4.2.10 Power Input Test

Systems will be subjected to the power input tests for normal operating conditions per DO-160. After being subjected to the tests, the system must operate electrically and show no significant lighting degradation.

4.2.11 Voltage Spike

The system shall be subjected to voltage spike testing per DO-160. After being subjected to the tests, the system must operate electrically and show no significant lighting degradation.

4.2.12 Audio Frequency Conducted Susceptibility

The system shall be subjected to the audio frequency conducted susceptibility tests specified in DO-160. After being subjected to the tests, the system must operate electrically and show no significant lighting degradation.

4.2.13 Induced Signal Susceptibility

The system shall be subjected to the induced signal susceptibility tests specified in DO-160. After being subjected to the tests, the system must operate electrically and show no significant lighting degradation.

4.2.14 Radio Frequency Susceptibility

The system shall be subjected to the radio frequency susceptibility tests specified in DO-160. After being subjected to the tests, the system must operate electrically and show no significant lighting degradation.

4.2.15 Emission of Radio Frequency Energy

The system shall be tested in accordance with radio frequency emissions requirements of DO-160, for the category to which the system is designed.