



Advisory Circular

AC 139-23 (0)

APRIL 2007

LASER EMISSIONS WHICH MAY ENDANGER THE SAFETY OF AIRCRAFT

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1. REFERENCES

- 1 • CAR 1988, Part 9, Division 9, 94 Dangerous Lights.
- 2 • ICAO Doc 9815, Manual on Laser Emitters and Flight Safety.

2. PURPOSE

2.1 This Advisory Circular (AC) provides general information and advice on measures to protect pilots of civil aircraft from accidental laser beam strikes, on or in the vicinity of an aerodrome.

2.2 It should be of interest to aerodrome operators, and to the operators of laser shows. It may also be of interest to Air Traffic Controllers.

2.3 This guidance should be used in the planning and control of advertising, entertainment, and similar visual displays using visible laser light.

2.4 This AC is unlikely to prevent wilful or malicious laser attacks against aircraft by those intent on causing mischief.

Advisory Circulars are intended to provide advice and guidance to illustrate a means, but not necessarily the only means, of complying with the Regulations, or to explain certain regulatory requirements by providing informative, interpretative and explanatory material.

Where an AC is referred to in a 'Note' below the regulation, the AC remains as guidance material.

ACs should always be read in conjunction with the referenced regulations.

3. STATUS OF THIS AC

3.1 This is the first AC to be issued on this subject.

4. GLOSSARY

4.1 **Irradiance (E).** The power per unit area expressed in watts per square centimetre (W/cm^2) or watts per square metre (W/m^2). Small values may be expressed as micro watts per square centimetre ($\mu\text{W}/\text{cm}^2$) or nano watts per square centimetre (nW/cm^2), 10^{-6} and 10^{-9} respectively.

4.2 **Laser.** 1). An acronym for light amplification by stimulated emission of radiation.
2). A device that produces an intense, coherent, directional beam of optical radiation by stimulating emission of photons by electronic or molecular transition to lower energy levels.

4.3 **Maximum Permissible Exposure (MPE).** The internationally accepted maximum level of laser radiation to which human beings may be exposed without risk of biological damage to the eye or skin.

4.4 **Protected Flight Zones.** Airspace specifically designated to mitigate the hazardous effects of laser radiation.

- (a) **Laser-beam critical flight zone (LCFZ).** Airspace in the proximity of an aerodrome but beyond the laser-beam free flight zone (LFFZ) where the irradiance is restricted to a level unlikely to cause glare effects.
- (b) **Laser-beam free flight zone (LFFZ).** Airspace in the immediate proximity to the aerodrome where the irradiance is restricted to a level unlikely to cause any visual disruption.
- (c) **Laser-beam sensitive flight zone (LSFZ).** Airspace outside, and not necessarily contiguous with, the LFFZ and LCFZ where the irradiance is restricted to a level unlikely to cause flash-blindness or after-image effects.
- (d) **Normal flight zone (NFZ).** Airspace not defined as LFFZ, LCFZ or LSFZ but which must be protected from laser radiation capable of causing biological damage to the eye.

5. GENERAL

5.1 Lasers can produce a beam of light of such intensity that permanent damage to human tissue, in particular the retina of the eye, can be caused instantaneously, even at distances of over 10 km. At lower intensities, laser beams can seriously affect visual performance without causing physical damage to the eyes.

5.2 Protection of pilots against accidental laser beam strike has become a serious factor in aviation safety with the advent of the laser light display for entertainment or commercial purposes.

5.3 To protect the safety of aircraft against the hazardous effects of laser emitters, the following protected zones should be established around aerodromes:

- (a) a laser-beam free flight zone (LFFZ),
- (b) a laser-beam critical flight zone (LCFZ), and
- (c) a laser-beam sensitive flight zone (LSFZ).

5.4 Figures 1, 2, and 3 may be used to determine the exposure levels and distances that adequately protect flight operations.

5.5 The restrictions on the use of laser beams in the three protected flight zones, LFFZ, LCFZ, and LSFZ, refer to visible laser beams only.

5.6 Laser emitters operated by authorities in a manner compatible with flight safety are excluded from these restrictions. Typical examples of lasers used to support aviation include some cloud base or visibility measurement equipment, some bird harassing devices, and some aircraft docking guidance systems. Aerodrome authorities are to ensure that these lasers have the beam aimed in such a direction, and/or that the times of operation are controlled, to ensure no hazard is posed to aircraft operations.

5.7 In all navigable air space, the irradiance level of any laser beam, visible or invisible, is expected to be less than or equal to the maximum permissible exposure (MPE) unless such emission has been notified to the authority and permission obtained.

5.8 The protected flight zones are established in order to mitigate the risk of operating laser emitters in the vicinity of aerodromes.

