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Night Vision Goggles May Be in Your Future

A test program is evaluating whether the safety of nighttime civil helicopter operations can be improved with electronic aids to vision.

by
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The U.S. Federal Aviation Administration (FAA) recently began a two-month testing program at its Atlantic City, N.J., U.S., Technical Center to determine if night vision goggles (NVG), now used almost exclusively by the military, might enhance the safety of civilian night helicopter operations.

The FAA test program is expected to provide some answers concerning the efficacy of NVG use in the civil sector. However, solving the problems of night helicopter operations, especially at low altitudes, will take more than technological advances, pilots, FAA officials and industry experts agree.

The challenges of night flight for fixed- and rotary-wing aircraft are similar. Pilots of both aircraft types can lose sight of the horizon and become dangerously disoriented. Pilots must operate their aircraft with reduced acuity and depth perception at night. But the helicopter's unique operational demands, particularly in the areas of emergency medical service (EMS), police surveillance and rescue operations place great demands on even experienced pilots.

A pilot's ability to see at night is determined first by individual genetics. Yet, no matter how well a pilot sees at night, the eye has universal physical limitations. Color perception becomes ineffective at night. At best, it is possible to distinguish between light and dark colors only in terms of reflected light intensity. Fine detail perception is not possible at night. Even under full moonlight conditions, acuity, or sharpness, is only one-seventh that of daylight vision.

One of the principal problems of night vision is a five- to 10-degree "blind spot" on the back of the eye's retina that interferes with night vision directly in front of the pilot. Since the blind spot's area increases as the distance between the pilot and the object increases, some objects may not be immediately apparent. Using offset vision or scanning across an object makes it more visible.

Another physical characteristic of night vision is dark adaptation. Piloting an aircraft at night, after leaving a brightly lit environment, impairs night vision for at least 30 minutes. Maximum night adaptation requires about 45 minutes. Looking at a navigational chart with a flashlight seriously impairs any night vision acquired through adaptation.

Bob Hawley, technical task leader for the Arlington, Virginia, U.S., consulting firm, Systems Control Technology (SCT) that conducted the year-long study leading to the current FAA flight tests, said the study was designed to determine the need, possible benefits, and the practical mission for NVGs.

"What the report said was that if someone is properly trained and equipped, and abides by the recommended use rules (enroute flight only), NVGs can be beneficial," Hawley said. The study also concluded that in addition to helping the pilot reach his destination, the NVG may be useful navigational and orientation tool once the pilot's destination is reached. Use of an NVG can help a pilot "see" objects as much as 1,000 feet away.

Despite the positive nature of the report, it details a number of caveats for the use of NVGs in the civil sector. One of the principal questions concerning NVG use is cost — will the aviation community be willing to spend up to $15,000 per aircraft to equip a helicopter with NVGs? In addition to cost, aviation regulatory agencies would have to establish quality and maintenance standards for NVGs. Since cockpit reflections can interfere with NVG operation, even interior paint schemes and color choices may need to meet new criteria. The military takes special care with both its color choice and interior design to get maximum effectiveness out of its NVGs.

Steve Fisher, project manager for the FAA NVG evaluation, reported about 76 flights would be conducted over a six- to 10-week period using approximately 34 pilots from both industry and the FAA. Fisher said the tests will concentrate on EMS operations since the SCT report identified that mission as having the most urgent NVG requirement.

The test will approximate the conditions that EMS pilots can expect to find in both urban and rural settings. Pilot performance will be examined at various altitudes, weather and lighting conditions. Airspeed and engine settings will be varied and the results analyzed. In addition, the pilots will be interviewed to determine how night flight affects individual performance. The test will not include mountainous terrain, but Fisher said those conditions may be studied in a follow-on effort.

At the end of the flight test, the results will be given to the FAA's Flight Standards Office and a recommendation will be made concerning civilian use of NVGs. The initial SCT report and any results from the night vision tests will not be available until later in the year, Fisher said. No decision has been made about releasing either the SCT report or flight study results to the general public.

FAA and industry officials say that the NVG tests are important to the understanding of safe helicopter operation at night. Diverse views of the problems and safety of night flight exist in both the government and private sector.

