



Laser Show Resource Guide

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Lasers and aviation safety

In late 2004 and early 2005, a number of incidents were reported in the U.S. where laser beams were aimed at aircraft. This page discusses these incidents. It contains answers to the most frequently asked questions regarding lasers in general -- especially laser pointers -- and their role in aviation safety. In addition to this page, [a separate page discusses laser light shows and aviation safety](#).

Summary

Most of these incidents appear to have involved laser pointers. Fortunately, legal laser pointers (below 5 milliwatts in power) are eye-safe in aircraft situations -- they are simply too weak to harm pilots' eyes.

But authorities are concerned about "visual effects": the brightness of the laser pointer distracting, causing glare, or possibly even temporarily flashblinding pilots. They are also concerned about accidental or deliberate exposure from stronger lasers.

One of the two main solutions is pilot information and training. Pilots can handle laser and bright light illuminations if they know a few basic guidelines. Also, work is underway to provide training materials, and to introduce lasers into simulator training. Studies have shown that after as few as three simulator exposures, pilots can fully "recognize and recover" from a laser incident.



*This 14-second animation shows the three visual effects that concern experts: **distraction** (dimkest), **glare** (medium) and **temporary flashblindness** (brightest, with fading afterimage). The animation demonstrates how an airplane laser exposure is almost always a flash, not a steady bright light. Click [here](#) or on the animation to find out more.*

The diagram below shows the distances at which these visual effects would occur, for a legal green laser pointer. The most serious of these effects,

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The other main solution is public education. The recent arrest of a New Jersey man facing 25 years in prison has gotten public attention. This is a strong reminder that ***no one should aim a laser at or near any aircraft or any other moving vehicle.***

The main concern is not so much eye safety -- in most situations like this, the laser will not be on the eye long enough or strong enough to cause damage. The main concern is visual effects: distraction, glare (inability to see past the light) and flashblindness (temporary loss of vision like a camera flash going off).

Frequently asked questions

Because of the intense interest in these potentially hazardous incidents, Pangolin has prepared this FAQ. It comes out of our continuing support, dating back almost ten years, for laser-aviation safety.

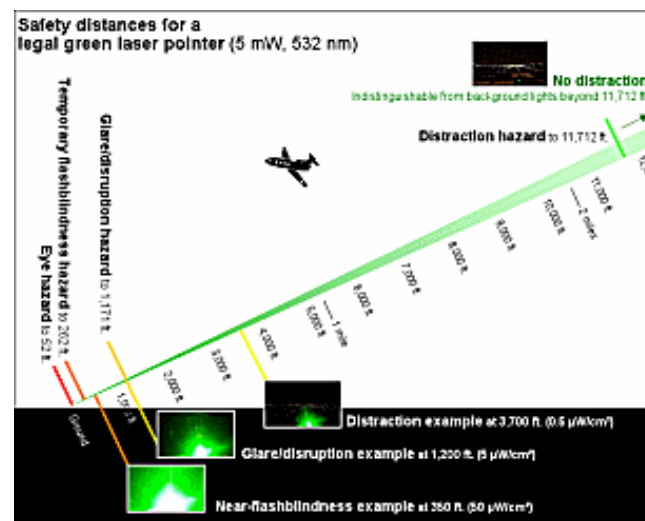
The FAQ was written and reviewed by experts with experience on the committees that helped create the U.S. laser-aviation safety regulations, and the ANSI standards for safe outdoor laser use. Click on any of these questions to find out more:

General

- [What is the concern with recent laser incidents?](#)
- [Have any of the incidents involved professional laser shows?](#)
- [What is the best solution for these incidents?](#)

How lasers could affect pilot vision

flashblindness and glare, occur within the first 1,000 feet of the laser pointer's beam.



Click [here](#) or on the diagram for an enlarged view. A more detailed discussion of laser pointer hazard distances is [below](#).

- How could a laser or bright light cause problems?
- What determines whether a laser is potentially harmful to aircraft?
- Can a laser beam "take down" an aircraft?
- Are there legal lasers which are deliberately aimed at pilots, for aviation purposes?
- What were the results of the FAA's simulator studies?

Laser pointer effects

- Can a laser pointer harm a pilot?
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- Are the hazards reduced because the airplane is moving?

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- What can pilots do if they see a laser or bright light?
- Should pilots have explicit instruction and training?

