AVIATION SAFETY BULLETIN, March 2017

MISREPRESENTATION OF LASERS USED FOR AIRPORT WILDLIFE MANAGEMENT.

SHORT FORM

Green 532nm lasers have proved useful for dispersing wildlife away from critical flight paths, thereby reducing the risk of collision between aircraft and wildlife (wildlife strike). However recent incidents in Europe, Oceania and North America have shown that some lasers advertised as suitable for use on airports are inadequately specified and under-classified. These misrepresented systems are a significant danger to air operations, personnel and wildlife as any safety procedures developed for their use are likely to be underestimated. Airports or other institutions that are planning to purchase or trial laser devices marketed for wildlife dispersal should ensure that, prior to commissioning a laser device, its classification and specifications are independently validated by an accredited testing agency and that commensurate safety protocols are adopted.

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AVIATION SAFETY BULLETIN

MISREPRESENTATION OF LASERS USED FOR AIRPORT WILDLIFE MANAGEMENT.

DETAILED FORM

BACKGROUND

In flight collisions between wildlife and aircraft (hereafter wildlife strike or strike) is an ongoing air safety, operational cost and conservation issue for global civil and military aviation. The risks to aircraft and animals from strikes can be mitigated by ecological and operational approaches that reduce the airspace conflict rate and by engineering resilience into airframes and engines that reduce the likelihood of catastrophic outcome after a strike has occurred.

For the past 10 years fixed and portable laser devices have been advocated as tools for dispersing wildlife away from critical flight movement areas. Aerodrome operators around the globe report that lasers used for this purpose can routinely disperse wildlife under certain circumstances (Blackwell et al. 2002). In particular, hand-held 532nm green lasers appear to be an effective tool for dispersing migrating waterfowl away from airside waterways/grasslands at night or in low light conditions.

Lasers used for wildlife dispersal are potentially hazardous particularly when used in the airport environment. High powered lasers can cause permanent eye damage, temporary blindness or distracting glare to persons or animals inadvertently exposed to the laser beam. Very high powered lasers (generally Class 4) can burn skin or cause ignition of combustible materials. There is also potential for serious incident if cockpit crew are inadvertently exposed and incapacitated during a critical phase of flight. The severity of vision compromise or tissue damage caused by accidental lasing is dependent on many factors but ultimately the wavelength, the power output of the laser, the beam divergence and the distance from the laser source to the target are the most critical. These factors must be clearly understood and properly assessed when developing a safety case for laser wildlife dispersal in close proximity to aircraft operations.

The risks to personnel, aircrew and wildlife associated with laser wildlife dispersal can be effectively managed by proper training and by using a range of operational and engineering controls (for more details see Australian Aviation Wildlife Hazard Group (2016) and ICAO Doc 9815 (2013). However, for any given laser system, these risks can only be effectively mitigated if the laser class, specifications and critical hazard distances are accurately listed according to accepted industry standards.

Misrepresentation of laser devices imported into western countries is a well-documented and continuing issue. Investigations both in Australia and USA in 2013 revealed that over 90% of randomly tested green laser pointers were underspecified with respect to power output and non-compliant with local regulations. (Wheatley 2013: Hadler et al 2013). A more recent study found similar misrepresentations of up to two orders of magnitude difference between actual and specified power outputs (Lee et al 2016). The authors concluded that *"……. there needs to be more rigorous testing and quality control of these commercially available lasers – merely imposing a power limit of less than 1mW is insufficient."*

AVIATION SAFETY ISSUE

The same haphazard quality control found with imported laser pointers also applies to some *"professional"* laser devices marketed for airport wildlife dispersal. In Europe investigations between late 2015 and mid-2016 demonstrated that three "Class 2M" airport, hand-held lasers deviated significantly from published specifications and were grossly under-classified. All of the laser units examined at this time had hazard distances approximately 100 times greater than originally specified and all should have been classified as 3B (Mallant, 2017). In addition, these tests revealed that the power output and beam profiles of the lasers were unstable and that the manufacturer/supplier had misapplied the assumptions and equations used to derive correct laser classification. As with the laser pointer issue cited above these findings suggest a lack of quality control across the production and safety assessment procedures used in airport laser manufacture and a failure of regulators to ensure the veracity of claims made by manufacturers.

More recently there have been several episodes in Oceania and North America where lasers nominally rated for airside wildlife dispersal were underspecified and incorrectly classed. Similar to the European experience, devices cited as Class 2M actually tested two classes higher as 3B. In addition, laser safety Nominal Hazard Zone (NHZ), distances critical to assessing airspace and personal safety were not supplied with these devices and the manufacturer's handbooks contained only rudimentary and sometimes misleading safety information.

WORST CASE

Ambiguous specification and under classification of high powered lasers will result in a misjudged safety case for airside laser operation. In turn this will result in underestimated hazard protection distances which could lead to permanent disability to persons or animals accidently exposed to the beam. In the worst case, misjudgement of the safety case could result in vision impairment of air crew and serious aircraft accident.

