SAE Aerospace
An SAE International Group

AEROSPACE RECOMMENDED PRACTICE

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Superseding ARP5297

Recommended Qualification Tests for Halogen Miniature Lamps Less Than 35 Watts for Aircraft Applications

RATIONALE

This document has been composed to provide guidance for qualification testing of halogen lamps. It has been updated to provide additional testing guidelines.

1. SCOPE

This SAE Aerospace Recommended Practice (ARP) provides the qualification test procedure requirements for low wattage halogen lamps (less than 35 Watts) intended for use primarily in aircraft applications. The purpose of these tests is to provide a laboratory means of determining the performance characteristics of lamps under airplane power and other environmental conditions and to verify the integrity of the lamp design and production processes.

2. REFERENCES

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 the 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

2.2 CEN Publications

EN 2756 Lamps, Incandescent Test

2.3 RTCA Publications

Available from Radio Technical Commission for Aeronautics Inc., 1828 L Street, NW, Suite 805, Washington, DC 20036, Tel: 202-833-9339, www.rtca.org.

DO-160 Environmental Conditions and Test Procedures for Airborne Equipment (latest applicable revision).

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
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3. GENERAL REQUIREMENTS

3.1 Test Conditions

Unless otherwise specified, tests are to be conducted under the following ambient conditions:

a. Temperature: 10 to 30 °C (50 to 86 °F) ±2 °C (±3.6 °F)

b. Humidity: 20 to 80% ±5% Relative

c. Pressure: 25 to 31 inches of Mercury (846.5 to 1049.8 millibars)

Where tests are specified at other than ambient conditions, the following tolerances apply:

a. Temperature: ±2 °C (±3.6 °F)

b. Humidity: ±5% Relative

c. Altitude: ±5%

3.1.1 Performance Degradation

Regarding photometric performance, “without performance degradation” means that the lamp should not suffer any significant visually detectable loss of intensity during and following any test, as applicable.

3.1.2 Test Configuration

It is recommended that the environmental tests listed in this document be performed with the lamp in its actual fixture with and the lens in place, as applicable.

3.2 Test Samples and Group Samples

Test samples must represent production lamps and must be subjected to production screening. In order to reduce time in a qualification program, lamps are to be divided into five groups of 10 lamps each, and they should be tested per the sequence shown in Table 4.

3.3 Production Screening Test

The purpose of this test is to eliminate lamp infant mortality failures. Every production lamp should be subject to an operational screening at rated voltage for 0.2% of its rated life or 5 hours whichever is lower.

3.4 Control Test

Purpose: The purpose of this test is to verify the lamp’s performance before and after each qualification test.

Procedure: This test should include a physical examination along with photometric and lamp current measurements at rated voltage. Lamps should be physically inspected for conformance with the appropriate lamp specification regarding physical dimensions and workmanship.

Pass/Fail Criteria: After 5 minutes of operation or thermal stabilization (whichever is longer), if the light output is less than or greater than 20% of the lamp’s rated mean spherical candle power (MSCP) intensity specified values, or the lamp current is less than or greater than 5% of its rated current at rated voltage, then the lamp fails the control test.

4. QUALIFICATION TEST REQUIREMENT

4.1 Photometric Test

Purpose: The purpose of this test is to measure the lamp's light output and lamp current at rated voltage, at 5% below rated voltage and at 5% over rated voltage. Note: it is also recommended that a UV Radiation test be performed on new lamps to insure that their UV Radiation is similar (within +/- 20%) of that generated by lamps that are already in agreement with this Aerospace Recommended Practice.

Procedure: The lamp is placed in a calibrated integrating sphere photometer. For calibration of the photometric equipment, standard lamps traceable to master standard lamps which are traceable to the National Institute of Standards and Technology should be used. The lamp is powered by an AC or DC power supply at the lamp's rated voltage level. After reaching thermal stabilization or 5 minutes (whichever is longer), the MSCP and the input current is to be recorded. Repeat the MSCP measurement at 5% over rated voltage and at 5% below rated voltage. Verify that the measured data meets expected values.

Pass/Fail Criteria: The lamp's input power (IxV) should be equal to ±5% of the specified values, and the MSCP should be within ±20% of the appropriate lamp specification.

4.2 Electrical Tests

4.2.1 Insulation Resistance

Purpose: The purpose of the insulation resistance test is to verify the integrity of the isolation between the lamp's two lead wires or between its contact and the outer base.

Procedure: Mechanically break the filament and then measure the isolation resistance between the mutually insulated terminals, e.g., between lead wires or between the contact and the outer base. The insulation resistance is to be measured at 500 VDC.

