Lighting the dark

As increasing numbers of international helicopter air ambulance operators consider the use of night vision goggles, what are the factors to consider when converting aircraft to be 'NVG-compatible'? Sara Waddington sheds some light on the subject

Night vision goggles are used by US HEMS operator STAR Flight

David Krussow / STAR Flight

When properly used, night vision goggles (NVG) can help to increase safety, enhance situational awareness and reduce pilot workload and stress during night operations. NVG eliminate the need for a 'sterile light environment', so that a medic in the cabin, for example, can work on a patient under bright lights while retaining the pilot's ability to fly safely under night conditions.

The Australian Civil Aviation Safety Authority (CASA) philosophy on the civil use of NVG is similar to that of the conclusions of an FAA study on the subject. The philosophy is: provided that NVG operations are properly prepared, equipped and trained for, there is considerable potential for enhancing the overall safety of night helicopter operations; and the proper use of NVG has the potential to enhance the safety of visual flight at night by assisting the crew's ability to see the horizon and terrain, observe much

> the external filters allow the modified component to remain generic

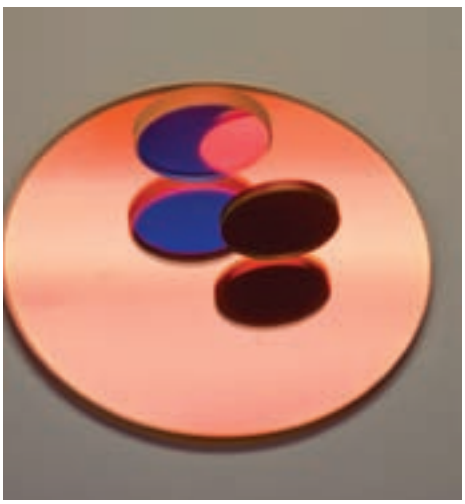
of the inflight meteorological conditions, and to identify objects that may cause a hazard to flight. CASA also underlines that careful consideration needs to be given to the suitability of NVG for certain types of operation. For example, over-water operations to small offshore islands, ships, decks or offshore platforms are most likely to be conducted in a low-contrast environment, which is generally not conducive to the use of NVG. Many variables can adversely affect the safe and effective use of NVG, such as flying towards a low-angle moon, flying in a shadowed area, flying near extensive cultural lighting and flying over low-contrast terrain. It is important to understand these limitations when considering the capabilities of NVG. However, there is no doubt that NVG today adds a valuable layer of safety to HEMS operations, a fact that has increasingly been recognised by various international regulatory authorities.

Night vision imaging systems (NVIS)

CASA describes NVG-compatible lighting as aircraft interior or exterior lighting with spectral wavelength, colour, luminance level and uniformity that has been modified or designed for use with NVG, and does not degrade or interfere with the image intensification capability performance of the NVG beyond acceptable standards. It further delineates NVIS as the system in which all of the elements required to operate an aircraft effectively and safely using NVG are integrated, including NVG and associated equipment, NVG-compatible lighting, other associated aircraft components and equipment, associated training and recency requirements as well as continuing airworthiness. NVIS is synonymous with aviator night vision imaging systems, sometimes called ANVIS.

A standard NVG cockpit conversion may include a combination of NVIS-compatible filters, bezels, post-lighting, internal modifications, bulb replacements and floodlighting to modify all instrumentation in both the cockpit and cabin to provide fully night-vision-compatible operations.

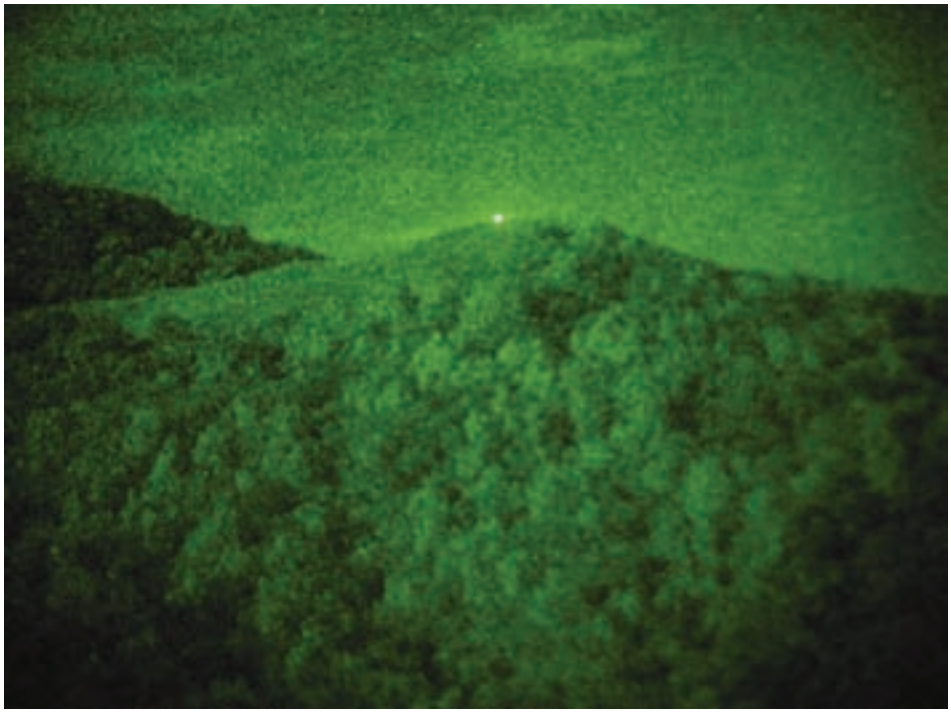
One provider of military and civil night vision aircraft lighting systems is REB Technologies. Based in Bedford, Texas, the company has extensive experience developing night-vision lighting for cockpit, cabin and crew stations as well as night-vision systems for external airframe applications. It has several FAA-approved



