illuminated individual can fill out a Laser Beam Exposure Questionnaire (Advisory Circular 70-2A). While unlikely, laser exposure can result in injury to the eye and an examination by an eye doctor may be warranted when an airman has any concerns about a laser illumination event. However, an eye exam is certainly recommended should the aviator experience persistent visual (blurred vision, afterimages, double vision, etc.) and/or physical effects (headaches, tearing, photophobia, etc.) that last more than a few hours after a laser beam exposure. Members of the general public who witness an individual aiming a laser at an aircraft can send an email to laserreports@faa.gov.

Why Green?

Reports indicate that over 90% of all aircraft illuminations by handheld lasers are green in color, followed by red with the remainder being other colors or combinations of colors. Effects on vision are wavelength dependent. “Laser exposure is most hazardous when a direct laser beam, or its specular (mirrorlike) reflection, enters the pupil along the axis of vision when the eye is focused on a distant object. The energy density of the laser beam can be intensified up to 100,000 times by the focusing action of the eye.” Due to this heightened visibility and increased likelihood of adverse visual effects, green laser light can appear as much as 30 times brighter than a red laser of equal irradiance. As the eye becomes dark-adapted, the peak shifts toward shorter wavelength blue-green light. Photoreceptor cells in the retina are much more sensitive to green light (532 nm) than red light (650 nm) of equivalent luminance due to the photoreceptor’s inherent peak sensitivity to wavelengths around 555 nm or yellow-green.

What Actions Can I Take?

Continuing research and interviews with pilots who were victims of laser events have provided a list of recommended actions to minimize the effects of laser illumination.

Anticipate – When operating in a known or suspected laser environment, the non-flying pilot should be prepared to take control of the aircraft.

Aviate – Check aircraft configuration and (if available) consider engaging the autopilot to maintain the established flight path.

Navigate – Use the fuselage of the aircraft to block direct laser beam by climbing or turning away.

Communicate – Inform Air Traffic Control of the situation. Include location/direction of the beam, your present location, altitude, etc. If on the ground, request and complete a “Laser Beam Exposure Questionnaire” (i.e., AC 70-2A).

Illuminate – Use hand signals, navigation lights, or alternative means to complete the flight.

Communicate – Inform Air Traffic Control of the situation. Include location/direction of the beam, your present location, altitude, etc. Once on the ground, request and complete a “Laser Beam Exposure Questionnaire” (i.e., AC 70-2A).

Illuminate – Turn on the cockpit lights to minimize any further illumination effects.

Delegate – If another crewmember has avoided exposure, consider handing over control to the unexposed crewmember.

Attenuate – Shield your eyes when possible (hand, clipboard, visor, etc.). Do not look directly at the laser beam and avoid drawing other crewmembers’ attention to the beam.

Do Not Exacerbate – Avoid rubbing of eyes and possibly inducing further injury.

Evaluate – If any visual symptoms persist after landing, get an examination by an eye doctor.

Can More Be Done To Protect Aviation Safety?

Continued monitoring of laser issues and effective reporting of illumination events provide data necessary to define the changing nature of the threat and develop better strategies for mitigating the problem. Strategies may include educating the public regarding the risks of lasers to aviation safety and encouraging the reporting of malicious behavior, restricting the sale of certain laser devices to the general public, encouraging manufacturers to attach warning labels on laser devices that address aviation concerns, performing studies on the use of laser eye protection as an option in the aviation environment, and investigating the value of deploying laser detection and recording systems on civilian aircraft. While no single strategy may completely end this threat, the FAA will continue to examine and recommend ways to best protect aviation from this serious hazard.

References

1. Public Law 112-95, FAA Modernization and Reform Act of 2012, Section 311
As part of the FAA Modernization and Reform Act of 2012, Public Law 112-95, made it a federal crime to aim a laser pointer at an aircraft. The office of Aerospace Medicine is responsible for providing information regarding the potential effects of laser beams on pilot vision.

**Laser** - an acronym for light amplification by stimulated emission of radiation. A laser is a device that produces an intense, directional, coherent beam of visible or invisible light.

### Laser Targeting of Aircraft

A Boeing 787 is on final approach to Boston Logan Airport's Runway 4 after flying for nearly three hours in nighttime conditions, when the captain is suddenly hit by a dazzling green laser light that obliterates his vision. The laser beam had hit the captain's eye with such intensity that he feels as if he has been "punched in the eye.” He ducks down, closes his eyes, and tells the first officer he has been hit by a laser beam and not to look at the light. The pilot experiences pain, spams, and spots in his vision. The flash was so bright that he believes the aircraft may be the target of a terrorist attack. So distracted by the events that occurred and visibly shaken, he gives up control of the aircraft to the first officer, who, fortunately, has not been hit by the laser beam and is able to land the plane safely.

The captain's symptoms persist in the hotel that night. Upon waking in the morning, he perceives that the vision in his left eye is noticeably more blurred with or without his glasses, and his "eye hurts and feels strained.” The pilot goes to an eye doctor that afternoon and is diagnosed with accommodative spasm, sluggish pupil response, and increased light sensitivity, which continue on for several days before finally clearing up. For a while, though, the pilot thinks that his flying days may be over.

This laser incident is fictitious but is based on actual events and reports of illumination of military and civilian aircraft by lasers, with law enforcement and medical evacuation flights and incorporated reports of laser events from CEDAR, Skywatch and manual input. Laser activity in navigable airspace is continually monitored to better define the nature of the threat from outdoor lasers. Reports of illumination events have increased steadily over the past few years. This increase may be due to heightened awareness of the problem by flight crewmembers, the introduction of an authorized reporting process, and the increased availability of high-output, handheld laser devices.

No accidents have been attributed to the illumination of crewmembers by lasers, but given the sizeable number of reports, and devices that can accompany such events, the potential does exist.

Laser events can occur anywhere but have been noted most frequently in the Western Pacific and Southern regions of the United States.  

- **FAA studies have also shown that almost 70% of all incidents occurred between 2,000 and 10,000 feet above ground level.**
- **51% occurred from August through December.**
- **Sunday is the most likely day of the week for an aircraft to be illuminated by a laser followed by Friday and Saturday.**
- **70% occurred between the hours of 7 and 11 p.m.**

### What Can Happen?

While the visual effects of laser exposure are most often transient, flashblindness or afterimage can linger for several minutes or a few hours, in some instances. Pilot complaints of residual physiological effects after being illuminated by a high-powered laser or high-intensity green light can be disabling when the eyes are adapted to the low-light conditions, when the eyes are adapted to the low-light conditions, when the eyes are adapted to the low-light conditions, when the eyes are adapted to the low-light conditions.

The FAA Laser Safety Initiative has compiled laser reports and debilitating effects that can accompany such laser illuminations when conducting low-level flight operations at night. The intense red or milky-white laser beams can threaten the lives of crew members and passengers.

FAA researchers have shown that the majority of helicopter laser exposures (70%) were within the Laser Free Zone (≤ 2,000 feet) versus 21% for fixed wing aircraft. This puts rotary wing pilots (medical evacuation, law enforcement, military, general aviation, freight, corporate) at greater risk for visual impairment from laser illumination as well as enhanced chance for adverse operational effects.

### What Can Be Done?

An aviator who has been exposed to a laser beam while in flight should be advised to report the event to the local Air Traffic authority and/or the FAA so that a proper investigation can be performed. The FAA's Office of Aerospace Medicine is responsible for providing information regarding the potential effects of laser beams on pilot vision.

*Figure 1: Laser illumination in a flight simulator as viewed from the pilots' perspective*