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THE OL 770-NVS SPECTRORADIOMETER & AEROSPACE VEHICLE COCKPIT LIGHTING MEASUREMENT GEOMETRY

Application Note: A21 Jan 2022

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The most often used geometry for the measurement of cockpit lighting for NVIS compatibility is the method employed for primary lighting measurements where the viewing optics of the measurement system is imaged directly onto the emitting source. See Figure 1.

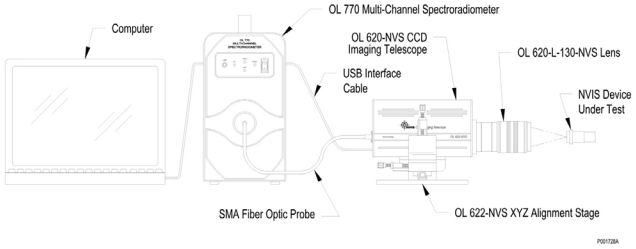

Figure 1.

Section 5.7.12.1 MIL-STD-3009 *(4.8.14.1 of MIL-L-85762A)* states the spectroradiometer employed for primary lighting spectral radiance measurements must meet the requirements contained within Appendix A of the specification. Appendix A section A.3.9 *(B30.9 of MIL-L-85762A)* states if the spectroradiometer is used to determine the source luminance, then the spectroradiometer optics must be capable of allowing measurement spot sizes down to 0.007 inches. Most commonly these are measurements of alpha-numeric characters or symbology on buttons and panels within the cockpit. The rationale behind the 0.007 inch spot size requirement is that in order to obtain an absolute luminance value, the spectroradiometer measurement aperture must be imaged within the stroke width of a single display character, i.e. the measurement is performed with measurement aperture in an "overfilled" condition as illustrated in Figure 2. The image obtained in Figure 2 was obtained by the CCD camera contained within the OL 620-NVS telescope and illustrates the measurement spot size in relation to the stroke width of the character being measured.

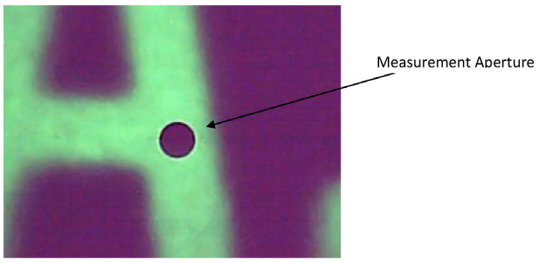

Figure 2

If the spectroradiometer system cannot image an aperture within the area of a single character, then a separate luminance meter capable of doing so must be utilized to determine the source luminance from which the scaling factor will be determined and then applied to the relative spectral radiance data obtained by the spectroradiometer.

The purpose of the scaling factor is to adjust the spectral radiance data so the luminance computed from the scaled radiance data matches the luminance requirements of Table III and III.a *(Table IX in MIL-L-85762A).* The scaling factor can make a dramatic difference in the NVIS radiance values reported as illustrated by the spectral radiance data contained in Figure 3. This data was obtained from the measurement of a Green A primary lighting component operating at 3 fL, resulting in a unscaled NRa value of 1.93 E^{-9} watt/sr cm^2. Once scaled to the 0.1 fL rating specified in Table IX, the NRa value to be reported drops to 6.45 E^{-11}, well under the 1.7 E^{-10} upper limit specified for this type of lighting component.

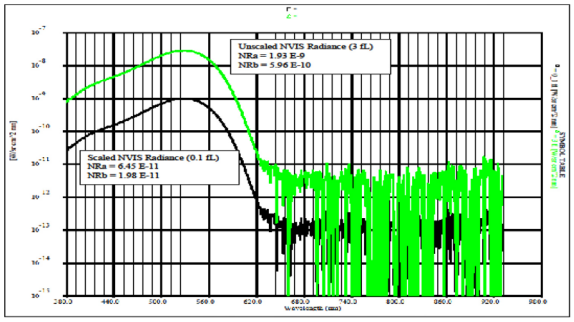

Figure 3

Clearly, there is a significant advantage to using a spectroradiometer capable of providing absolute luminance values rather than having to utilize two separate measurement systems in order to determine the NVIS radiance of a source. The OL 620-NVS CCD Imaging Telescope equipped with the OL 620-L-130-NVS lens provides a 0.007 inch measurement spot size, allowing the capability to image the measurement aperture with the stroke width of a single character.