Consolite's coated glass filters Consolite

supplemental type certificates (STC) and has performed lighting modifications and installations for military and civil customers in over eight different countries.

Development of the civil air medical and law enforcement helicopter markets is evident by the company's sixteen STC modifications in the past several years. REB Tech has also recently completed six new law enforcement helicopters in the US with the company's night vision cockpit and cabin lighting equipment and systems. Earlier this year, it delivered two aeromedical Bell 407 helicopters with REBtech-equipped cockpits to Med-Trans.



Even low-power light sources will show up brightly with NVG, as with this image where a lost hiker can easily be located ASU

On 24 October 2008, United Rotorcraft Solutions (URS), and partner Ahlers Aerospace were awarded an FAA STC for their night vision lighting modifications on the Eurocopter EC135. The STC incorporated a modification design using filters that are externally mounted, thus reducing installation time and cost. The external filters allow the modified component to remain generic, thus retaining the advantages of local repair and/or overhaul. The filter material used greatly improves daylight readability.

Air Methods Products Division recently delivered

> conventional cockpit lighting emits a significant amount of light within the same wavelength range to which NVGs are sensitive

a new EMS-equipped EC145 helicopter to Stanford Life Flight in Palo Alto, California. The aircraft cockpit is NVG-compatible and is configured for single-pilot IFR operations. Because of its extensive experience with the use of night vision goggles, LifeFlight Eagle has been able to quickly step up to meet FAA recommendations that air ambulance programmes enhance their level of safety with the use of NVGs. "I could actually see fog roll in along the riverbank," said Marty Pinkham, safety officer for LifeFlight. "Passing clouds were actually casting shadows on the ground. More importantly, we can see telephone poles and wires as clearly as in the day. It is as if you are flying during the day." NVGs have allowed pilots to be more comfortable with their 'go, no go' decisions, commented Chuck Lacelle, assistant director for PHI Air Medical Operations, since their ability to see weather in the distance is now 100 miles in the dark.

Cockpit lighting

Conventional cockpit lighting emits a significant amount of light within the same wavelength range to which NVGs are sensitive. This can cause a reduction in contrast, brightness and visual acuity of the NVG image. NVG-compatible cockpit lighting is required to prevent these problems. Lighting must not decrease the quality of the NVG image, needs to remain bright enough

Nick Rice, MD of Consolite Technology Ltd Consolite

"unmodified cockpit lighting can swamp the NVGs, making it impossible for the pilot to see outside the aircraft"

within the visible light range to enable a pilot to see clearly the helicopter instruments when looking at them unaided under the NVGs, and instrument lighting needs to be adequate for daytime use.

To satisfy these requirements, the amount of light emitted by the cockpit lighting within the same wavelength range to which NVGs are sensitive should be minimised. There are a number of commercial options available to modify the cockpit lighting. They include filters that can be placed over existing cockpit light sources, modified light sources and NVG-compatible cockpit floodlighting.

"The techniques for modifying aircraft cockpit lighting to be compatible with night vision goggles (NVGs) have been well established in the UK and US since the mid-1980s," Nick Rice, managing director and owner of Consolite Technology Ltd, told *Waypoint*. "NVGs are image intensifiers, and therefore make everything brighter, including the cockpit lighting. Unmodified cockpit lighting can swamp the NVGs, making it impossible for the pilot to see outside the aircraft. "Put simply, aviators' NVGs use a filter on the front to restrict the wavelengths seen by the goggles.