5.9 The dimensions indicated for the various zones are given as guidance, but ICAO Doc 9815 advises that they have been found to provide for the safe operation of aircraft in the vicinity of aerodromes.

6. LASER-BEAM FREE FLIGHT ZONE

6.1 Within this zone, the intensity of laser light should be restricted to a level that is unlikely to cause any visual disruption. The irradiance should not exceed 50 nW/cm^2 unless some form of mitigation is applied. The level of brightness thus produced is indistinguishable from background ambient light.

7. LASER-BEAM CRITICAL FLIGHT ZONE

7.1 While the suggested extent of this zone is shown in the Figures, this zone may have to be adjusted to meet air traffic requirements.

7.2 Within this zone the irradiance should not exceed $5 \mu\text{W/cm}^2$ unless some form of mitigation is applied. Although capable of causing glare effects, this irradiance will not produce a level of brightness sufficient to cause flash-blindness or after-image effects.

8. LASER-BEAM SENSITIVE FLIGHT ZONE

8.1 The extent of this zone should be determined by the operations at the particular aerodrome. The LSFZ need not necessarily be contiguous with the other flight zones.

8.2 Within this zone the irradiance should not exceed $100 \mu\text{W/cm}^2$ unless some form of mitigation is applied. The level of brightness thus produced may begin to produce flash-blindness or after-image effects of short duration; however, this limit will provide protection from serious effects.

9. NORMAL FLIGHT ZONE

9.1 The NFZ is any navigable airspace not defined as LFFZ, LCFZ or LSFZ. The NFZ should be protected from laser radiation capable of causing biological damage to the eye.

9.2 The maximum irradiance level (MIL), should be equal to or less than the maximum permissible exposure (MPE).

10. FURTHER INFORMATION

10.1 Further guidance on how to protect flight operations from the hazardous effects of laser emitters is contained in the ICAO publication “Manual on Laser Emitters and Flight Safety (Doc 9815)”.

Patrick Murray
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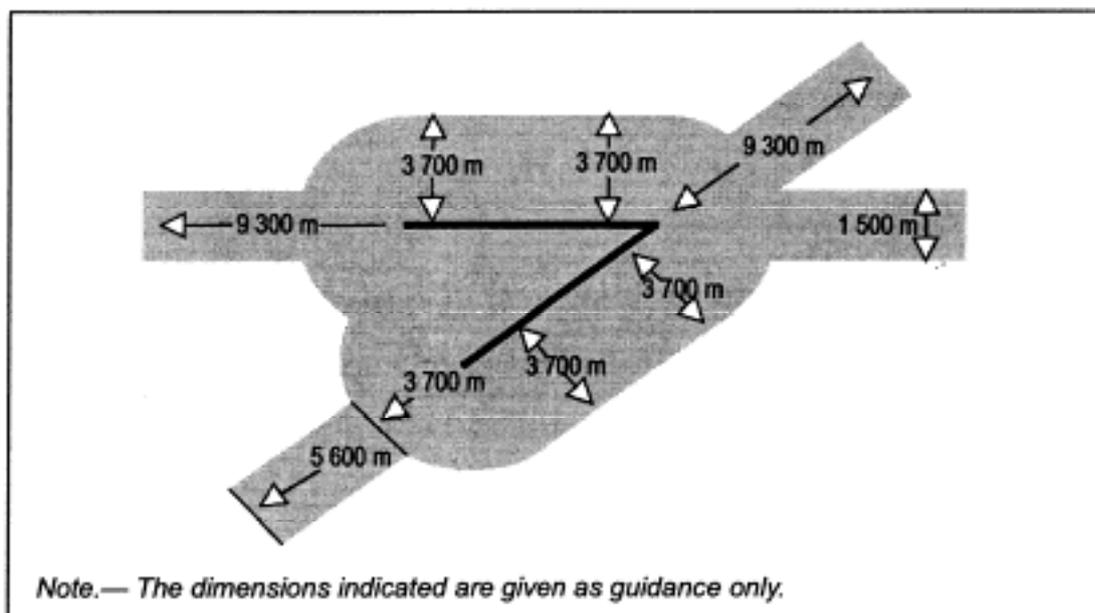
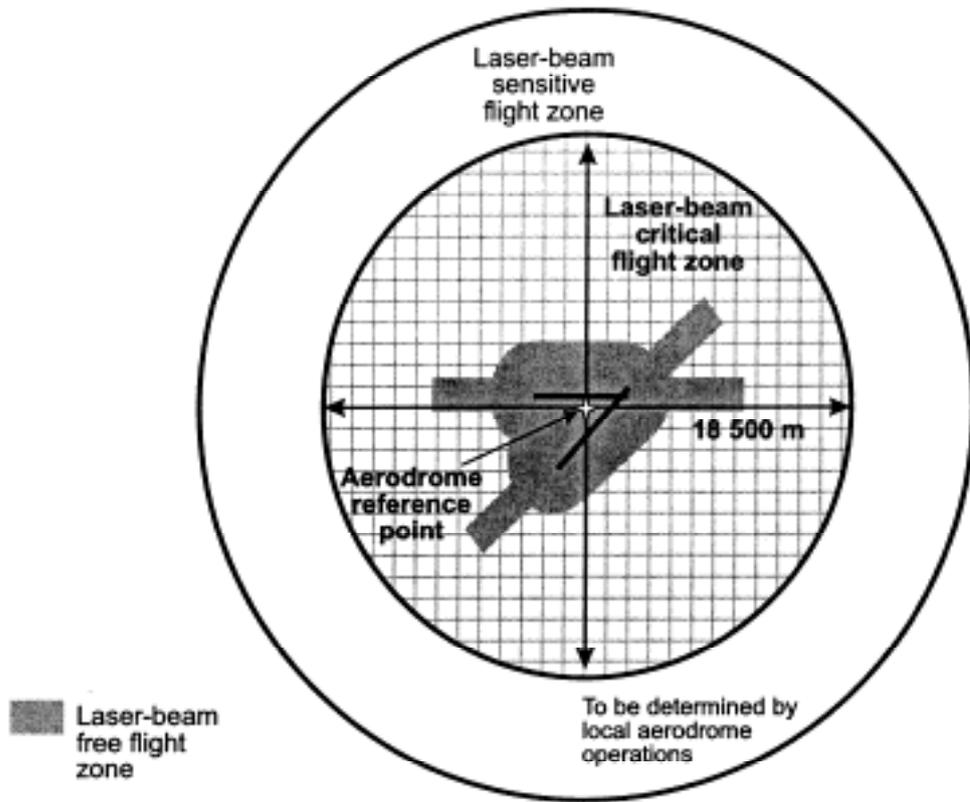