Laser classifications

- How are lasers classified for safety purposes?
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- Who regulates lasers in the United States?
- Can anyone buy a laser?
- Why not just ban laser pointers?

- [How does the FAA regulate lasers?](#)
- [What are the FAA requirements?](#)
- [What is the penalty for illuminating an aircraft with lasers or bright lights?](#)
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General

Q: [What is the concern with recent laser incidents?](#)

A: There have been over a dozen incidents in late 2004 and early 2005 where bright lights -- probably laser pointers -- were aimed at commercial airplanes in the U.S. A key concern is how much this affects pilots. The consensus of safety experts is that legal laser pointers could not cause any eye damage. However, **FAA simulator studies show that a bright light may interfere with pilot performance by being a visual distraction, or at worst, by causing temporary flashblindness like a camera flash going off.** (See [animated photo above](#) that shows what these effects look like.)

Update: The FBI appears to be confirming that the recent incidents are not deliberate or using high powered lasers. On Jan. 4 2005, an FBI spokesman said "All incidents to date have been more of nuisance -- a prank or accident." (Link to full story [here](#).)

Another concern is whether terrorists equipped with more powerful lasers could do more serious harm. This concern became public in December 2004, shortly after the FBI and Homeland Security Department issued a nationwide memo that unnamed "terrorist groups overseas have expressed interest in using these devices against human sight." (Ironically, it is possible that publicity about the memo may have helped trigger the recent spate of nuisance laser pointer incidents.) With more powerful, harder-to-obtain lasers, terrorists' intent would be to cause vision problems that would make it more difficult for a pilot to fly a visual approach during landing.

Note that the laser's effect extends to vision only -- **terrorists or others could not hope to create or**

obtain any laser weapons effective against the aircraft itself.

Q: Have any of the incidents involved professional laser shows?

A: No, none of the recent incidents have been linked to laser shows.

Laser shows are very safe. The laser show industry cooperates with safety regulators. In the U.S., laser show operators working outdoors file reports with the federal government, including the Food and Drug Administration (FDA) and the Federal Aviation Administration (FAA). Both of these agencies know where these shows are, and how to contact the operators. The shows employ various techniques including spotters to ensure that beams do not hit aircraft. These control measures are described in the reports and must be acceptable to the FDA's laser safety agency and to the FAA. **This program has been very successful in keeping professional shows safe.**

Q: What is the best solution for these incidents?

A: There are two main solutions. The first is **education of laser pointer users.** They need to understand that it is unacceptable to aim even low-powered lasers at or near aircraft. **The media can help tremendously by making it clear that no one should point lasers at aircraft, cars or even people** (e. g., keep away from eyes and head).

The second solution is **pilot information and training, which can reduce or eliminate these concerns.** Pilots are experts at anticipating emergency situations. Given knowledge and even brief simulator experience, they can learn simple procedures to recover from even the brightest and most deliberate exposures. Detailed suggestions are given below.

Some people have suggested banning laser pointers. For reasons why this is not a complete solution, see the FAQ question below.

How lasers could affect pilot vision

Q: How could a laser or bright light cause problems?

A: There are four problems with lasers and bright lights. The first three are "visual effects" that distract or block pilots' vision temporarily. The animation at the top of the page demonstrates these effects. Here are more details about them:

- **Distraction and startle.** An unexpected laser or bright light could distract the pilot during a nighttime landing or takeoff. A pilot might not know what was happening at first. They may be worried that a brighter light or other threat would be coming.
- **Glare and disruption.** As the light brightness increases, it starts to interfere with vision. Veiling glare would make it difficult to see out the windscreen. Night vision starts to deteriorate.
- **Temporary flashblindness.** This works exactly like a bright camera flash. There is no injury, but night vision is temporarily knocked out. There may be afterimages -- again, exactly like a bright camera flash leaving temporary spots.

The three visual effects above are the primary concern for aviation experts. This is because they could happen with lower-powered lasers that are commonly available. **The fourth concern, eye damage, is much less likely.** It would take specialized equipment not readily available to the general public.

- **Eye damage.** Though it is very unlikely, high power lasers could cause permanent eye injury. A person may not notice the damage -- it may be detected only by medical exam. At higher levels, the damage may leave noticeable spots in the same area of vision as where the original light was viewed (this is why one should not look directly straight into the sun or any bright light).

