AEROSPACE RECOMMENDED PRACTICE

ARP4967™ REV. C

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Superseding ARP4967B

Night Vision Imaging Systems (NVIS) Integrally Illuminated Information Panels

RATIONALE

Minor technical updates were made to the document, including aligning panel thickness with current industry practice, adding metric units to multiple sections, and updating the brightness of marking section to clarify luminance uniformity. Additionally, the statement regarding the performance of blue/green NVIS filters and changes in lamp color temperature was reworded.

1. SCOPE

This document is intended to highlight critical design issues that a panel designer should understand when designing panels for NVIS applications. It is not intended to be a discussion of the benefits of one lighting technology versus another. Refer to ARP4168 for a more complete discussion of these lighting technologies.

1.1 Purpose

This document covers design considerations for NVIS panels when utilizing incandescent, electroluminescent (EL), or LED light sources that, when filtered, produce NVIS compatible panels that meet the requirement specified in MIL-L-85762 or MIL-STD-3009.

2. REFERENCES

2.1 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.

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2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

ARP4168 Night Vision Goggle (NVG) Compatible Light Sources

ARP4169 Night Vision Goggle (NVG) Filters

2.1.2 U.S. Government Publications

Copies of these documents are available online at https://quicksearch.dla.mil.

MIL-DTL-7788 Panels, Information, Integrally Illuminated

MIL-L-85762 Lighting, Aircraft, Interior, Night Vision Imaging System (NVIS) Compatible

MIL-PRF-5425 Plastic Sheet, Acrylic, Heat Resistant

MIL-PRF-19500/708 Displays, Diode, Light Emitting, Solid State, Red, Numeric and Hexadecimal, With On Board Decoder/Driver

MIL-STD-3009 Lighting, Aircraft, Night Vision Imaging System (NVIS) Compatible

NASM3498 Screw Assembly, Panel

2.2 Definitions

NVIS COMPATIBLE, INTEGRALLY ILLUMINATED INFORMATION PANELS: Panels where the spectral wavelengths, luminance level, and uniformity will not interfere with the intended use of night vision goggles and allow the crew member to view the panel with the unaided eye.

3. LIGHT SOURCES

3.1 Lamps, Incandescent

The designer needs to select a lamp that is compatible with the available power, which normally in incandescent applications is 5.0 V or 28.0 V. In type IV or V panels (as defined by MIL-DTL-7788), it is recommended to use T-1 short length wire terminal bulbs which, because of their size, are readily adaptable to NVIS compatible filters which are available. Selection of lamps should also take into consideration that some NVIS filters also will absorb a significant amount of available light. Maximum power consumption limits on the panel manufacturer should not be too restrictive.

3.2 Lamps, Electroluminescent

The phosphors used in thick film EL lamps have spectral distribution emissions which are essentially contained within visible spectrum with little emission in the near infrared. However, some filtering is generally required to meet the NVIS radiance requirements of MIL-L-85762 or MIL-STD-3009.

Thick film EL lamps are AC operated devices and, therefore, AC power (typically 115 V/400 Hz) must be available to the panel. This is normally accomplished by either aircraft power or using small, low power DC to AC inverters.

3.3 Lamps, Light-Emitting Diodes

LED lamps may be either hermetic or plastic encapsulated packages with leads for either through-hole or surface-mount assembly.

The LED lamps should be selected for light output and color and undergo reliability screening as may be deemed necessary.

Screening should be performed in accordance with either MIL-PRF-19500/708 or as detailed in the LED lamps specification.

3.4 Further Data

For a more complete discussion of the properties of incandescent and EL lamps and additional details relative to light sources, refer to ARP4168.

4. DESIGN CONSIDERATIONS

4.1 Panel Thickness

As defined by MIL-DTL-7788, the finished panels, excluding grommet and power connectors, shall be 6.096 mm ± 0.584 mm (0.240 inch ± 0.023 inch).

4.1.1 Incandescent and LED Panels

The thickness of standard cast acrylic sheet manufactured to MIL-PRF-5425 typically runs at nominal or thinner than it does to the plus side of the tolerance. It is recommended that the finished acrylic bezel thickness selected accommodates the various lengths of cylindrical optical filters, which are available to the panel manufacturers and still allow enough acrylic between the top of the filter and the face of the panel, as specified in MIL-DTL-7788.

4.1.2 Electroluminescent Panels

EL lamps are a flat area light source, and thus panels utilizing them do not require light piping and/or cylindrical filters. This allows EL panels to be made as thin as 2.54 mm (0.100 inch) when required, which is well below the requirements of MIL-DTL-7788, or the recommended design thickness for incandescent panels.

