NIGHT VISION:
DEFINING THE DIFFERENCES

IN THIS FIRST OF OUR REGULAR SERIES OF EDUCATIONAL AND SAFETY-RELATED NIGHT VISION COLUMNS, WE TRY TO CLEAR UP SOME MISCONCEPTIONS AND HELP EXPLAIN WHAT TO LOOK FOR WHEN GETTING YOUR GOGGLES AND CREATING YOUR NIGHT VISION SYSTEMS.

by Adam Aldous & David Luke/nvgsafety.com

Since the invention of aviator's night vision imaging systems (ANVIS), there have been many technological advances that have increased the reliability and functionality of the night vision goggles (NVGs) used by aviators. However, different standards don't always mean a new version is superior to a previous one. For example, identifying the ANVIS-9 as superior to the ANVIS-6, based on the fact that nine is higher than six, is simply false.

To explain, let's begin with the terms ANVIS-6 or ANVIS-9, which the helicopter industry commonly references when identifying which NVGs they either have or want. First, the technically correct nomenclature is actually AN/AVS-6 or AN/AVS-9. This military nomenclature is derived from the Joint Electronics Type Designation System (JETDS), more commonly known as MIL-STD-196E. The JETDS used to be called the Joint Army-Navy Nomenclature System (AN System) and was first adopted in 1943.

As spelled out by MIL-STD-196E, the purpose of JETDS is to "standardize the preparation of requests for nomenclature and the assignment of type designations for electronic items," such as radios, radars, weapon control systems, electronic countermeasures, flight control and aircraft navigation aids, lasers, and fiber optics and associated equipment (such as NVGs). Today, military forces in the United States, Canada, New Zealand, Australia and the United Kingdom use MIL-STD-196E as their common nomenclature system.

The three letters used after AN within the JETDS identify the following key points about each designated item: "where it is," "what it is" and "what it does." So, while AN is obviously "army" and "navy," the AVS part of AN/AVS-6 and AN/AVS-9 refers to: A for "piloted aircraft"; V for "visual and visible light"; and S for "detecting/range and bearing, search." The -6 and -9 are the model numbers of specific types of equipment.

SO, WHAT'S THE DIFFERENCE?

The first NVGs designed specifically for flight operations were for the U.S. Army. Their designation was AN/AVS-6. This has since progressed to AN/AVS-6(V)1, 1A, 2 and 3. The original (V)1 and 2 versions had a single interpupillary distance (IPD) adjustment for both monoculars; an objective lens on each monocular, which only turned two-thirds of one turn to go from infinity to close focus; and an eyepiece lens on each monocular with 18 millimeters of eye relief (distance from the lens to the user's eye). The (V)2 designation was the same as the (V)1, but it had an offset fore-and-aft slide assembly on the pivot and adjustment shelf specifically for Bell AH-1 Cobra pilots; this version is now obsolete.

The current enhanced features of (V)1, 1A and 3 include 25-mm-diameter (up from 18 mm) eyepieces for increased eye relief, independent IPD (eye-span) adjustment for each monocular, a more stable mounting point to accommodate various types of flight helmets, and an increased fore-and-aft adjustment capability.

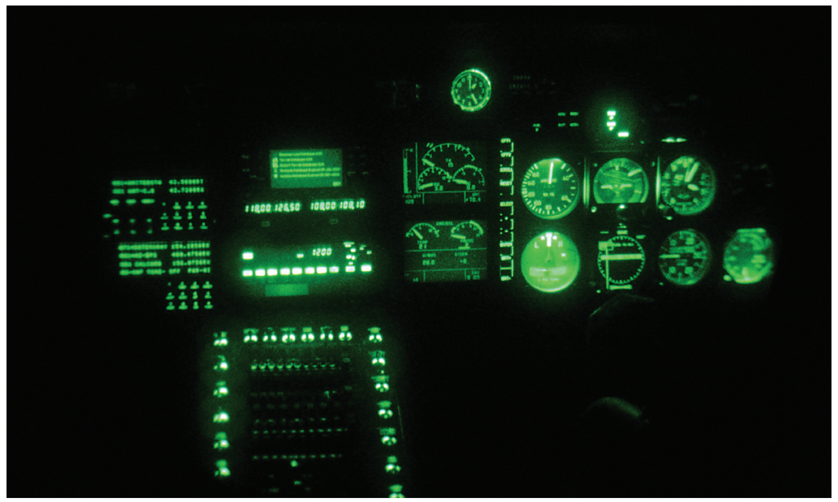
The newest NVG version used in the U.S. Army is AN/AVS-6(V)3. However, through the Army's aviation safety action messages, all (V)1 and 1A NVGs have been upgraded to the (V)3 configuration. The most notable current improvement is the objective lens now goes from infinity (approximately 110 feet) to close focus in just under 360 degrees (i.e., one-turn fine focus). This version also has a new, contoured, low-profile power pack and numerous advancements and variations of image intensifier tube technology.