A Harrier aircraft with incompatible lights around it in an NVG shot

An upgraded aircraft in for ground test

Adding a complementary filter to the cockpit lighting then makes it effectively invisible to the goggles. The pilot looks under his goggles at the lit instrumentation and through the goggles for an unimpaired view out of the cockpit." He added that the cockpit must be usable by day, night or with NVGs, so 'the lighting must work and not inhibit flight at any time'. Rice added that sunlight readability can be an issue, but is readily overcome with the correct choice of filter and sometimes coatings, and pilots often comment that non-NVG flight is more comfortable with an NVG-configured cockpit.

Consolite Technology Ltd has been involved in the manufacture of NVG-compatible lighting products and the modification of aircraft cockpits since the very early days of the technology, starting with military aircraft in the mid-eighties. Civil aviation has started to adopt this equipment, led by the police and increasingly search and rescue (SAR) and air ambulance services. Gaining approval of the modified cockpits by the civil authorities has been problematic in the past, but is getting easier with better understanding and clearer definitions from the authorities, Rice told *Waypoint*.

"A variety of techniques have been used to modify cockpit lighting," added Rice. "Many involve 'add-ons' that provide compatible lighting externally to the instruments, while the existing internal lighting is switched off. However, the best fits are those that do not disturb the appearance of the cockpit and continue to make use of the internal lighting. This means that the modifications must be integrated into the lighting system and instruments. In most cases, some form of filter is required. This may be a substitute for an existing instrument window, or it could be a filter assembly to go inside an instrument to filter the illumination at source."

Filter types originally used were glass/film laminations, but the options were limited, said Rice. Later, single-piece glass materials became available, but these also have limitations. He continued: "More recently the use of plastics has been developed, originally by Korry Electronics in the US. Specially designed coatings can also be applied to glass or plastic to control the wavelengths passed through the filter."

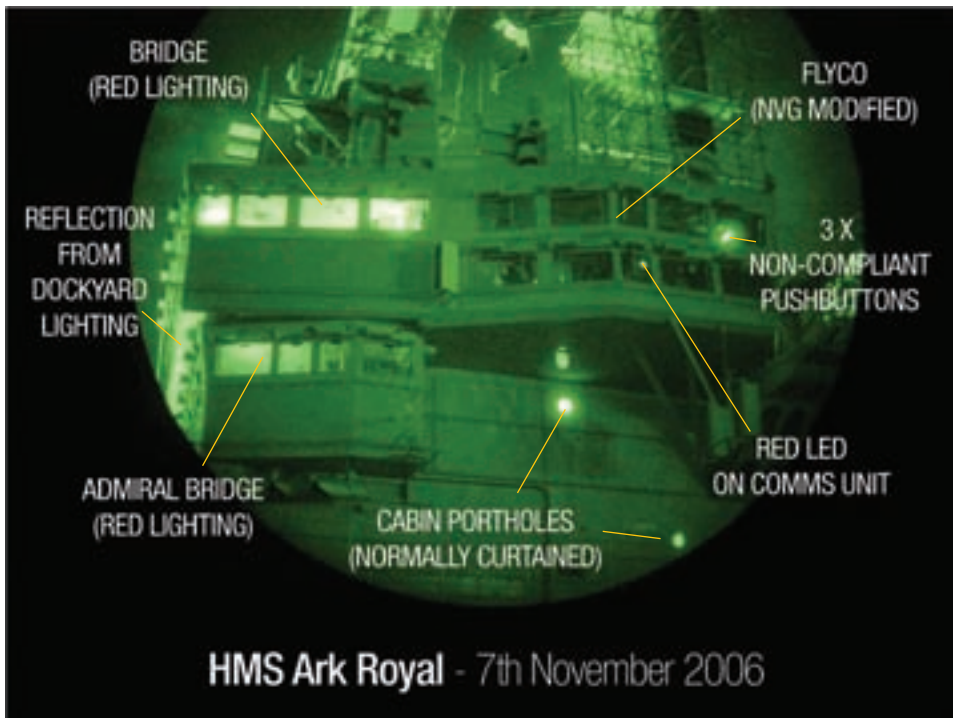
external lighting can also cause a reduction in the quality of the NVG image

A good upgrade company should have knowledge and access to all of these different materials to offer the best solution for any part of the cockpit. The plastic filter approach is a simple one, as the material can be produced in many variations for all types of light source. It can be laser cut or milled so that no specialist machinery is required and can come with anti-reflective coatings if required. Whilst plastics offer the largest variation of filters on the market, they do have limitations. Coatings are not as easily deposited on plastic and it will scratch more easily than glass. To benefit fully from the versatility of plastics and the durability of glass, Korry worked with

Consolite Technology to produce a new product call NS Glass. The plastic is poured between two pieces of glass, which can be coated beforehand. Another simple retrofit is the addition of filtered lamp or LED assemblies.
The modification of cockpit lighting can be a significant cost component of an NVIS installation, due to the use of specialised materials and the significant work involved in conversion and testing of a helicopter cockpit.