MEASUREMENT OF MULTI-FUNCTION DISPLAYS

Multi-Function Displays *(MFD)* that contain either a CRT or LCD to convey flight information require a larger measurement spot size in order to avoid sampling only a few pixels when performing a measurement. In accordance with this measurement requirement, section 5.7.12.1 MIL-STD-3009 *(4.8.14.9 of MIL-L-85762A)* states the measurement shall similarly be in accordance with section 5.7.12.1 *(4.8.14.1 of MIL-L-85762A),* but also that the "spectroradiometer shall be placed so that as much of the display as reasonably possible is within the spectroradiometer test field." This statement is meant to avoid a measurement that could potentially sample a small number of pixels that would not truly represent the averaged NVIS radiance of the entire display area. Since the OL 620-NVS telescope accepts interchangeable lenses, substituting the standard OL 620-L-130-NVS lens with the optional

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OL 620-L-114 lens this measurement condition requirement for an MFD condition can easily be met. See Figure 4.

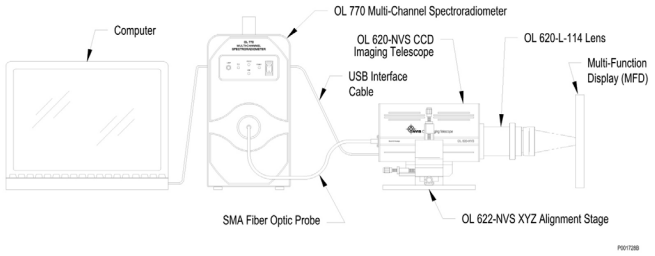
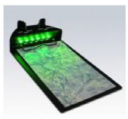


Figure 4.

MEASUREMENT OF SECONDARY LIGHTING



Unlike primary lighting measurements, secondary lighting requires different measurement geometry altogether as the measurement optic is not imaged directly onto the source itself. In this case, a source such as a map light is placed perpendicular to a calibrated white diffuse reflectance standard, and the spectroradiometer viewing optics at a 45 degree angle to the illuminated surface of the reflectance standard and imaged upon it. Normally, the source is operated at a drive condition which provides a 0.1 footlambert (0.343 cd/m^2) luminance level at the surface of the reflective plaque at a distance of 12 inches from the plaque. Again, as in the measurement of CRT or LCD displays, there is no strict limitation on measurement spot size thus larger spot sizes may be used to obtain a better averaging of the projected source beam as well as improve the sensitivity of the spectroradiometer. The only requirement is that the area imaged by the measurement system fall within the illuminated area of the reflectance standard, thus the optional OL 620-L-114 lens may be used to provide a measurement spot size larger than provided by the OL 620-L-130-NVS lens. See Figure 5.

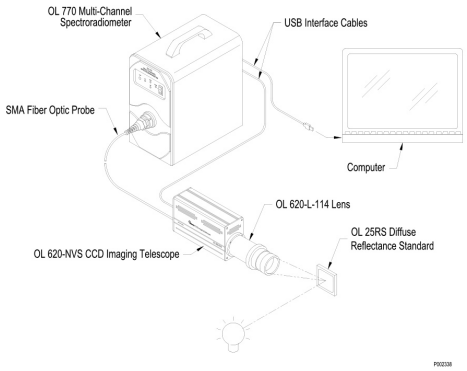


Figure 5.

Head up displays may be measured using alternate geometry. The symbology projected by the HUD onto the combiner in the direct line of view of the pilot may be imaged upon directly by the viewing optics, similar to the measurement of a back illuminated character on a button or switch on the instrument panel. Alternatively, the collimated beam may be projected directly into a measurement system having a lens focused at infinity. Using either method, there is no limitation on measurement spot size, the only criteria being the measurement aperture be in an overfilled condition so absolute values may be obtained. See Figure 6.

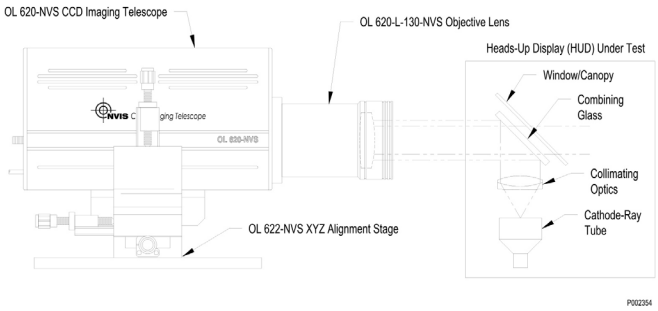


Figure 6. - TBD

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