

Laser Attacks on the Rise

How to Protect Your Eyes

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Thousands of airline pilots have been illuminated by lasers, and these laser hits may harm a pilot's vision. Although such incidents have become more frequent despite being illegal, educated pilots can minimize the risk and preserve their visual health.

Laser basics

A laser emits an intense, very narrow beam of light of a single wavelength, giving it a specific color. The brightness is related to the wavelength, power, distance from the source, and whether the laser has a pulsed or continuous emission. A pulsed laser

emits more concentrated bursts of power than a continuously powered laser. Dust, moisture, and smoke reduce perceived brightness and diffuse the beam.

Inexpensive battery-powered, handheld laser pointers are available in stores and on the Internet. In the U.S., the most powerful and legal noncommercial laser pointers authorized for manufacture or sale emit 5 milliwatts (mW). Commercial lasers may exceed 1 watt and can be bought from overseas sources via the Internet, and owning them isn't illegal in the U.S.

A 5 mW green laser's maximum range to cause eye damage is 52 feet, but glare and visual disruption

can occur at ¼ mile, and distraction may occur as far away as 2.2 miles. A 500 mW green laser theoretically can cause damage from as far away as 520 feet, glare and visual disruption at 2 miles, and distraction as far away as 22 miles. The chance of permanent damage to vision in flight is very slight. Distraction and temporary effects are much more likely to occur.

Vision basics

Visible light ranges from the blue-purples at wavelengths

of about 400 nanometers (nm) to the reds, near 760 nm. Wavelengths below 400 nm are ultraviolet (UV), and those greater than 760 nm are infrared (IR).

The human eye perceives different wavelengths of light from equal power sources differently. Green-yellow light at 550 nm is perceived as 35 times as bright as red light of the same power and distance, so modern emergency vehicles and safety vests often use green-yellow colors to increase visibility.

The retina of the eye

converts the light energy of various wavelengths into neurological signals in the brain that we perceive as color. The cones of the centrally located macula of the eye produce color vision and the best visual acuity. More peripherally, the rods of the retina are used for night vision and can function in much dimmer light but generally do not perceive color. Other structures of the eye (cornea, lens, vitreous humor) absorb UV light, and the retina absorbs IR light and heat.

Permanent eye damage can result when enough energy is concentrated on a portion of the eye to destroy tissue. The retina is most sensitive. Permanent damage results if light energy concentrated on the retina burns the sensitive retinal cells, which don't regenerate, causing "holes" in the visual field. The size of the loss of visual field correlates with the amount of retina damaged. Cataracts may result from energy being absorbed in the lens.

The cornea and the lens concentrate light by as much as 200 times when focusing on the retina. The pupil dilates in dim light to allow more light to enter the eye and increase the energy focused on the retina. This is why laser exposures at night are so disturbing to vision, as the dilated pupil allows a large amount of light to enter before constricting.

Temporary responses to laser-energy insults to the eye include discomfort, light sensitivity, glare, halos, flash

Advice to Pilots

ALPA has published an excellent guide, *Laser Illumination Threat Mitigation*, on procedures to follow if exposed to a laser in flight (see insert in this issue). The key medical points are

- ▶ Don't look directly at the laser; go heads-down if safe to do so.
- ▶ Turn up all cockpit lights to reduce the size of your pupils and minimize afterimages.
- ▶ Don't rub your eyes.
- ▶ Download, print, and use the ALESA form if you have concerns.
- ▶ See an eye specialist if your responses to the ALESA form suggest doing so.
- ▶ Contact ALPA's Aeromedical Office for any physical or psychological concerns.

Laser protective eyewear (LPE) glasses are available, but ALPA's Aeromedical Office doesn't recommend purchasing them at this time. LPE only blocks out a single wavelength of light, so it's useful only if you are struck by a laser of the same wavelength. Some LPE may reduce the visibility of cockpit displays of the same color as the laser. 



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blindness, and afterimages. Visual acuity is reduced briefly, and night vision is compromised for minutes to hours after a laser illumination. The eye's response to this damage is to produce tears and a chemical reaction that triggers itching in the eye and a desire to shut the eyelids. Corneal abrasions may occur after rubbing the eyes.

