A Review of Laser Pointer Incidents and Safety Considerations for the Aviation Environment

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Laser illuminations of aircraft are a significant aviation safety problem.
Currently (July 2015) almost 15 incidents per night in the U.S.
What is the problem?
Lasers can be safely managed in airspace

- Many safe outdoor laser operations
  - Including astronomy laser guide stars, laser satellite communications, and laser light shows
Problem is consumer misuse
What kind of person deliberately aims a laser at an aircraft?
Who deliberately aims at aircraft?

1: Persons who do not realize the hazards
   - Laser “can’t reach the plane”
   - Laser will hit underside of plane
   - Laser will be a little dot at the plane
   - Laser will be dim like a flashlight
Planetary Boundary Layer

• 300-1000 yard altitude
Who deliberately aims at aircraft?

- 2: Persons who do not care about hazards
  - Antisocial or criminal
  - May be bothered by noise
  - Often doing something else illegal

- 6 months
- 15 months
- 24 months
- 30 months
- 37 months
- 168 months
Green lasers = biggest problem

- The “sweet spot” for consumer lasers
  - Most milliwatts per dollar
  - Example: 50 mW, $25 online shipped from China
Green lasers = biggest problem

- Over 90% of FAA incidents involve green light
  - More visible
  - Lasers tend to be more powerful
Hazards of laser illuminations for pilots
Hazards of laser illuminations

- **Primary hazard:** Visual interference when in a critical phase of flight
  - Takeoff, approach, landing, emergency, low-level flight (helicopters)

- **Secondary hazard:** Eye injury
No interference

- On a “runway” in a flight simulator
Visual interference hazard

- Distraction (really, task interference)
Boeing 777 at 15,000 feet over Buenos Aires
Visual interference hazard

- Glare
Laser glare as seen from police helicopter
Visual interference hazard

- Temporary flashblindness/afterimage
Hazard distances of a 5 mW, 1 milliradian green laser pointer
Hazard distances of a 5 mW 1 mrad green pointer
“A laser pointer is a hazard to pilots over 2 miles away”
Most hazards are relatively close to the laser source

- Of the total eye and visual hazard distance, distraction is 90% of that distance

- Distraction is a *mental* hazard
  - Easier to overcome by focusing on the task of flying
  - Does not interfere with vision
Effects of laser illuminations on pilots
Visual interference effects

- **Eye:** vision blocking, eye watering, sensation of pain
- **Body:** headache, “shock”
- **Task:** Startle, distraction -- remember to “fly the plane”
- **Post-exposure:** corneal abrasions from rubbing the eye
Adverse eye effects

- Occur in about 1.5% of all FAA-reported incidents
- For 2014, about 43 incidents
Eye injury from laser exposure

- A secondary concern
- No documented reports of permanent eye injury in over 21,000 FAA and CAA incident reports
- FAA, March 19 2015: “The FAA is unaware of any U.S. commercial pilot who has suffered permanent eye damage as a result of exposure to laser light when in the cockpit.”
Why eye injury is unlikely

- Laser exposure may be outside the NOHD
Real-world laser pointer NOHDs

Distance in feet

- 1 mW pointer, 1.0 mrad: 23 feet
- 5 mW pointer, 1.0 mrad: 52 feet
- 25 mW handheld, 1.0 mrad: 116 feet
- 125 mW handheld, 1.0 mrad: 259 feet
- 250 mW handheld, 1.1 mrad: 333 feet
- 500 mW handheld, 1.25 mrad: 415 feet
- 1000 mW (1W) handheld, 1.5 mrad: 489 feet
- 2000 mW (2W) handheld, 1.75 mrad: 593 feet

Distance in feet
Why eye injury is unlikely

- Exposure inside the NOHD does not mean certain injury
  - NOHD has a “reduction” factor
  - Handheld laser + moving target is unlike lab tests conducted on anesthetized eyes
  - Lab tests were looking for “minimally detectable lesions” -- may not cause noticeable vision defects
“Afterimages are not injuries. An injury results in a minimally visible lesion which histologically involves the retinal pigmented epithelium and the photoreceptors.”

-- Bruce Stuck
Eye injury caveats

- This is for consumer visible laser pointers and handhelds (currently < 2 watts) in the U.S. and U.K.
- Military pilots in conflict areas may have had permanent eye injuries
  - If so, data would be classified
- Future perpetrators might be more determined
Could a laser illumination cause an aircraft crash?

- Illuminations can be managed when not in a critical phase of flight
  - Enough time to recover
- In critical phases, can be managed with proper pilot procedures
  - Look away from the light, “fly the plane”
Could be a contributing factor

- Aircraft accidents almost always are due to an unforeseen combination of factors
  - A laser distraction or flashblinding, at the wrong moment, could be a contributing factor
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What can be done?
About 10 times a night, U.S. pilots report seeing or being illuminated by laser beams. The primary hazard is temporary interference with vision – distraction, glare, flashblindness – during critical phases of flight such as takeoff and landing.

Some ways to help reduce the number and severity of laser pointer/aircraft incidents

**Pilot training & glasses**

- Provide information on safely reacting to laser illuminations
- Mandatory simulator training with safe bright light
- Cockpit-certified laser blocking glasses for 1st responder pilots
  (Note: Anti-laser glasses are NOT recommended for routine use)

**Arrests & prosecution**

- Fines and jail for anyone intentionally aiming at aircraft
- News reports of arrests & prosecutions let users know the hazard is serious

**Laser labeling**

- Manufacturers voluntarily add aircraft safety labels
- Government can write new laws mandating labels

**User education**

- Educating users via laser sellers’ websites, manuals
- Media coverage of hazards, prohibitions

If the above does not work, **new laws & restrictions** may be necessary

**Limited restrictions**

- Import restrictions to try to keep out illegal lasers
- At locations where misuse is high (beach resorts)
- By age (no public possession by youth, teens)

**General restrictions or ban**

- Nationwide - consider restricting sale and/or possession of consumer handheld lasers above a specified power level
- Exemptions/licenses for legitimate use

Note: Restrictions may not be effective. Australia banned pointers over 1 milliwatt in 2008, yet aircraft incidents rose 27% from 2008 to 2011. A 2013 scientific study concluded that the ban “may have detrimentally affected laser pointer safety within Australia without overtly impacting availability.”

Source: LaserPointerSafety.com
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Source: LaserPointerSafety.com
Add a warning

NEVER AIM AT AIRCRAFT - IT IS UNSAFE AND ILLEGAL
New labeling format for packaging and larger lasers?

Visit LaserSafetyFacts.com for more information
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8 years of prosecutions

- 2005-2013: 17,725 FAA incidents
- 134 arrests (0.75% chance of getting caught)
- 80 convictions (0.45% chance of going to jail)
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Laser protective eyewear
Laser illumination procedures

- “Fly the plane” first
- Do not look directly at the light
- Block the light if possible (visor, hand, clipboard)
- Turn up cockpit lights
- Inform Air Traffic Control; report incident to FAA
- Resist the urge to rub your eyes
- Seek qualified eye care if you have any concerns
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For more information:

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Questions?