And most unlikely of all is injury causing a complete and permanent loss of vision. To do this requires very specialized equipment and a desire to deliberately target aircraft. Anyone wanting to do this could find far less expensive, and much easier ways to attain their goals.

Also, it should be noted that claims of permanent injuries are not proof of injury. Some laser experts are skeptical of some reported pilot injuries, as the injuries would have required different types or powers of lasers than those reported.

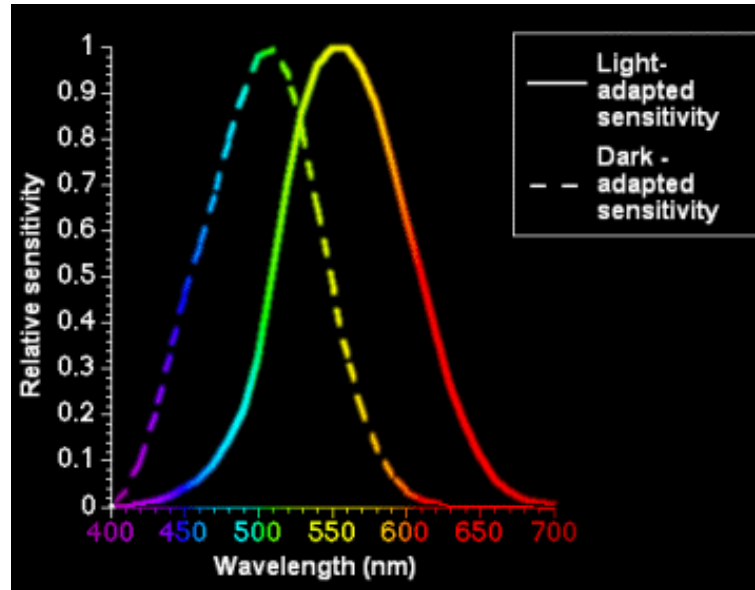
It is extremely unlikely that any of the four elements above would cause loss of the aircraft, especially if the pilots react properly and work as a team. However, many pilots have not had specific instruction or training. The brighter the laser, the longer it stays on the cockpit, and the more unfamiliar the pilot is with bright-light recovery techniques, the larger the chance for concern.

Q: What determines whether a laser is potentially hazardous to aircraft?

A: A laser beam's potential hazard to aircraft is governed not only by its raw **power**, as many people think, but also by its **color** (wavelength), **divergence** (sharpness of the beam), **pulsed nature**, and **exposure time**.

- **Power:** The more powerful the laser, the more energy it delivers when it hits an object. This factor is important when calculating potential for eye damage.
In addition, for lasers emitting visible light, the more powerful the laser, the brighter it appears. This factor is important when calculating visual effects such as distraction and glare.

- **Color:**
The eye is more



sensitive to yellow and green than to red, blue and purple. Thus, if you have two lasers with equal light power, in the dark a green one will appear 3 to 5 times brighter than a red one (see dashed Dark-Adapted curve in the chart).

The eye's color response is one reason why most laser-aircraft incidents involve green lasers – they are simply more visible (and thus more annoying) than equivalent-power red or blue lasers.

It is also possible to have invisible laser beams whose beams are in the ultraviolet or infrared spectrum. These produce no visual effects (distraction, glare, flashblindness) but at high powers could be eye hazards to pilots.

- **Divergence (beam spread):** Laser beams are tighter than other light, but they do spread out. At a very close range, the entire beam of a laser pointer could enter someone's eye. But after 1000 feet the beam is about a foot in diameter. It will appear much dimmer since only a fraction of the beam would then enter the eye.
- **Continuous vs. pulsed.** A laser's light can be always on, like a flashlight, or it can be pulsed, like a strobe light. The pulsing can be so fast that the beam appears continuous.

A pulsed laser of a given power (light output) is more of an eye hazard than a

continuous laser of the same light output. This is because more power is packed into each pulse. (It is the difference between someone applying steady pressure with their fist on your arm, and repeatedly hitting you on the arm.)

Pulsing is a factor only when discussing eye hazards. For visual effects (distraction, glare and flashblindness), a pulsed laser can be treated as an equivalent-power continuous laser.

