

Bright Ideas

Performing accurate, repeatable measurements at low spectral radiance levels requires understanding of specifications.

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The sensitivity of micro-channel plate image amplification elements in night vision imaging systems (NVIS) goggles has increased in absolute value, spectral range, and resolution. These increases have caused concern regarding compatibility with aircraft cockpit instrumentation displays and lighting. The near-IR energy generated by cockpit lighting affects the automatic gain control of the NVIS goggles, blinding the goggles and endangering the entire aircraft crew.

To address this compatibility problem, the U.S. Naval Air Development Center (NADC) developed MIL-L-85762, which set acceptable radiance and irradiance levels and measurement methods. The latest revision to this specification, MIL-STD-3009, addresses new types of displays such as fluorescent or LED-backlit active matrix LCDs. The specification includes three relative-response functions that describe spectral sensitivity curves for different applications of night-vision devices (see figure). Applying the response functions to the spectral radiance data from the device yields the respective NVIS radiance level.

Measurement Equipment

MIL-STD-3009 specifies a spectroradiometer for measuring chromaticity and spectral radiance over the wavelength range from 380 to 930 nm. These measurements must be made at a half-power bandwidth of 10 nm and a root-mean-square signal-to-noise ratio of 10:1. Such specifications require a spectroradiometer with a sensitivity of at least 1.7×10^{-11} W/cm²-sr-nm with a 10:1 signal-to-noise ratio in the 600- to 900-nm region.

Practically speaking, however, measuring lighted cockpit instrumentation to 1% repeatability requires spectroradiometer sensitivities 100 to 1000 times higher than those specified in MIL-STD-3009 (current-generation spectroradiometers exceed this practical requirement by as much as two orders of magnitude). Although MIL-STD-3009 allows the display under test to be set to a luminance level of 15 ft-L, many manufacturers make the measurement at the scaling luminance

level of 0.1 ft-L. The underlying reason for this action is that the spectral power distribution of the display backlight shifts as the intensity of the display is changed. At high-intensity settings the display may fail, but at low-intensity settings (at which they are typically used with goggles) they will not exceed the MIL-STD requirements.

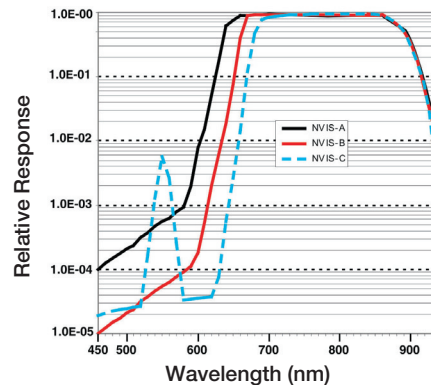
Calculation Method

Once the spectral radiance of a cockpit-lighting component has been accurately determined, the engineer must calculate the NVIS radiance. Consider measurements for a Class A device. First, we determine the luminance of the lighting component to permit computation of the scale-factor value. The scale factor allows the measurement results to simulate the luminance level that would typically be used when viewing cockpit displays with goggles. Depending on the application, the luminance L_D used to calculate the scale factor for NVIS can vary from 15 ft-L to 0.1 ft-L. Suppose, for example, analysis of the spectral radiance data yields a measured luminance $L_M = 5.432$ ft-L (18.610 cd/m²). Then for NVIS Class A radiance, the scale factor S set to a luminance L_D of 0.1 ft-L is $S = L_D/L_M = 0.01841$.

Second, we apply the known scale factor to the spectral radiance data, which is then convolved with

the relative NVIS Class A response function $G_A(\lambda)$ and integrated over the 450- to 930-nm spectral region. The result of this integral is the NVIS Class A radiance of the lighting component; specifications require that it fall below 1.7×10^{-10} NR_A.

New specifications can be tricky, but with a clear understanding of the definitions and goals, MIL-STD-3009 can yield accurate, repeatable results. **oe**



NVIS radiance Class A includes the lowest wavelengths and hence has the highest gain of the available night sky illuminance; Class B sensitivity turns on at a higher wavelength, so it is generally less sensitive. Class A, Class B, and Class C night-vision devices have different applications in battlefield use. Class A goggles are used by helicopter pilots and Class B goggles are used in faster jets that use more color in cockpit-indicator lighting. The Class C function is used with the newer displays.

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