"Many pilots feel that flying at night is unsafe unless you're fully instrument rated," Fisher said, "and many rely on instruments even if the conditions are VFR." He said helicopters have some advantages over fixed-wing aircraft since a helicopter can hover to allow orientation time before preceeding with forward flight. Yet, fixed wing aircraft generally have an advantage because the flight path is at least several thousand feet above ground level. Another FAA official said, that a helicopter's inherent "instability can get a pilot into trouble quicker than in a fixed-wing aircraft."

Dr. Ron Lofaro, of FAA's research and development division, noted that helicopter pilots are "more reliant on visual cues" for orientation and navigation. He said NVGs restore some visual cues, but they may create as many problems as they solve. According to Lofaro, the newest generation of light intensifying NVGs provide great clarity and brightness.

"Some pilots," Lofaro said, "are deceived into thinking that they see everything that's out there." He said the goggles are not much better than the human eye at distinguishing nighttime texture gradients and do not improve depth perception. In some respects, the eye is better than the goggles, Lofaro said.

Other Night Vision Limiting Factors

If NVGs are approved for civilian use, some factors affecting reduced night vision will not change. These include:

- *Smoking*. Smokers have a significantly increased level of carbon monoxide in their bloodstream. If a pilot smokes one to one and one-half packs of cigarettes within 24 hours prior to flight, the body's ability to carry oxygen is reduced by 10 percent. The hypoxia caused by carbon monoxide poisoning affects night vision sensitivity and dark adaptation time.

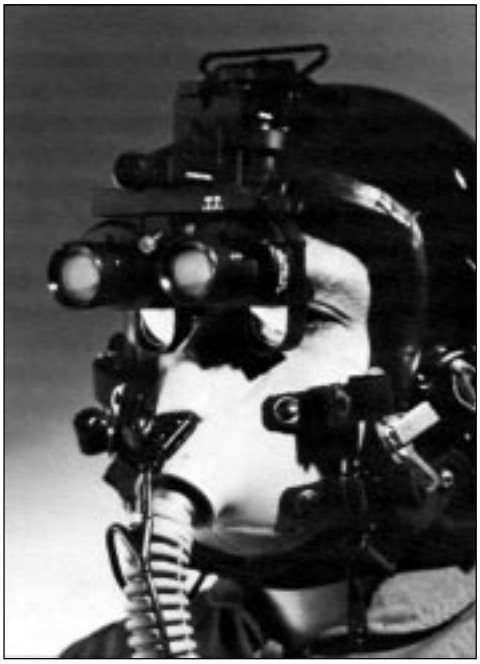
- *Alcohol*. The level of night vision damage is directly related to the amount of alcohol consumed. Yet, even small amounts in the bloodstream can cause a pilot to stare at an object instead of scanning the horizon. Beware of residual effects even if alcohol consumption is stopped the regulation eight hours prior to flight.

- *Fatigue***.** Like the effects of alcohol, fatigue can cause the pilot to stare at one object or a single point on the horizon instead of scanning it.

- *Other factors determining night vision quality*. Illness, nutrition and physical conditioning can all impair the ability to see well at night.

What Are NVGs And How Do They Operate?

If you look through a set of night vision goggles (NVG) in a pitch black room, you will still be in the dark, for this apparatus does not make light, it simply intensifies available light. Since the great outdoors has its own constant light sources — starlight and moonlight, for example — NVGs always have some light to intensify, even if there is no artificial illumination available.



The image a pilot sees through NVGs is an electronic representation of an object that has been converted from light (photon energy) to electrons and back to light. When photon energy reflected from the object first enters an NVG, it is converted to electrons after passing through a layer of photocathode material — the most recent models of NVGs use gallium arsenide. Next, these electrons are amplified as they pass through a device called the multichannel plate (MCP). After next passing through a zero-vacuum tube, the electrons bombard a tiny (.75-inch) phosphor screen which glows and creates a light intensified image of the object.

The image on the phosphor screen is upside down and must be righted. To present the eye with a properly oriented image, a fiberoptic inverter twists the image right-side-up. The final image is presented in a bluish-green tint and is one of the reasons cockpit colors must be made NVG-compatible.

