SAE INTERNATIONAL

AEROSPACE RECOMMENDED PRACTICE

ARP5647 REV. A

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Superseding ARP5647

(R) High Intensity Discharge Light Sources

RATIONALE

Information contained herein has been expanded from ARP5647 to include additional design considerations unique to HID technology including explosion proofness and outgassing. Additional FAA reference documents have been added as well.

1. SCOPE

This SAE Aerospace Recommend Practice (ARP) is intended to identify both safety related best practices and unique design considerations of 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 specific 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 ARP1870A: Aerospace Systems Electrical Bonding and Grounding for Electromagnetic Compatibility and Safety

RTCA/D0-160G: Environmental Conditions and Test Procedures for Airborne Equipment.

FAA Federal Aviation Regulation Part 25 Section 1383 - Landing Light Requirements

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 in a contained arc tube. An igniter supplies the high voltage necessary to start the lamp, and ballast controls the lamp operation after start-up. Once the arc sufficiently heats the enclosing fused quartz or ceramic arc tube, metal salts evaporate and greatly increase the lights intensity and luminous efficacy. Typical HID lamps exhibit high luminous efficacy (up to 100 lumens per watt), long life (500 to 4000 operational hours) and a high correlated color temperature (over 4500 K).

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3.2 Applications

HID lighting systems are typically used for applications including landing, taxi, runway turnoff lighting, ground maneuvering 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 25KV during hot re-strike conditions. High voltage must be contained particularly at altitude where dielectric breakdown occurs more easily. At a minimum, qualification of HID equipment, particularly in fuel vapor rich environments, should include a procedure to evaluate dielectric breakdown at the luminaries maximum operating altitude. It is recommended to test at voltages 20% higher than the 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.

Materials in close proximity to the high voltage contacts within the lamp and igniter should be chosen to avoid outgassing within the lamp assembly. Outgassing can result in undesirable chemical reactions with other parts of the luminaire, and degradation of optical surfaces.

HID equipment in fuel rich environments shall also comply with explosion proofness requirements identified in DO-160.

4.2 Start Characteristics

A visible quantity of light should be available to the observer within 2 seconds of powering on the light. Such response times provide visual feedback to the user that the light is functioning properly. For Landing, Taxi, and Runway Turnoff lights 70% of the lamps peak output should be available within 10 seconds of ignition. For other less critical systems such as Logo, and Cargo Loading lights 70% peak output shall 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 lamps require a higher ignition voltage for hot start than for cold start due to the existing pressure and metal salts already in vapor form. 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 may be used by control tower personnel to identify and communicate with an aircraft. Pulsing does not require full extinction of the lamp. Instead, the light level may drop to 25% or less of nominal power. It should be noted that the high voltages required for hot re-striking, cycling, and igniting a HID lamp contribute significantly to electrode degradation and thus lamp end of life.

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 and guidelines identified in Section 21 of DO-160 should be followed. In addition, attention should be given to emissions generated during ignition. The lamp and power supply must not interfere with the aircraft power system, or other aircraft equipment.

4.7 Lamp Burst Containment

Pressure in the bulb may reach 50 bars (725 psi) when hot. There is a small risk that the arc tube may burst under such increased pressures, in either the on or off states. The risk of arc tube rupture increases near the bulb's end of life. 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.

4.8 Faulty Lamp Detection

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

4.9 Ultra Violet (UV) Protection

The arc generated in an HID light source, particularly metal halide, can produce large amounts of UV radiation. UV exposure can damage skin and eyes. Long exposure may occur in cargo area lighting applications. Lamp assemblies should be equipped with UV filtering features (UV jacket, lens) to keep UV exposure within 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

HID bulbs can reach several hundred degrees 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 reduce the risk of injury.

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 a UV filter installed. If there is a need to operate the lamp without a UV filter, 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.

4.14 Grounding and Bonding

Proper grounding and bonding is required to minimize/eliminate the risks of burst, personnel shock, and reduce EMI.

Aircraft lighting and their power supplies should use the aircraft structure as a ground reference. Internal circuits that are transformer isolated from aircraft power should also be ground referenced to the enclosure. Power supply enclosures should act as a grounded electrical shield for all of the internal circuitry. Likewise, the enclosures used for light assemblies that are not integrated into a power supply enclosure (e.g., gear mounted take-off lights), should also act as electrical shields and be grounded to the aircraft structure at designated bonding points. A minimum of four bonding points should be designated and be located to form a rectangular pattern of relatively equal center to center spacing between the points.

Electrical connections (inter-connecting cables) between the power supplies and light assemblies should be provided with shielded cables. The cable shields are electrically connected to the enclosures.