Basics of NVG Lighting

Aircraft Internal Lighting

When aircrew fly with the aid of NVGs (often simply referred to as "aided" flying) the aircraft instrument lighting and other cockpit and cabin lighting has to be specially modified. The aim is to remove the near infra-red (NIR) and some of the far red wavelengths from the light, as this is the wavelength range over which the NVGs are sensitive. The NVGs use image intensification, and too much emission from the lights in this range means that the NVG performance is degraded, either due to reduced sensitivity or through "blooming" or other undesirable effects in the field of view.

At the same time cockpit instrument and other lighting is required to function normally so it can still be used by the pilot, who will glance below the NVGs to read the instruments, or by other, non-aided, crew members.

The practice of modifying aircraft interior lights for use with NVGs was established in the UK and USA in the mid-1980s, and the performance requirements are now well defined and recognised world-wide. The primary standard is MIL-STD-3009, which defines the colours and the levels of compatibility with the NVGs for specific lighting functions. Compatibility means, in effect, the extent to which the lighting emissions and the NVG sensitivity range overlap each other. The smaller the overlap the more invisible the light will be to the NVG, for a given level of luminance, and so the more compatible the lighting is. The parameter used to define NVG compatibility is NVIS Radiance (NR).

This concept of overlap is shown in Figure 1. The NVIS Green A light output, shown by the green line, has negligible overlap with the NVG response, shown by the dark red line, and so is NVG compatible. The unmodified filament lamp output, shown by the black line, overlaps throughout the response range, and so is wholly incompatible.

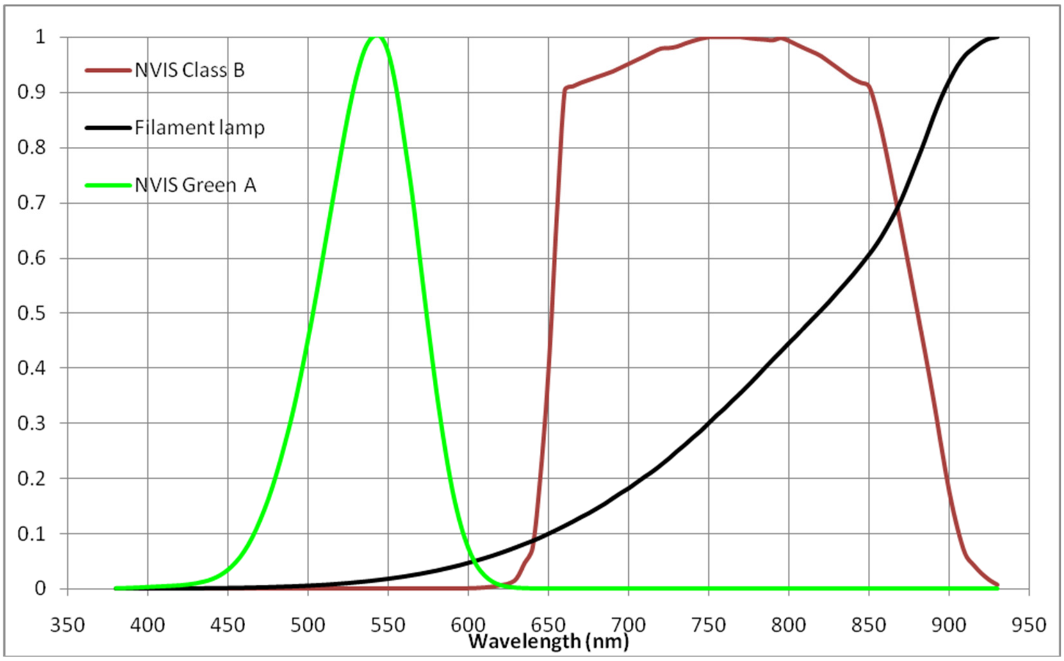

Figure 1. NVG Compatible and Incompatible Lighting Relative to the NVG Response

Aircraft External Lighting

Once the requirement for aircraft internal lighting to be made NVG compatible had been addressed a secondary need emerged for exterior lighting to be modified. This is particularly necessary when aircraft are flown in close formation on NVGs, when their position and anti-collision lights can adversely affect neighbouring pilots' NVGs.

However, whereas internal lighting is generally required to be very compatible, with negligible impact on NVGs, external lighting needs to be visible, both through NVGs and to the naked eye, in order to perform its intended function of providing awareness of position and direction of flight. This means there has to be a greater degree of overlap between the emissions and the NVG response, but not so much that the NVGs are degraded – a balance is required. This is illustrated in Figure 2, where an NVG friendly light output is compared with an NVG compatible source, relative to the Class B NVGs response.