Pass/Fail Criteria: The insulation resistance should not be less than 100 MΩ.

4.2.2 Dielectric Strength

Purpose: The purpose of this test is to verify the integrity of the isolation between the two lead wires or between the contact and the outer base.

Procedure: A dielectric withstanding voltage of 1500 V rms, 60 Hz, is to be applied between the isolated lead wires or between the contact and the outer base for 1 minute. The voltage should be applied and removed at a uniform rate of 250 to 500 volts per second.

Pass/Fail Criteria: Any arcing as evidenced by flash over, spark over, breakdown or leakage current exceeding 2 milliamperes will constitute a failure. After this test the above insulation resistance test should be repeated.

4.2.3 Power Input and Voltage Spike

Purpose: The purpose of these tests is to verify that the lamp operates satisfactorily under aircraft power conditions.

Procedure: The lamp is to be tested to the requirements (either for its AC and DC voltage sources, or both) as described in Section 16, Power Input, and Section 17, Voltage Spike, of RTCA/DO-160. In case where a transformer must be used to step-down the voltage for a low voltage lamp, e.g., 115 VAC/28 VAC, then all abnormal input voltage, surge voltage and others are to be applied to the transformer's primary. If the test voltages are applied directly to the lamp, then the test voltages (except the Voltage Spike test) are to be calculated accordingly with the same ratio as the transformer's input/output ratio..

Pass/Fail Criteria: The test article should operate satisfactorily without burnout or degradation of performance as described in Section 3.1.1..

4.3 Environmental Tests

4.3.1 Thermal and Altitude

Purpose: The purpose of these tests is to verify the performance of lamps which are to be used in non-temperature controlled and non-pressurized areas.

Procedure: The lamps are to be tested per Section 4 of RTCA/DO-160, for Category D2 equipment.

Pass/Fail Criteria: The lamps should operate satisfactorily without performance degradation as described in Section 3.1.1.

4.3.2 Thermal Variation

Purpose: The purpose of this test is to verify satisfactory performance of the lamps during normal temperature variations between high and low operating temperature extremes, specified for Category B equipment, as defined in Section 5.2 of RTCA/DO-160.

Procedure: Lamps are to be tested per Section 5, Temperature Variation, of RTCA/DO-160.

Pass/Fail Criteria: Any degradation of lamp performance as described in Section 3.1.1 will constitute a failure.

4.3.3 Salt Spray

Purpose: The purpose of this test is to determine the effects on the lamp after prolonged exposure to a salt atmosphere or to salt spray as experienced in normal operation.

Procedure: Lamps are to be tested per Section 14, Salt Spray, of RTCA/DO-160, Category S. After completion of Salt Spray Testing, the Insulation Resistance and Dielectric tests should be performed.

Pass/Fail Criteria: Any evidence of corrosion of the base, an insulation fault or damage to the contacts will constitute a failure.

4.3.4 Humidity

Purpose: The purpose of this test is to determine the effects on the lamp after prolonged exposure to Humidity as experienced in normal operation.

Procedure: Lamps are to be tested per Section 6.0, Salt Spray, of RTCA/DO-160, for which ever category applies. After completion of Humidity testing, the Insulation Resistance and Dielectric tests should be performed.

Pass/Fail Criteria: Any evidence of corrosion of the base, an insulation fault or damage to the contacts will constitute a failure.

4.3.5 Fluids Susceptibility

Purpose: It is recommended that the lamp, while in its specific housing, be tested for Fluids Susceptibility. The purpose of this test is to determine the effects on the lamp after prolonged exposure to Fluids Susceptibility as experienced in normal operation.

Procedure: Lamps are to be tested per Section 11.0, Fluids Susceptibility, of RTCA/DO-160, and only the specific fluids experienced during the lamp's specific application are required. After completion of Fluids Susceptibility testing the Insulation Resistance and Dielectric tests should be performed.

Pass/Fail Criteria: Any evidence of corrosion of the lamp, an insulation fault or damage to the contacts will constitute a failure.

4.4 Mechanical Tests

It is recommended that the lamp be tested to validate compliance to the mechanical test per EN 2767. However, consideration should also be given to the lamp's housing application; therefore, vibration testing per RTCA/DO-160 using each lamp's specific housing is also recommended.

4.4.1 Vibration

Purpose: The purpose of this test is to verify that the performance of the lamp design complies with the standard vibration requirement for equipment mounted on an instrument panel, console, equipment rack, or light fixture as used in fixed wing aircraft with turbojet engines.