- **Length of exposure:** The longer the laser shines on an object, the more energy is absorbed. That's why a laser flashed in an eye (or cockpit) is much less dangerous than the same laser held steady.

Legal laser pointers have such low power output (<5 mW) that a person can blink and turn away well before damage is likely to occur. One study by the Mayo Clinic has shown that 5 mW exposures of 15 minutes do not cause harm. ("Other than transient afterimages that lasted only a few minutes, we were unable to document any functional, ophthalmoscopic, fluorescein angiographic, or histologic evidence of damage to any structures of the eyes." *Arch Ophthalmol.* 2000;118:1686-1691.)

However, there have been a few cases where ignorant people have deliberately stared into lasers and have damaged the part of their retina that was looking at the beam.

These four factors are directly applicable to laser-aircraft incidents. If a person wanted to distract or flashblind a pilot, they would want (1) a powerful laser, preferably with (2) a green color, that has (3) a tight beam. They also would need (4) a way to keep the laser on the airplane windscreen for as long as possible.

This last factor, length of exposure, is complex. Try hand-holding a laser pointer and aiming at a small target, such as a retroreflective stop sign that is a few blocks away. You'll see how hard it is to hand-hold a laser on a static target even over such a short distance. **A laser hand-held at a moving aircraft would mostly miss, and sometimes hit the cockpit.** The pilot would experience a flashing light more than a continuous beam.

This explains why **helicopters are more susceptible to laser incidents.** They move slower in general, they fly closer to the ground, and they often hover. It is easier for a person to hand-hold a laser and have it remain on the helicopter..

Q: Can a laser beam "take down" an aircraft?

A: In a word, no. It is practically impossible for terrorists to obtain or make lasers that are powerful enough to harm the aircraft itself. Even the U.S., with the world's richest and most advanced military, has only a few lasers capable of destroying aircraft and missiles. The most mobile one, the

Airborne Laser, has cost around \$2 billion so far and still has not fired a single beam from a mobile platform.

A terrorist group that wanted to destroy an aircraft from the ground would undoubtedly choose readily-available conventional anti-aircraft weapons, such as missiles and hand-held rockets. These are much cheaper and have been proven to be effective against aircraft.

Q: Are there legal lasers which are deliberately aimed at pilots, for aviation purposes?

A: There are no operational systems at this time. However, a number of systems have been proposed and tested. These include lasers to indicate guide slopes, and a laser warning system tested by NORAD to be aimed at pilots who stray into restricted airspace. In addition, tests have been run in simulators with lasers directed into the eyes of active commercial pilots.

Of course, all tests and research consider the safety impact of these aviation lasers on pilots.

Q: What were the results of the FAA's simulator studies?

A: In June 2004, the FAA published the results of a study entitled "The Effects of Laser Illumination on Operational and Visual Performance of Pilots During Final Approach." In a Boeing 727 simulator, they shined laser light at various levels on volunteer pilots. The illumination happened during a demanding maneuver -- a simulated "short-final" landing, when the plane was in a 30-degree turn 100 feet above the ground.

Pilots were asked to report how the illumination affected their "ability to operate the aircraft and ... visual performance." Under these conditions, perhaps the most demanding of any normal flight, **pilots reported a slight-to-moderate effect for the lowest tested light level, and a moderate-to-great effect for the highest tested level.** The light levels correspond to a laser pointer located roughly one mile away for for the slight-to-moderate effect, and roughly 500 feet away for the moderate-to-great level.

Keep in mind that the lasers were tested during an especially demanding flight segment. A similar study was done by the FAA using less-critical flight maneuvers. This August 2003 study showed **pilots reported none-to-slight effect for the lowest tested light, and slight-to-moderate for the highest tested level.**

The clear implication is that **laser light interference with a flight depends partially on the taskload and flight segment.** Most safety experts would say that, outside of critical flight maneuvers (takeoff, approach, landing, emergency situations), laser or bright light events can be successfully handled without concern.

Laser pointer effects

Q: Can a laser pointer harm a pilot?

A: Legal laser pointers cannot harm a pilot.

Legal laser pointers, with light output of less than 5 mW (5/1000 of a watt), are relatively weak. They are so weak that, at close range, **it is difficult or impossible to cause confirmed eye damage**. For example, the Mayo Clinic study mentioned [above](#) showed no damage to the retina even after a 15 minute exposure to a legal (5 mW) laser pointer. This is echoed by [Canadian laser regulators](#) who state that laser pointers cause eye damage only "if you look directly into the beam from a laser pointer for more than a minute and a half in a very steady manner."