While the U.S. Army currently uses the designations AN/AVS-6(V) 1, 1A, and 3, the AN/AVS-9 designation was requested by the U.S. Air Force to denote its ANVIS model, which is much like the AN/AVS-6(V)3 it preceded. The notable initial differences between the AN/AVS-6 and AN/AVS-9 were the inability of the AN/AVS-6 to mount to fixed-wing pilot helmet systems and the bulky power pack mounted to the back of the helmet that interfered with the ejection capability of fighter jets. Also, the objective lens assembly on the AN/AVS-6 translates fore-and-aft, while the AN/AVS-9 rotates when adjusting for clear focus of the viewed scene. The U.S. Army requires an objective lens that translates instead of rotates in order to accommodate mounting the AN/AVS-7 heads-up-display (HUD) that attaches to the objective lens. Having a rotating objective lens would mean the HUD symbology rotates when focusing the NVGs.

That's it… those are the differences between ANVIS-6 and ANVIS-9. (Although, it's worth pointing out that there are numerous model variances within ANVIS-9 in regards to helmet mounts, battery packs, objective lens classes, objective lens focus, and HUD compatibility.)

Okay, so what should I be concerned about? Performance and compatibility.

A higher number doesn't necessarily mean a superior goggle: ANVIS-9 is simply a different standard than ANVIS-6. **Mike Reyno Photo**



TOP NVIS-Class-B-modified cockpit lighting as viewed through Class-A objective lens ANVIS-9 NVGs. Making sure the NVGs and the rest of the NVIS are compatible is critical. In this instance, the unfiltered light being emitted in the 625- to 665-nanometer range will activate the automatic-gain-control in newer goggles, causing an ongoing loss of visual acuity for the scene outside the cockpit.

ABOVE NVIS-Class-B-modified cockpit lighting as viewed through Class-B objective lens ANVIS-9 NVGs. Lighting modified to NVIS Class B emits light up to about 665 nanometers. A Class-B objective lens filters all light below 665 nanometers, hence no unfiltered light in the wrong range. The use of the 665 limit, instead of the 625 limit in Class A, allows the additional use of some red lighting, primarily to allow for three-color multi-function displays.

PERFORMANCE CHARACTERISTICS

In general, there are three key components to NVGs — the eyepiece lenses, the objective lenses and the image intensifier tubes — that are combined in numerous configurations to determine the performance of the system. Several factors can be used to measure performance, the most notable is visual acuity (visual clarity). The image intensifier tubes are the key performance components for visual acuity, however, the eyepiece and objective lenses contribute a bit, as well. (An important note for consideration is that numerous variations of image intensifier tubes are currently available under different performance level classifications.)

The general performance of the image intensifier tube, in regards to exportability, is measured by a factor called figure of merit or FOM. FOM is "a numerical quantity based on one or more characteristics of a system or device that represents a measure of efficiency or effectiveness." The FOM for NVGs is derived from the number of line pairs per millimeter (measure of image resolution) multiplied by the tube's signal-to-noise ratio (measure of low-light resolution). Higher FOM values equal higher NVG performance.

Due to the benefits NVGs offer, the U.S. government has recognized that NVG technology has an impact on national security. Accordingly, the U.S. State Department has established export regulations based on the FOM of NVGs. Generally speaking, NVGs are placed into one of two categories — exportable or non-exportable —and are defined by an FOM value. Exportable FOMs are determined by the U.S. State Department on a case-by-case basis (we'll expand on this in a future article).