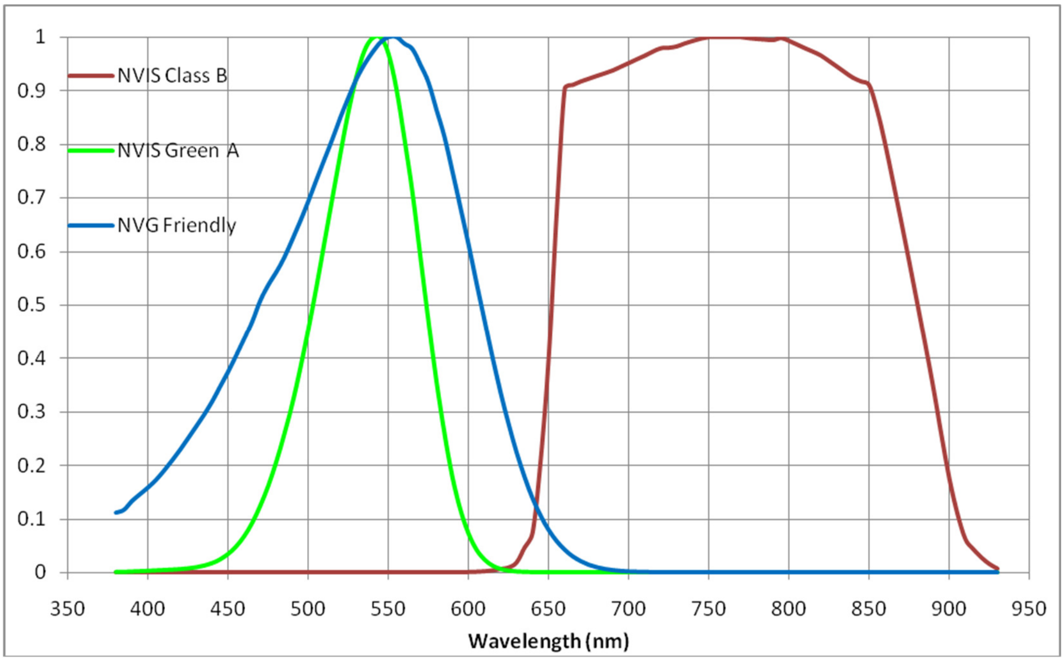

Figure 2. NVG Compatible & NVG Friendly Light Relative to NVG Response

The preferred parameter for defining point sources of this kind is NVIS Radiant Intensity (NRI), rather than NR. An SAE standard, ARP5825, provides recommendations for NRI levels for various external light types, but this standard is by no means as well established or universally recognised as MIL-STD-3009 is for internal lighting.

The type of lighting that is required to be seen through NVGs but without adverse effect is known as NVG friendly lighting

Warship Lighting

When aircraft are flown with the aid of NVGs from or onto the flight deck of a warship a new set of issues arises. Many of the lights need to remain switched on, for two possible reasons. One is that they may have a function in guiding the aircrew onto the flight deck, or at least in providing information to approaching aircrew. The other is that the deck crew and other ship's staff require lighting to perform their tasks.

Although it may be possible for aircrew to revert to unaided flight when close to the flight deck, there are risks in doing so as the human eye has to adapt to a changed focal length and field of view, and probably a different state of dark adaptation. In general they would prefer either to remain on NVGs, or at least to have the choice of using NVGs or not.

The two reasons for using lighting mentioned above, to guide aircrew and to provide illumination for ship's staff, naturally lead on to the distinction between NVG friendly and NVG compatible lighting.

The lighting that is to be seen by NVG aided aircrew should be NVG friendly, in the same way that aircraft exterior lighting should be NVG friendly. It must be seen by both unaided aircrew and those using NVGs so that it can still perform its normal function, but it must not interfere with NVG performance.

The lighting that is for the benefit of the ship's staff should not, in general, be visible to the aircrew, with one or two exceptions, as it could create confusion. Therefore it should be NVG compatible. It needs to be of adequate quality that the crew can perform their tasks and yet have minimal output in the response band of the NVGs.

Ultimately NVG lighting on warships should be seen as a safety aid, particularly for peace time and training operations.

In summary the benefits of having NVG lighting on aviation capable warships are very clear:

NVG aided aircrew can carry out operations without being forced to revert to unaided operation close to the ship, or without suffering dangerously reduced visibility through NVGs when close to the ship.

Ship's staff can carry out their normal operations in fully lit, safe conditions at night with no danger of affecting NVG operations. Deck edge and trip hazards can be seen, and colours can be differentiated.

Figure 3 shows the impact of an unmodified stern light on a UK carrier viewed from an approaching aircraft on NVGs. Not only is there substantial blooming of the NVGs due to the direct light, there is also a major impact from light reflected off the sea, and the overall image through the NVGs is severely degraded.