The latest models of NVGs use 1.8 million light-transmitting fibers in the image inverter to create an image. By contrast, the human eye uses about 7 million cones and more than 100 million rods for the same work. Yet, the most recent generation of NVG can spot a man at a distance of 1,000 feet with resolution on the tiny phosphor screen 21 times that of a standard 19-inch home television screen. Also, modern NVGs do not "smear" or "white out" as easily as older models did in the presence of sudden light flashes.

While NVG technology continues to be developed, the current generation was used successfully during the Panama invasion last year to operate helicopters in tight landing zones, helping U.S. Army pilots avoid power transmission lines and poles. The goggles also enabled helicopter pilots to distinguish U.S. troops from Panamanian troops.

One of the biggest problems with NVGs is the limited field of view they provide. Normal field of view is about 140 degree, but NVGs provide only about 40 percent of that field of view. Although the U.S. military has had great success overcoming this limitation through training, flying with NVGs takes a more concentrated effort in the cockpit.

Lofaro said the approval of NVG goggles for the civil sector presents a unique problem. "The night vision provided by NVGs is better than it would be without the goggles," Lofaro said. He pointed out, however, that without proper training, NVGs might make flying at night even more of a safety risk.

Night flight, with or without goggles, presents formidable challenges to any pilot. Approach and landings are especially difficult since dangerous illusions are created by the eye's shortcomings. Without a frame of reference, the runway or heliport can become a "black hole" and distance to the ground may be impossible to judge.

Water is another nighttime hazard. Reflections in calm water on a clear night can confuse a pilot. Without a frame of reference or a horizon, distinguishing between the stars in the sky and those reflected in the water can become a dangerous game.

Glenn Leister, director of safety for Helicopter Association International (HAI), said that wire strikes are a particular hazard at night. Even NVGs are not completely effective in helping pilots spot wires. In addition, EMS pilots can lose effective night vision by looking at the flashing lights that guide them to the scene of an accident. Bright landing lights on smooth surfaces such as roads also impair night vision. Even light-colored clothing can destroy night vision by reflecting light into the eye.

Poorly maintained plexiglass cockpits also present challenges to night operation, Leister said. Scratches not visible during the day may become an intricate web of scratches at night. Condensation on the plexiglass, par-

ticularly on older helicopters, is another night operations problem, Leister said. Floodlight illumination of heliports can contribute to night vision loss.

John Zugschwert, president of the American Helicopter Society (AHS), said, "You have to be aware of what visual cues you don't have at night that you do have during the day, and then figure out how to compensate for them at night."

Zugschwert, who flew the first generation of NVGs in 1971, said the early models had a tendency to white out if the goggles received too much light. Early models also left a white tail trailing behind the brightest objects as the pilot's head scanned the horizon. While these early problems have been solved, looking through an NVG does not recreate daylight.

One solution to the limitation problems of NVGs is the addition of a forward looking infrared system (FLIR). FLIRs measure a temperature differential in objects up to 3/10th of a degree. Military helicopters incorporate the two systems to increase night vision potential. Yet, training requirements for NVGs are formidable enough in the civil sector as a new technology without the additional FLIR training.

As more technology is introduced into the cockpit, helicopter pilots, especially those flying EMS missions, may find an increasingly hectic cockpit environment. EMS industry guidelines already recommend using two pilots at night. Many helicopter pilots presently flying these difficult missions are able to draw on military training, but that may change in the future, Lofaro said, as fewer pilots enter the civil helicopter pilot market with this valuable experience. Flying with sophisticated new NVG equipment may be an easily learned skill for ex-military pilots, but non-military trained pilots may require a long training period. It is these practical considerations, along with basic safety questions, that will play a major role in the FAA's decision regarding the approval of NVG use in civilian helicopter operations. ♦

About the Author

Mark Morrow is a free-lance aviation journalist and photographer. He is former editor of the bi-weekly newsletter Helicopter News *and congressional editor of* Armed Forces Journal International. *A licensed pilot, he flew and reviewed light single- and twin-engine aircraft for aviation publications and wrote about business use of aircraft.*

Morrow reports on business trends, technological developments and the progress of U.S. federal legislative and regulatory issues in the rotary wing industry. He also covers federal legislative and regulatory affairs in the areas of defense, aerospace, foreign relations, intelligence and government operations.

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