Figure 1. Laser-beam Free Flight Zone - Multiple Runways



Note.— The dimensions indicated are given as guidance only.

Figure 2. Laser-beam Protected Flight Zones.

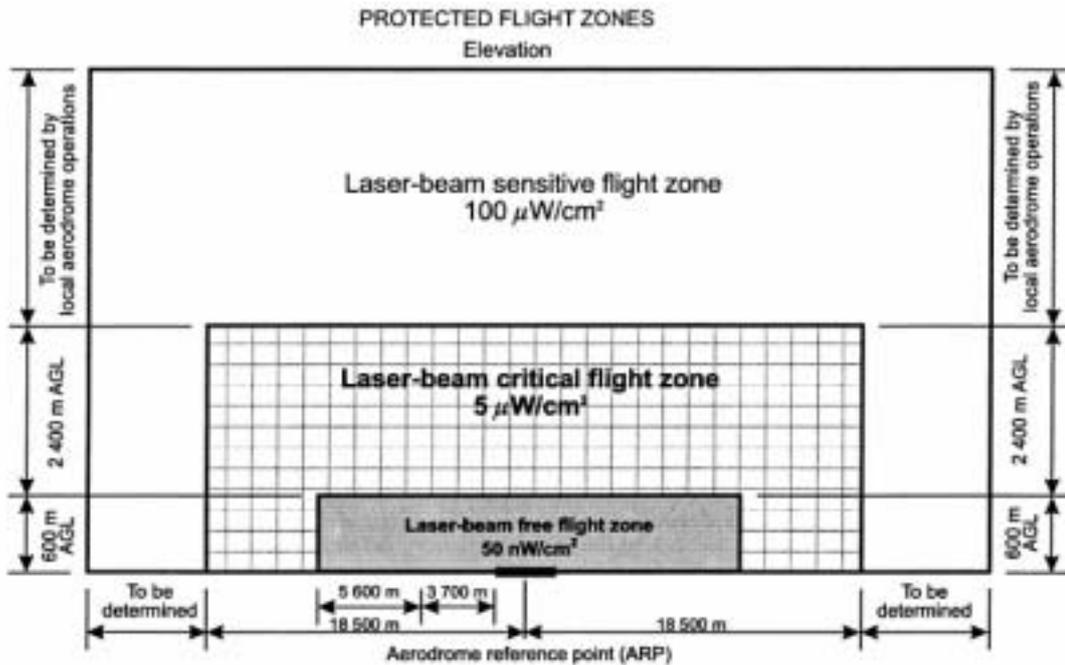


Figure 3. Laser-beam Protected Flight Zones with indication of maximum irradiance levels for visible laser beams.