The second image, Figure 4, shows the stern light switched off. There is still some impact from unmodified quarterdeck and boat bay lighting, which is in fact of very low luminous intensity and practically invisible to the naked eye at that range. However, the remainder of the deck lights, such as the runway marker lights and the approach lights around the edge of the flight deck are clearly visible without creating any adverse effect.

Figure 5 shows the flight deck close up through NVGs, illustrating that the lights are clearly visible and yet have minimal impact on NVG performance, even at this close range.

Figure 3. Impact on NVGs of Unmodified Stern Light

Figure 4. Stern Light Switched Off

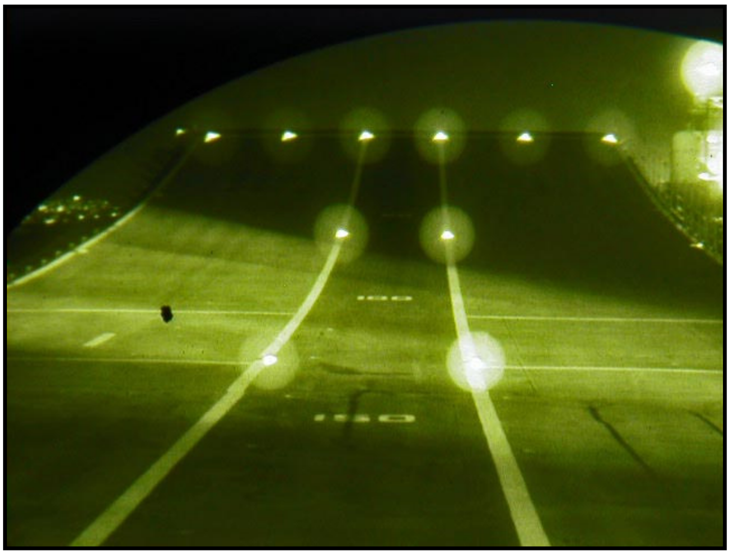

Figure 5. Flight Deck Modified Lighting Close Up

It is also important for internal lighting emitting onto the flight deck or otherwise visible to aircrew to be modified. Figure 6 shows the superstructure of an aircraft carrier in port. The Flyco is completely modified except for some small red LED indicators, while the Bridge is unmodified. The lighting levels in both are comparable, yet the difference through NVGs is very obvious. The difference would be emphasized further in a truly dark environment.

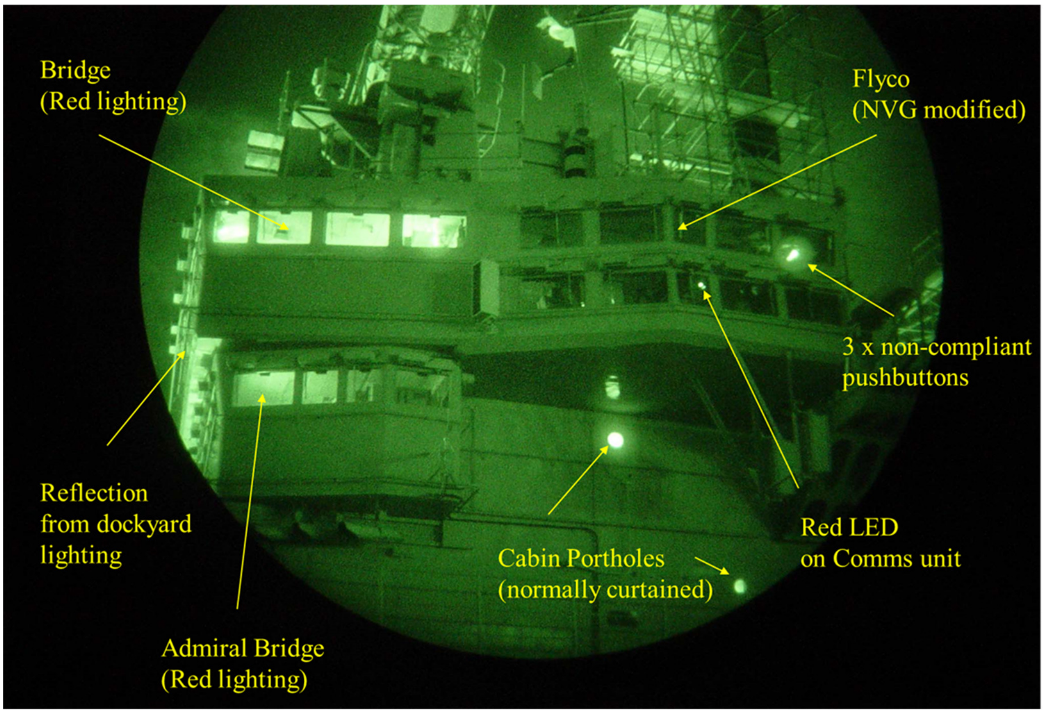

Figure 6. Importance of NVG Internal Lighting