RECOMMENDATIONS

Airports or other institutions that are planning to purchase or trial laser devices marketed for wildlife dispersal should consider the following:

1. That the wavelength, power output and beam divergence of the laser are unambiguously specified by the manufacturer. Purchasers should be particularly cautious about accepting devices where a manufacturer uses vague statements such as "Power output varies with device" instead of quoting an actual standardised power level.
2. That the laser is correctly classed and labelled. Purchasers should be particularly cautious about devices where the quoted power output of a laser does not match its Class rating according to current standards.
3. That before a laser device is purchased or used for airside operations, the wavelength, maximum power output, accessible emission level, beam divergence and classification should be independently validated by a local accredited testing agency.
4. Laser devices prescribed for aviation wildlife hazard management must include engineered controls that restrict beam discharge to safe azimuth and elevation arcs. These include safety interlocks, horizon/tilt limiting switches and/or software driven fail-safes
5. Manufacturer's specifications for devices marketed for use in aviation should include the following safety distance estimates based on laser nominal hazard zones (NHZ) as outlined in *ICAO Doc 9815 Manual on laser emitters and Flight Safety.* :
    a. **Retinal Damage Distance** - Nominal Ocular Hazard Distance (NOHD). Distance at which beam irradiance falls below 2.5 mW/cm^2. At this distance or beyond, accidental eye exposure to the beam is unlikely to cause detectable retinal damage, assuming a normal blink or aversion reflex time of < 250 ms. Persons operating inside this range from the laser are considered at risk of retinal damage even if they have a normal blink reflex time.

b. **Flash Blindness Distance** - Sensitive Flight Zone Exposure Distance (SFZED) or distance at which the beam irradiance falls below 100 µW/cm^2. Persons operating inside this range from the laser and accidentally exposed are at risk of temporary flash blindness with afterimage.

c. **Glare Distance** - Critical Flight Zone Exposure Distance (CFZED) or distance at which beam irradiance falls below 5 µW//cm^2. Persons operating inside this range from the laser and accidentally exposed are at risk of being subject to glare which could restrict vision.

d. **Distraction Distance -** Laser Free Flight Zone Exposure Distance (LFFZED), or distance at which beam irradiance falls below 50 nW/cm^2. Persons operating inside this range from the laser and accidentally exposed could be momentarily distracted from the task at hand.

In addition, manufacturers should specify the following NHZ distances.

a. **Nominal Skin Hazard Distance** (NSHD) – distance at which beam irradiance falls below 200mW/cm^2. Persons operating inside this range from the laser and accidentally exposed could cause detectable skin damage. NSHD are usually determined for 5s and or 10s exposures

b. **Material Fire Hazard Distance** (MFHD) – distance at which beam irradiance falls below 500mW/cm^2. Combustible materials located inside this range from the laser and accidentally exposed could ignite.

For examples of Nominal Hazard Zone distances calculated for various laser power outputs and wavelengths, refer to the Laser Hazard Distance Chart (2016) and for further information on MFHD refer to US National Fire Protection Agency, NFPA Code 115 Standard for laser fire protection.

6. These NHZ safety distances should be used to design and implement Standard Operating Procedures that are specific to area of planned use and should include:
    a. Laser safe firing arcs in azimuth and elevation
    b. Positioning of personnel, backdrop assessment and actuation of horizon limiters or tilt switches prior to firing the laser
    c. Reflective surfaces
    d. Assessment of substrate and ambient conditions to decide the risk of accidental fire when using the laser.

7. Manufacturer's specifications must also include evidence-based guidelines on operation of the laser device to ensure the safety and welfare of the animals that are being targeted for dispersal. It is the manufacturer's responsibility to prove the animal welfare case for their device; it is the end-users responsibility to ensure that the safety case is legitimate and that the device is used according to the manufacturer's specifications. The animal welfare case provided by the manufacturer should include specific guidelines on:

    a. The correct techniques to be used so that animals are not adversely irradiated during the lasing procedure, in particular:
        i. Never pointing the beam directly at an animal but rather using the beam spot and sweeping the beam on the ground adjacent to the animals.
        ii. Advising the maximum practical distance that the laser should be used to prevent accidental lasing of an animal.
    b. The minimum distance (s) for lasing towards animals so that permanent ocular or tissue damage to the animal does not occur in the event of an accidental exposure. (animal NOHD)
    c. Any variations or considerations for animal NOHD for different taxon groups.
    d. Detection and assessment of animals that may have been vision compromised through laser exposure.

These guidelines should be used to design and implement a wildlife laser dispersal priority plan relevant to the species diversity in the area of planned use.

8. IF, a manufacturer presents a laser device for use in the aviation industry but they have failed to specify, or incorrectly specified any of the following:

    a. Maximum Power Output, Divergence or Wavelength
    b. Laser Class
    c. Nominal Ocular Hazard Distance
    d. Flight Zone safety NHZ distances (as listed above).
    e. Nominal Skin Hazard Distance
    f. Material Fire Hazard Distance
    g. Animal welfare safety distances and procedures

THEN, the prospective end-user should assume that the device is unsafe and that it should not be used for wildlife dispersal or in proximity to aircraft operations until the laser's specifications can be validated and its NHZ distances determined and collated into a valid safety case.

9. Manufacturers/suppliers should consider providing the following information for lasers designated for airport wildlife management: for each hazard level, a graphical representation of the percentage by which the Maximum Permissible Exposure (MPE) is exceeded as function of the distance to the laser. This information will simplify risk assessment process for end-users.

10. All personnel using lasers for wildlife dispersal in airport environs should be trained and tested competent in laser safety, weapons safety, airside operations, animal behaviour and animal welfare.

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Laser Safety Hazard Chart 2016 http://www.lasersafetyfacts.com/hazard_distance_chart.html

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