In aircraft incidents, it is safe to say that **absolutely no eye damage could occur from even the brightest legal laser pointer**. The aircraft would be well beyond the 50 foot range of eye hazard, the aircraft is moving at high speeds, the pilot would naturally blink or avoid the light, and the beam's light would spread out due to the large laser-to-aircraft distance.

Even illegal laser pointers are not a great concern. For example, if an illegal laser pointer is five times brighter, the eye hazard distance increases to 250 feet. This is still a relatively short distance. This short distance, coupled with the aircraft's movement and the pilot's normal blink/avoidance mechanism, would protect the pilot from permanent damage.

Finally, eye damage limits were set conservatively, with a "safety margin". If you are exposed to laser light at the eye damage limit, it would be unlikely in most people to cause permanent damage.

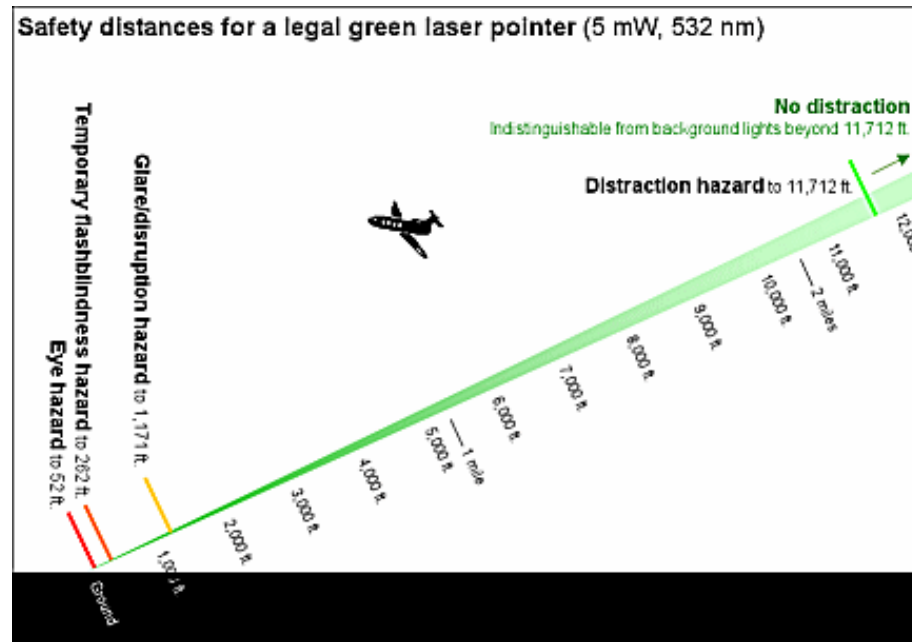
What concerns experts is not eye damage, but the brightness of laser pointers. This can cause distraction or other visual effects.

Q: For a laser pointer, what are the distraction hazard distances?

A: A legal laser pointer (maximum permitted power 5 mW) with a beam size of 2 mm and a divergence of 1 milliradian has the following visual effects, according to safety experts at [Rockwell Laser Industries](#):

- **Eye hazard** causing blink reflex (looking away from bright light): 0-52 feet
- Causes **temporary flashblindness** and afterimage: 52-262 feet
- Causes **glare or disruption** (difficult or impossible to see past light): 262-1,171 feet
- Causes **distraction**: 1,171-11,712 feet
- **No distraction** -- not visible or blends into existing lights: Beyond 11,712 feet

The diagram below shows graphically how most of the hazard is within about 1,000 feet of the laser pointer source. Click [here](#) or on the diagram to see an enlarged view. (For an expanded version of the diagram which includes example photos, click [here](#).)



Q: Are the hazards reduced because the airplane is moving?

A: Yes, the hazards are greatly reduced, compared with the above safety distances. These distances are a "worst case" scenario. They cover a green pointer where both the laser and the observer are stationary.