Aviation laser events

Aircraft laser illumination events rose exponentially from 2004 (49 known events) through 2011 with 3,591 events reported in the U.S.—about 10 per night, or 1 for every 2,528 flights. Canadian pilots reported 229 events in 2011, with the most coming from Alberta, British Columbia, Ontario, and Quebec. The United Kingdom had 2,300 attacks in the same year—a rate more than twice that of the U.S.

The overwhelming majority of illuminations occurred below 8,000 feet AGL; 94 percent involved green lasers. Most events were near airports in the taxi, takeoff, or approach and landing phases of flight. Phoenix led the U.S. with 129 events in 2011. Chicago, Dallas-Fort Worth, Denver, Houston, Las Vegas, Los Angeles, the greater New York City area, Orlando, Philadelphia, Portland (Ore.), San Jose, and San Juan reported more than 50 events each. Most laser illumination events in aircraft



involve continuous-emission lasers emitting 5–200 mW. All reported events were with visible (usually green) light (the human eye can't detect IR and UV lasers, which may cause eye damage).

Of the 3,591 aircraft illuminations reported to the FAA in 2011, in 970 incidents laser light entered the cockpit. Of these, 181 involved tracking the aircraft. In 55, temporary eye effects were noted. These effects included watering, afterimages, eye discomfort, blurred vision, and headaches.

Of the 55 incidents with eye effects, 31 pilots reported pain or discomfort; 31 also reported vision impairment. Seven pilots sought medical attention, and one was grounded temporarily. Ten pilots reported disorientation. In three incidents, the flight was affected, with two pilots having to turn over control. The third had to land.

Fortunately, none of the events reported in 2011 resulted in permanent eye injury.

The most significant negative consequences of a pilot's being illuminated by a laser are anxiety regarding safely operating the aircraft, uncertainty about damage to vision and reporting medical visits to the FAA, frustration at the administrative requirements for reporting an incident, and concern about the possibility of being lased again—not the physical damage to the eyes.

The United Kingdom's Civil

ALPA members can contact the Aeromedical Office at 303-341-4435, Monday to Friday, 8:30 a.m. to 4:00 p.m. mountain time, or at www.AviationMedicine.com.

Pilot Speaks Out About Threat from Laser Attacks on Airplanes

At a recent news conference, ALPA was joined by regulatory, military, federal, state, and local law enforcement reps to emphasize the safety threat posed by laser attacks on aircraft and underscore the public's need to be aware of the danger and the legal consequences of deliberately or unintentionally shining a laser at an aircraft.

"The public needs to know that individuals who shine lasers at aircraft are jeopardizing the safety of air transportation and will be prosecuted to the maximum extent of the law. Intentional or not, these laser strikes are no joke and have serious consequences," stressed Capt. Robert Hamilton (PSA), who is the current chairman of ALPA's Security Council and has been lased while flying an airplane. 



Capt. Robert Hamilton (at the podium) during the news conference.

Aviation Authority, working with the British Air Line Pilots Association, has deployed a very useful self-administered tool to reassure pilots who haven't suffered significant eye damage that they may forgo medical evaluations. If potential for injury exists, the Aviation Laser Exposure Self-Assessment (ALESA) provides parameters for consulting an eye specialist and is recommended for that purpose.

For pilots experiencing recurrent, intrusive thoughts regarding the laser exposure, counseling may be an appropriate and effective treatment. Any pilot having concerns about vision or psychological effects should stop flying until the concerns are resolved. Contact ALPA's Aeromedical Office for assistance.

Legislation

On Feb. 14, 2012, President Obama signed into law new legislation that increased the

penalties for aiming a laser at an aircraft or its flight path. The new penalties include a fine of as much as \$250,000 and as many as five years in prison for each act.

Previous laws required proof that a person willfully tried to interfere with a flight to endanger safety. The new law only requires proof that a person knowingly aimed the laser at an aircraft. This is a much lower standard of proof for federal prosecutors. As a result, more cases are now being prosecuted in the U.S. Similar laws in Australia, Canada, the United Kingdom, and other countries are leading to more prosecutions. The FAA also interprets FAR 91.11, which prohibits interfering with a flight crew member, to include lasing an aircraft. 

To read more about laser illumination threat mitigation, see the insert in this issue.