SAE Aerospace
An SAE International Group

AEROSPACE RECOMMENDED PRACTICE

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High Intensity Discharge Light Sources

RATIONALE

The use of high intensity discharge (HID) light sources on aircraft has increased substantially in the past few years. HID light sources, like many other light sources, can potentially be dangerous if not used properly. This document addresses characteristics of HID systems that need to be considered for aircraft applications.

1. SCOPE:

This SAE Aerospace Recommend Practice (ARP) is intended to recommend safety related best practices when using metal halides high intensity discharge (HID) lamps and power supplies in aircraft applications.

1.1 Purpose:

The purpose of this document is to set forth safety related considerations and criteria which should be observed when designing high intensity discharge (HID) lamps and power supplies for aircraft applications.

2. REFERENCES:

CIE S 009/E:2002: Photobiological Safety of Lamps and Lamps Systems.

FAA AC 43.13-1B, section 15: Acceptable Methods, Techniques, and Practices – Aircraft Inspection and Repair. Grounding and Bonding

SAE ARP1870: Aerospace Systems Electrical Bonding and Grounding for Electromagnetic Compatibility and Safety

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3. BACKGROUND:

3.1 High Intensity Discharge:

HID lamps emit light by producing a luminous arc that operates in a dense vapor atmosphere between two electrodes. An igniter supplies the high voltage necessary to start the lamp, and a ballast controls the lamp operation after start-up. Typical HID lamps exhibit very high luminous efficacy (up to 100 lumens per watt), long life (500 to 4000 hours) and a high correlated color temperature (over 4500 K).

3.2 Applications:

HID lighting systems applications include landing and taxi lighting, taxi camera lighting, wing and engine scan lighting, logo lighting, cargo lighting (interior and exterior), and maintenance/loading area lighting.

4. ISSUES AND RECOMMENDATIONS:

In this section, we describe safety related issues and propose best practices to address those issues.

4.1 High Voltage Containment:

Lamp startup voltage can reach 25 KV (hot re-strike). High voltage must be contained particularly at altitude where dielectric breakdown occurs more easily. To a minimum, qualification for operation in (fuel) vapor rich environment should include procedure to ignite the lamp at altitude (it is recommended to test for voltages higher than the typical maximum ignition voltage). Alternatively, dielectric breakdown test can be performed at sea level using adjusted (higher) voltage to simulate conditions at altitude. Preferably, the igniter should be an integral part of the lamp assembly or such that it is placed in as close proximity to the lamp as possible since the extremely high voltage between the igniter and the lamp can pose a serious danger for the installation.

4.2 Start Characteristics:

Light needs to be available quickly for applications like landing and taxi lighting. For these types of applications, some light should be available within 2 seconds after powering to signal the pilot proper functioning, and 70% of full luminous power should be reached within 10 seconds of ignition. For other applications (logo lights, cargo loading for example), some light should be present within 2 seconds after powering but 70% of full luminous power can be reached within 1 minute of ignition.

4.3 Hot Re-strike Capability:

The action of igniting an HID that was just turned off is called hot re-strike. Typically, HIDs require a higher ignition voltage for hot start than for cold start. The HID power supply should be capable of igniting the HID burner within 10 seconds of extinction (and after the lamp has been on for at least 3 minutes).

4.4 Pulsing Capability:

This is a particularly important feature for landing light as pulsing is frequently used to help control tower personnel identify aircraft. Pulsing does not require full extinction of the lamp. Instead, the light level may drop to 25% or less of nominal power.

4.5 Dimming Capability:

Wing and engine scan light may require dimming capability when used during aerial refueling operation. HID may be stepped instead of being continuously dimmed. This process usually results in loss of lamp life.

4.6 EMI Considerations:

Start voltage creates EMI and must be considered in RF emissions qualification test. Standard practices should be followed. In addition, attention should be given to emissions generated during ignition.

4.7 Lamp Burst Containment:

Pressure in the bulb may reach 50 bars when hot. There is a small risk of lamp burst in the on and off states. The bulb enclosure must be able to contain the burst to prevent damage to other components. Steps to reduce the possibilities of lamp burst include: absence of fingerprints/body oil; operation with compatible ballast; replacement of the bulb when scratched, cracked or damaged in any way; electrical insulation of any metal support in contact with the outer bulb (to avoid glass decomposition).

4.8 Faulty Lamp Detection:

The power supply should include a faulty lamp detection feature to turn the lamp off automatically as lamp failure is detected (open and short circuit detection). This is particularly important to prevent arc formation after lamp burst.

4.9 Ultra Violet (UV) Protection:

UV exposure can damage skin and eyes. Long exposure may occur in cargo and bay area lighting applications. Lamp assemblies should be equipped with UV filtering features (UV jacket, lens) to keep worst case UV exposure under International Commission on Illumination safe level (publication CIE S 009/E:2002, Photobiological Safety of Lamps and Lamps Systems). Preferably, the bulb should contain an outer shell that filters a large portion of the UV energy.

4.10 Warning Label, High Temperature:

Bulb glass can reach several hundred degree Celsius when the bulb is in operation and can remain very hot for a few minutes after operation. Maintenance personnel should wear protective gloves and eye protection when replacing bulbs. In addition, a minimum cool down period should be recommended to minimize the risks of injuries.

4.11 Warning Label, High Voltage:

Ensure power is off before handling the lamp. In addition, a waiting period should be recommended in consideration for potential capacitive discharges.

4.12 Warning Label, UV Rays:

Prolonged UV exposure can damage skin and eyes. A lamp should not be operated without its UV filtering lens installed. If there is a need to operate the lamp without its UV filtering lens, it is imperative to wear safety UV glasses and protective clothing.

4.13 Replacement Lamp Identification Label:

Some HID bulbs of different wattage have common sockets. Most ballasts provide constant power (not constant voltage or constant current). Therefore it is imperative that the lamp wattage match the ballast constant power level. The lamp identification label should clearly indicate the lamp type to minimize chances of installing the wrong lamp.