Procedure: Lamps are to be subjected to the Standard Vibration Test as defined in Section 8 of RTCA/DO-160 after aging for 25% of their rated life. The vibration spectrum should be from 5 to 2000 Hz, and the acceleration power spectral density level test category selected to match each specific application (i.e., as those required for equipment mounted on instrument panels, consoles, equipment racks or light fixtures). Throughout the entire vibration test the power (at rated voltage) to the lamps must be switched with a cycle of 10 minutes on and 10 minutes off.

Pass/Fail Criteria: At the completion of the Vibration test, lamps should still be functioning and show no evidence of damage to any lamp component or experience loose parts due to the vibration testing.

4.4.2 Tensile Test

Purpose: The purpose of this test is to verify the integrity/strength of the lamp base and its ability to handle the insertion force experienced during lamp installation.

Procedure: For bi-pin lamps, an insertion force as specified in Table 1 is to be applied progressively between the bulb and one of the pins along the axis of the pin for 1 minute.

For bayonet base lamps, an insertion force as specified below is to be applied progressively between a surface simulating a terminal of the lamp socket and the center contact of the base along the axis of the base for 1 minute.

Pass/Fail Criteria: After the test, lamps should function normally, and there should be no sign of lamp component damage or deformation.

TABLE 1 - INSERTION FORCE

Type of Base	Bi-pin	Bayonet	Others
Insert Force	10N*	15N*	*
* This is the recommended force. It is recommended that the lamp manufacturers and light assembly manufacturers provide the required values for each specific application.			

4.4.3 Rotational Torque Test

Purpose: The purpose of this test is to verify the integrity/strength of the lamp base and its ability to handle the rotational torque experienced during lamp installation.

Procedure: A rotational torque, as defined in Table 2, of which the axis coincides with that of the base, is to be applied progressively between the bulb and the base. This force is maintained for 1 minute.

Pass/Fail Criteria: After the test, lamps should function normally, and there should be no sign of lamp component damage or deformation.

TABLE 2 - INSERTION TORQUE

Type of Base	Bayonet	Others
Insert Torque	0.5Nm*	*
* This is the recommended torque. It is recommended that the lamp manufacturers and light assembly manufacturers provide the required values for each specific application.		

4.5 Life Tests

4.5.1 Static Operating Life Test

The Static Operating Life of the lamps is defined as the time from when the static life test begins until the time when 50% of the lamps fail.

Purpose: The purpose of this test is to determine the lamp Static Operating Life in controlled laboratory conditions without power interruption except at several specified periods for light output verification.

Procedure: Lamps are to be operated at their rated voltage and their operating current is to be monitored for indication of light loss. The light output (MSCP) should also be monitored. If the light output of a lamp lost more than 20% of its initial light output, then remove that lamp from the test.

If the lamp is intended for both DC and AC voltage applications, then two groups of lamps (one for each rated voltage) are required for this test.

Pass/Fail Criteria: A lamp burning out or losing more than 20% of its initial light output or a lamp which has a rated current 20% above or below its rated value will constitute a failure.

4.5.2 Accelerated Static Life Test

Purpose: The purpose of this test is to reduce the qualification test time for the lamp Static Operating Life Test described in Section 4.5.1 (i.e., potentially by more than 4000 hours). This is accomplished by running the Static Operating Life test at 10% over the lamp's rated voltage and using the relationship between lamp life and operating voltage to calculate the lamp's Static Operating Life (See Eq. 1). This test may be used in place of the Static Operating Life Test of Section 4.5.1.

Procedure: The accelerated Static Operating Life test is conducted the same as described in Section 4.5.1 except that lamps should be powered at 10% over their rated voltage. The following formula is the relationship between Operating Life and operating voltage.

$$\text{Accelerated Lamp Life} = \text{Rated Lamp Life} \cdot \left(\frac{\text{Rated Voltage}}{\text{Operating Voltage}} \right)^{12} \quad \text{(Eq. 1)}$$

Pass/Fail Criteria: A lamp burning out or losing more than 20% of its initial light output at its elevated operating voltage will constitute a failure.

NOTE: for safety reasons, because of the high fill pressure of Halogen lamps, it is recommended that the manufacturer be consulted before performing this test.

4.5.3 Dynamic Operating Life Test

Purpose: The purpose of this test is to determine the performance of the lamps under different operating conditions such as temperature, power cycling, over voltage and vibration.

Procedure: These tests should consist of the five phases defined in Table 3.

Pass/Fail Criteria: Lamps should function normally and show no sign of lamp component damage or deformation after all phases.