4.2 Color of Illumination

The lettering, numbering, and marking on the panel shall be white in daylight when the lighting units are not energized. When the lighting units are energized, the light transmitted through the panel markings and all elements illuminated by the panel shall fall within the area of the 1976 CIE chromaticity diagram described as u'1=0.088, v'1=0.543, r≤0.037 as specified in MIL-L-85762 for NVIS green "A." Special consideration in the paint selection must be included since the white paint used for non-NVIS panels can fluorescence when illuminated with NVIS filters. Color selection for the paint should be in accordance with MIL-DTL-7788, paragraph 3.6.2.1, Table II.

4.3 Brightness of Markings

The luminance of all markings on the panel, per MIL-DTL-7788, shall be 3.4 cd/m^2 ± 1.7 cd/m^2 (1.0 fL ± 0.5 fL) with nominal voltage applied to the connector. The luminance uniformity within a given panel and the average luminance ratio panel to panel should be taken into consideration. MIL-L-85762 requires the average luminance ratio to be ≤ 2:1.

4.4 Mounting Techniques

MIL-DTL-7788 specifies grommets and captive screws, per NASM3498. Manufacturers may offer a variety of alternative mounting techniques.

4.5 Power Requirements

Power draw at rated voltage varies between the two technologies.

4.5.1 Incandescent Panels

Power requirements will vary based on panel layout which determines the quantity of lamps and filters.

4.5.2 Electroluminescent Panels

Power requirements are roughly 7 mW/cm^2 (45 mW/in^2) of lighted area.

4.5.3 LED Panels

Power requirements will vary based on panel layout which determines the quantity of LEDs and filters.

4.6 Rated Voltage

MIL-DTL-7788 specifies 5.0 V ± 0.05 V or 28.0 V ± 0.1 V for incandescent panels, except for incandescent blue/white panels which are rated at 4.5 V ± 0.05 V and 115 V ± 2 V 400 Hz ± 5 Hz for EL.

5. NVIS COMPATIBLE FILTERS FOR MIL-DTL-7788 PANELS

5.1 Filters for Incandescent Lamps

The incandescent lamps used in type IV and type V panels need to be filtered to achieve NVIS compatibility as defined by MIL-L-85762 or MIL-STD-3009. Filters, made of NVIS compatible filter material, are used to encapsulate the lamps.

The NVIS compatible material transmits the lamp's energy in the wavelength region where NVIS has little or no sensitivity, typically in the blue and green regions of the visible spectrum. The filter material suppresses the red and near-infrared energy from the lamp to reduce the amount of energy which is emitted in the NVIS response region.

The spectral distribution of an incandescent lamp varies as a function of applied voltage. As a result, the color coordinates of the filtered lamp will also vary. It is important to consider this variability when selecting a filter. For example, some filter materials will exhibit a large color shift as a function of the applied voltage. These materials are typically very blue in color. Greener-appearing filters are much less susceptible to this color shift. A panel will remain in the specified color region over the entire operating range of the lamp.

Similarly, the measured NVIS radiance of the filtered lamp will also vary as a function of the applied voltage. In general, NVIS radiance (scaled to the specified luminance level) increases as voltage is reduced on an incandescent lamp. Therefore, it is possible to meet the MIL-L-85762 or MIL-STD-3009 requirements for NVIS radiance at a particular voltage level, however, at lower voltage levels, the measured NVIS radiance of the same component can exceed the maximum allowable value. Again, this phenomenon is related to the transmission curve of the filter material. Certain filter materials are more susceptible to this variation in NVIS radiance than others.

A final consideration for the selection of filter material is the need to make the panels uniform in appearance with respect to other lighting sources in the cockpit. Typically, edge lighted panels are in proximity to other emitting light sources such as monochromatic CRTs or LED displays. Green is the most common color of these displays. Therefore, it is important that the color of the panels surrounding these displays appears as close as possible to the display color. Green filter material will provide this uniformity and will eliminate the "Christmas tree" color variation which is undesirable in an NVIS-equipped cockpit.

5.2 Filters for Electroluminescent Panels

There are several filters available to filter the energy from the EL source to meet the requirements of MIL-L-85762 or MIL-STD-3009. These filters generally range in thickness from 0.254 to 0.763 mm (0.010 to 0.030 inch) depending on the manufacturer.

The spectral distribution of an EL lamp does not vary as a function of the applied voltage and, therefore, the color and NVIS radiance (scaled to the specified luminance level) remain constant as the intensity is varied. This simplifies filtration requirements.

5.3 Filters for LED Panels

The LEDs used in type VII panels still require some level of filtering to be fully compliant to MIL-L-85762 or MIL-STD-3009. LED spectral distribution does not change as radically as incandescent lamps will. Therefore, large color shifts will not be a factor in considering filter selection. However, the mixing of LED and incandescent panels within the same cockpit can create a multitude of green colors. Therefore, it is important that the filter selection should aid in providing a uniform color that will match the other nearby light sources within the cockpit environment.