- **Do not look directly towards the light**; instead, look a bit away from it. Be prepared to look completely away and warn the other pilot if the beam or light returns
- If conditions permit – the light is gone or is low enough in intensity – one pilot may want to **cautiously ascertain the direction and nature of the light**: Where did it come from? How long did the exposure last? What color was it? Was there more than one beam? New FAA procedures instituted in January 2004 ([FAA Advisory Circular 70-2](#)) require pilots to report laser and bright light incidents. These questions will help find perpetrators.
- The pilot should **report the incident to ATC and/or on unicom**. (See [FAA Advisory Circular 70-2](#) for more details on the procedures.) The tower should warn other aircraft in the area and should contact local law enforcement authorities if necessary. The tower should also check for NOTAMs (Notice to Airmen) about any legal, regulated laser activity in the area.
- The pilot should understand that **the likelihood of actual eye damage is extremely low**, even if the light was very bright. There may be one or more afterimages, but these do not mean there is permanent damage to the retina. **Avoid rubbing the eyes**, as it may cause more harm than a flash exposure. Certainly if the pilot is concerned, they can be checked by a qualified eye doctor with experience in retinal examinations. The ophthalmologist can be either hired by the airline or can be privately retained by the pilot.

Q: Should pilots have explicit instruction and training?

A: In our opinion, yes. Certainly pilots are aware of the recent incidents, and want to know the best way to handle the situation. **Even basic written or videotaped information will be very helpful** in understanding how to recover from a laser or bright light.

As of late January 2005, the SAE G-10T Laser Hazards Subcommittee is working on training documents and protocols. These will be submitted to the FAA for its consideration. It is expected that for commercial pilots, G-10T will recommend exposure to laser light in a simulator. Previous studies have found that pilots can work around the laser effects, after as few as three trials.

Laser classifications

Q: How are lasers classified for safety purposes?

A: U.S. government regulations divide lasers into a number of "classes". The class depends on the potential harm from the laser beam. For visible continuously-emitting lasers (not pulsed), the classes and corresponding power levels are:

- **Class I:** Not harmful. Power less than 0.00039 milliwatts (39/100000 watt). Barely visible even in a dark area.
- **Class II:** Not harmful given the eye's normal blink reflex. Power above Class I but no greater than 1 milliwatt (1/1000 watt). Visible in a dark area, barely visible in a lit area.
- **Class IIIa: (Includes legal laser pointers)** Not harmful given the eye's normal blink reflex. May be harmful if viewed by binoculars, telescope, camera viewfinder or other light-concentrating optics. Power between 1mW and 5mW (5/1000 watt). Visible in lit areas; e.g. legal laser pointers.
- **Class IIIb:** Harmful if a direct exposure or reflected off a shiny surface. Not harmful if the beam is reflected off a diffuse (not shiny) surface. May be harmful at long ranges (e.g., to a pilot at XXXX feet away) if the beam divergence is low. Power between 5mW and 500mW (1/2 watt). Illegal laser pointers can be between 5mW and roughly 30mW.
- **Class IV:** Harmful if a direct exposure, or if the beam is a small dot reflected off a diffuse or shiny surface. May burn skin or clothing. All powers greater than 500mW (1/2 watt). These are typically expensive (tens of thousands of dollars), large, and specialized to use. Indoor lightshow lasers are generally in the ½ to 20 watt range; outdoor lightshow lasers are generally in the 5 to 50 watt range.

The exact power levels are different for pulsed lasers and invisible lasers (infrared and ultraviolet). However, the general principles apply: the greater the power, the more potential hazard and thus the higher the class.

Q: How do the laser classes apply to airspace safety?

A: The classes were developed for those closely working with lasers, such as scientists and technicians. Since laser beams do spread out, the hazard is lessened when one is much farther from the laser source. A laser beam from a powerful Class IV laser may be reduced to a safe laser-pointer-like level after the beam spreads out over distance..

For this reason, **it is not correct or appropriate to imply that a laser which is hazardous at close range would cause similar hazards at aircraft distances.** It is perfectly possible for a laser that can light a cigarette two feet away, to be safe to look at when one is 1,000 feet away from it.

In addition, the laser is made even safer by the fact that the beam is likely to scan briefly over the cockpit, rather than be accurately tracking for many seconds an aircraft moving at hundreds of miles per hour.

Thus, it also is not correct or appropriate to imply that a laser which is hazardous when the beam and its target are fixed, would be as hazardous when the beam is hand-held and/or the target is rapidly moving.