External lighting

Lighting modifications required for NVG-compatibility are not limited to components inside the aircraft – external lighting can also cause a reduction in the quality of the NVG image. While it is impractical to modify all external lighting, it may be beneficial to modify the types of lighting that are typically encountered by NVG pilots. This may include lighting at designated landing areas, external helicopter lighting or emergency services lighting on land vehicles.
"Exterior lighting is an important part of the NVG upgrade, as light reflected from the ground or other objects can adversely affect the NVGs," Rice explained. "Filters or high-brightness LED assemblies can be used. A new area of night vision lighting is in the upgrade of aircraft capable warships. Increasingly, flight crews wish to operate from ships with NVGs, so the lighting on the ship requires an upgrade."
Anti-collision lights and other exterior lighting may also have adverse effects on NVG utilisation. Exterior lighting may cause energy to enter the cockpit and adversely affect NVG performance. For example, position lights located near the cockpit, anti-collision light reflections possible from the main rotor blades, and reflections off clouds or dust etc. may interfere with NVG performance in the cockpit. External lighting can be made compatible by using NVG-compatible filters or globes, by shielding the light from the cockpit or implementing specific operational procedures.



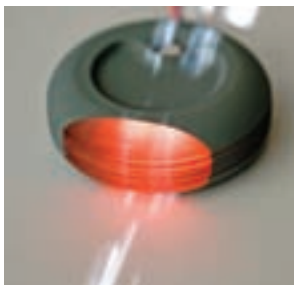
The bridge of the Ark Royal aircraft carrier at night

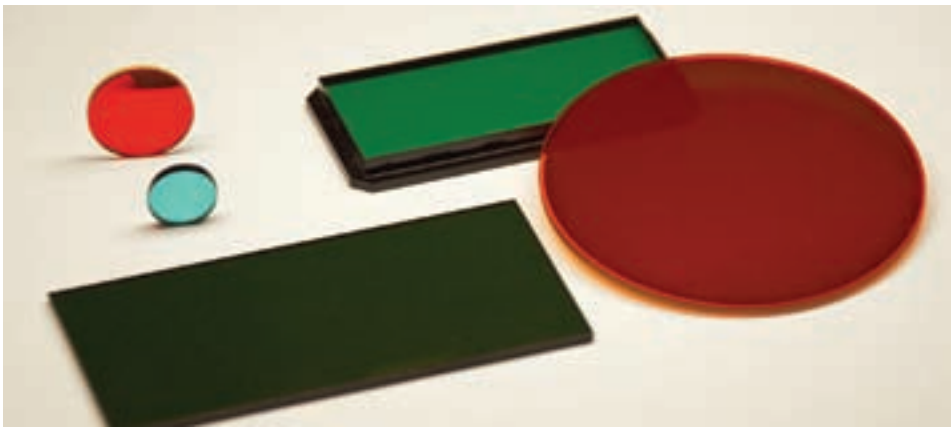
> it may be useful to equip flight and ground crew with NIVS-compatible torches and utility lights

Additional considerations

A radar (radio) altimeter may assist in mitigating depth perception problems with NVGs at critical times (such as take-off and landing), by providing additional height information. CASA and the Federal Aviation Administration (FAA) mandate that a radar altimeter must be fitted to any helicopter performing NVIS-assisted operations. Consideration may also be given to methods that reduce glare on the windscreen such as non-reflective cockpit paint and extension of the glare shield. It may also be useful to equip flight and ground crew with NIVS-compatible torches and utility lights.

For pilots, NVG flight skills are more perishable than day visual flight rules (VFR) flight skills and therefore require increased NVG recency to retain proficiency. A robust training and checking programme should cater for the broad cross-section of operating exigencies. NVIS training curricula have been developed by both civil and military organisations around the world. Appropriate operating procedures should also be considered for all aspects of flight that are likely to be affected by the use of NVGs. It is essential that sufficient resources are available to ensure the safe and effective use of NVGs. Specifically, sufficient resources need to be allocated for the initial cost of the NVGs, the additional costs in the set-up and maintenance of other required hardware, the initial training of crew and support staff, as well as the ongoing costs of recurrent training and airworthiness.


A landing gear control knob assembly with red NVIS lighting Consolite


Cockpit instrument filters come in various shapes, sizes and colours, and can be coated or uncoated Consolite

Acknowledgements:
'Night Vision Goggles in Civil Helicopter Operations', produced in April 2005 by the Australian Transport Safety Bureau for the Australian Government Australia Civil Aviation Safety Authority US Federal Aviation Administration

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