Another key performance indicator is halo measurement. All non-compatible light sources as viewed from NVGs will produce a halo around that light source. The size of the halo (measured in millimeters) is a performance indicator (smaller is better). Although the halo never gets bigger or smaller, it is sometimes perceived to be changing in size as the viewing distance and/or the intensity of the light source changes. Additionally, an incorrect perception of halo size is often made when viewing numerous, closely grouped light sources together at the same time, such as in brightly lit urban areas.

Other image intensifier tube performance indicators to consider include auto-gated vs. non-gated power supply for the image tubes (auto-gated NVGs are non-exportable), tube and system gain, and black spots.

COMPATIBILITY CONSIDERATIONS

NVGs must be able to exist and perform in harmonious combination with the entire night vision imaging system (NVIS). The NVGs, aircraft lighting configuration and other integration items — such as type of helmet and the use of an HUD — all factor into the complete compatibility of your NVIS. One of the most common compatibility issues occurs when trying to align a "Class A" or "Class B" objective lens on the night vision device with the lighting configuration of the aircraft.

Due to the brightness and spectral characteristics of conventional aircraft lighting and the sensitivity of the NVGs' spectral response in the range of approximately 600 to 900 nanometers in wavelength, the aircraft lighting must be modified for the two to efficiently work together. The image intensifier tube is extremely sensitive to light within this range. Without modification, when light from the instruments, radios or other light sources within the aircraft enters the image intensifier tube through the objective lens, the automatic gain control (if present) will be activated and the NVGs will become less sensitive to the radiance of the outside scene, causing the pilot or crewmember to lose visual acuity when viewing objects outside the cockpit.

There are numerous aircraft lighting modification methodologies available to properly filter the overt light produced within the aircraft. Whichever is used, the key question to answer is: What NVIS lighting classification has the lighting in my specific aircraft been modified to?

There are two modification classifications for aircraft lighting, commonly recognized as either NVIS Class A or NVIS Class B. An aircraft lighting system modified to NVIS Class A emits light up to approximately 625 nanometers, which allows the use of blue, green and some yellow lighting. Lighting modified to NVIS Class B emits light up to about 665 nanometers, which enables the use of some red lighting, primarily to allow for three-color multi-function displays.

NVG original equipment manufacturers, meanwhile, have three specification classes: Class A, Class B and Class C (sometimes referred to as Modified Class B or Leaky Green). During the NVG manufacturing process, a "minus blue" filter is built into each objective lens to reduce the amount of light entering the image intensifier tube. As we'd surmise from the last paragraph, a Class-A objective lens would filter light below 625 nanometers and a Class-B objective lens would filter light below 665 nanometers. This is where the potential incompatibility arises: if the lighting of the aircraft was modified to NVIS Class B and Class-A NVGs are used, the pilot or crewmember's visual acuity would be reduced because the automatic brightness and gain controls in the goggles (if present) would be activated due to the light being emitted in the aircraft in the 625- to 665-nanometer range. As for Class C NVGs, their objective lenses filter light below 665 nanometers, just like Class B NVGs, but they have a "notch" in the filter to allow a small amount of light to enter the image intensifier tube so HUD symbology can be viewed (hence the Leaky Green reference).

IMPORTANT TAKEAWAYS

The four key points to take away from our first night vision column are:

1. Don't be misled by the common misconception that ANVIS-9 is better than ANVIS-6. The main difference is that ANVIS-9 objective lenses rotate on most models, while ANVIS-6 objective lenses translate, to accommodate the use of an HUD. The numbers are not an indication of performance.

2. Always evaluate the performance specifications of the image intensifier tube. (This point is true only for the U.S.; users in other countries are not provided with multiple performance choices.)

3. Identify the classification that the lighting OEM has or will modify your aircraft lighting to and ensure your NVGs' objective lenses are compatible with that.

4. Address other considerations identified in this column but that were not discussed in detail — such as an auto-gated power supply for the image tubes, the type of helmet used and the use of an HUD — to ensure there is a harmonious combination of elements within the entire NVIS.

Note: As we've purposely avoiding naming any lighting OEMs, NVG OEMs or NVIS distributors, if you have questions related to the specific lighting modification classification of your aircraft and the performance or compatibility specifications of your NVGs, please check with the respective manufacturer or a reputable vendor.

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