To see these two principles in action, try hand-holding a laser pointer to keep it on a retroreflective stop sign a few blocks away. At the stop sign, the once pinpoint beam will now be spread out to perhaps six inches in diameter. And your hand will have a hard time keeping the beam on the stop sign – which is not moving as fast as a plane in the sky.

This is why legal (Class IIIa) laser pointers are primarily an annoyance to fixed-wing pilots. Their power spreads out, and is not able to be held steady on the aircraft, so the pilot gets flashes of bright light but nothing powerful enough to harm the eye.

The situation is slightly different for helicopter pilots, who fly lower and slower, and who often hover in populated areas. The helicopter is closer. This makes it easier to hit, and the beam doesn't spread out as much. The pilot's natural blink and aversion reflex (looking away) prevents permanent damage, just as it would in a classroom or office situation. But **the distraction and possible temporary flashblindness hazards are potentially greater for helicopter pilots than for fixed-wing pilots.**

Regulation and control

Q: Who regulates lasers in the United States?

A: In the U.S., the responsible federal agency is the FDA's Center for Devices and Radiological Health. Under CFR Title 21, Subchapter J, Part 1040.10, CDRH sets up the classification system, and specifies the safety devices and performance standards used to make hazardous lasers safer. (For example, warning labels and lights.)

Manufacturers and importers of lasers make product reports to the FDA. In addition, **the FDA regulates three uses of lasers: medical users, construction devices, and entertainment lasers (lightshows)**. All other uses of lasers, such as for industry, are unregulated by the CDRH. This does not mean these lasers are completely unregulated; there may be regulations by other agencies such as OSHA or individual states.

Q: Can anyone buy a laser?

A: Yes, anyone can purchase a laser. And, except for medical, construction and entertainment uses, anyone may use the laser as they wish without needing federal approval (a "variance") from the CDRH. There may be other regulations, especially in certain states such as Arizona, New York and Texas which strictly regulate laser equipment. And there may be general purpose laws, such as those restricting interference with an aircraft, which can be applied to those aiming lasers at airplanes.

But there is no impediment to buying a laser. This is not as bad as it sounds. For one thing, as laser powers increase, so do the prices. Legal laser pointers are affordable, so many people have them – but they are quite safe in general and in relation to aircraft concerns. Illegal laser pointers, and general purpose lasers are in the hundreds or low thousands of dollars, so fewer people own them. Even more powerful lasers, like those used in professional outdoor lightshows, start around \$10,000 and can go to \$50,000 or more.

For a determined person, these prices might not be restrictive. But at least they keep the more powerful lasers out of the general public's hands.

Another factor to consider is that higher powered lasers generally are more complex to operate. A laser pointer is simple: put in a battery and hold down a button. But Class IV lasers often have special electrical needs (220 or 440 VAC) and may even need water cooling (such as two gallons of water per minute to cool the tube). In the past few years, solid state lasers have made it easier to operate lasers. But high-powered lasers still require special handling and are not usually "plug-and-play" devices.

Q: Why not just ban laser pointers?

A: This could be done. Class IIIa (5mW maximum) laser pointers could be banned, with only "Class II" (1 mW maximum) permitted. This would provide a 500% reduction in power, and owing to how the eye sees bright light, about a 50% reduction in perceived brightness.

Unfortunately, this is not a complete solution.

- Current laser pointers are **useful for a variety of everyday tasks**, including astronomy education. A lower power would make them essentially useless for some of these tasks.
- Current laser pointers would not vanish. **They would still be available** as "used" lasers on eBay and elsewhere.
- **Higher-powered lasers would still be available** -- they just would not work like laser pointers, with a press-on, release-off button.

- This does nothing to solve **the problem of any deliberate use** of high-powered lasers against pilots.

For this reason, **pilot information and training is a must**, no matter what additional regulations or restrictions are imposed on laser users. Pilots need accurate information on how to handle a bright light exposure.

Q: How does the FAA regulate lasers?

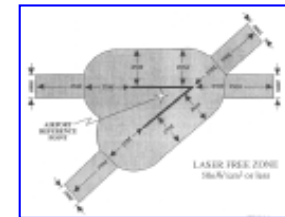
A: The Federal Aviation Administration does *not* regulate lasers. It has issued an order (7400.2E, ch. 29) covering the use and location of outdoor laser operations. **People who want to use lasers outdoors can fill out FAA forms** in Advisory Circular 70-1 [*caution: a 2.2 MB download*]. The forms describe the laser powers, and how the user will prevent pilots from being illuminated by powers above FAA-required levels.

Recall that the Food and Drug Administration's CDRH division regulates three uses of lasers: medical, construction and lightshows. Since lasers are a problem to aviation primarily at night, it is only the lightshows which are of concern to FAA. Therefore, if a lightshow wants to get permission from the CDRH to present its show (a "variance"), the CDRH requires it to conform to the guidelines in FAA's order. This is **the only known situation where the FAA order has the effective force of law.**

Q: What are the FAA's requirements?

A: The FAA is most concerned with laser light around airports. They have established permissible light levels in three areas:

- The so-called "**Laser Free Zone**". This is a distance of from 2 to 5 nautical miles around an airport where aircraft should not be exposed to light above 50 nanowatts per square centimeter (the same as 0.05 microwatts per square centimeter). This very low light level, 50 billionths of a watt, "should not cause any visual disruption" according to the FAA.
- **The Critical Flight Zone**, a cylinder encompassing a radius of 10 nautical miles around an airport, up to 10,000 feet vertically. Light levels should be below 5 microwatts per square centimeter. This will "avoid flashblindness or afterimage effects."
- **Sensitive Flight Zones**, with light levels below 100 microwatts per square centimeter. These are optional. Local FAA personnel and the military can



designate these zones as needed. An example would be military airspace or a particular air route.



All other areas which are not in the LFZ, CFZ or SFZ are designated as “**Normal Flight Zones**”. Within this zone, the laser power must not be an eye-hazard. (Technically, power must be below the Maximum Permissible Exposure, the “level of laser radiation to which a person may be exposed without hazardous effect or adverse biological change in the eye or skin”)

Obviously, the LFZ and CFZ zones cover a lot of airspace. If these zones were strictly adhered to, then industries, observatories, military bases and popular laser shows like those at Walt Disney World would all be shut down. Therefore, **the FAA does not object to laser operations in airspace if there are “alternative control measures”**. These can include aircraft spotters for temporary laser uses, and the use of radar or similar devices for permanent uses.

For the most part **these safety measures have worked**. The current concern is not over laser users who report to the FAA, but over unknown “rogue” laser users.

Q: What is the penalty for illuminating an aircraft with lasers or bright lights?

A: Within the U.S., there is no specific law covering laser or bright light illumination. There are general laws against interference with an aircraft. A suspect in the late 2004 incidents, David Banach, was charged with “interfering with the operator of a mass transportation vehicle”. This is a felony under the Patriot Act. The penalty is up to 20 years in prison and a \$250,000 fine.. (Banach was also charged with making false statements to the FBI, potentially another five years and another \$250,000.)

There may be similar local and state laws of a general nature, prohibiting unsafe acts. Some of these have been used in the past in isolated laser incidents. Because these incidents are so few and far between, at this time (early 2005) there does not appear to be the need for more specific laws.

Q: Are there no federal or state penalties?

A: As mentioned earlier, **three laser uses -- medical, construction and entertainment -- are regulated at the federal level** by a division of the FDA. These users can face administrative sanctions such as withdrawal of approval or fines for deliberate or reckless violations of FDA regulations.

Over at the FAA, their Order 7400.2E, Part 6, Chapter 29 only covers the process of reviewing and approving applications for those using lasers outdoors. There is no apparent penalty for not submitting reports, or for violating the various airspace safety zones.

The only laser users restricted by the FAA's order are those regulated by the FDA -- effectively, laser entertainment companies. FDA requires outdoor laser shows to be reported to the FAA. If FAA objects, then FDA will not permit the outdoor show to continue. And again, any FDA penalties would be administrative.

Some states have laser registration laws. Most states do not have any specific laws applying to lasers or bright lights.

An [Internet source](#) states that in California, it is a criminal misdemeanor to shine a laser pointer at individuals who perceive they are at risk (police officers?) and it is a felony to aim one at an aircraft. We cannot independently confirm that this laser-specific law exists. The same source also states that "some local governments have passed regulations requiring anyone purchasing a laser pointer to be 18 years of age or older. Again, we do not have additional specifics.

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