

ADVISORY CIRCULAR

SUBJECT: LASER EMISSIONS THAT MAY ENDANGER THE SAFETY OF CIVIL AVIATION	DATE: 2016-06-15	AC NUMBER: 077-01	VERSION: 2.0
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NOTE: THIS ADVISORY CIRCULAR IS PUBLISHED TO PROVIDE REGULATORY INFORMATION AND DESCRIBE ACCEPTABLE MEANS OF COMPLIANCE WITH THE GENERAL AUTHORITY OF CIVIL AVIATION REGULATIONS (GACAR).

CHAPTER 1 – INTRODUCTION

1.1 Purpose.

The purpose of this advisory circular is to provide 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. This guidance should be used in the planning and control of advertising, entertainment, and similar visual displays using visible laser light. The guidance provided in this advisory circular is unlikely to prevent willful or malicious laser attacks against aircraft by those intent on causing mischief. Chapter 3 of this advisory circular provides an acceptable means of compliance under GACAR § 77.63(a) for the notification to project a directed bright light source into navigable airspace.

1.2 Applicability.

This advisory circular is applicable to aerodrome operators, and to the operators of laser shows. It may also be of interest to air traffic controllers.

1.3 Cancellation.

This is the first official version of this advisory circular and it cancels no other advisory circulars.

1.4 Related Regulatory Provisions.

GACAR Parts 1, 4 and 77.

1.5 Related Reading Material.

Manual on Laser Emitters and Flight Safety (ICAO Doc 9815).

1.6 Definitions of Terms Used in this Advisory Circular.

Affected parties should refer to Subpart A of GACAR Part 1 for a full listing of defined terms used in the GACAR. The following additional terms are used in this advisory circular:

Irradiance (E) means the power per unit area expressed in watts per square centimetre (W/cm²) or watts per square metre (W/m²). Small values may be expressed as micro watts per square centimetre (μ W/cm²) or nano watts per square centimetre (nW/cm²), 10⁻⁶ and 10⁻⁹ respectively.

Maximum Permissible Exposure (MPE) means 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.

Protected Flight Zones means 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.

1.7 Approval.

This advisory circular has been approved for publication by the Assistant President, Safety, Security and Air Transport Sector of the General Authority of Civil Aviation.

CHAPTER 2 – PROTECTING AIRCRAFT FROM THE HAZARDS OF LASERS

2.1 General.

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. 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.

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).

Figures 1, 2, and 3 may be used to determine the exposure levels and distances that adequately protect flight operations. The restrictions on the use of laser beams in the three protected flight zones, LFFZ, LCFZ, and LSFZ, refer to visible laser beams only. 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 operators and meteorological service providers 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. In all navigable airspace, 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 GACA and permission obtained. The protected flight zones are established in order to mitigate the risk of operating laser emitters in the vicinity of aerodromes. The dimensions indicated for the various zones are given as guidance, but ICAO advises that they have been found to provide for the safe operation of aircraft in the vicinity of aerodromes.

2.2 Laser-Beam Free Flight Zone.

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/cm² unless some form of mitigation is applied. The level of brightness thus produced is indistinguishable from background ambient light.

2.3 Laser-Beam Critical Zone.

While the suggested extent of this zone is shown in the Figures, this zone may have to be adjusted to meet air traffic requirements. Within this zone the irradiance should not exceed $5 \mu\text{W}/\text{cm}^2$ 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.

2.4 Laser-Beam Sensitive Zone.

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

2.5 Normal Flight Zone.

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.

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

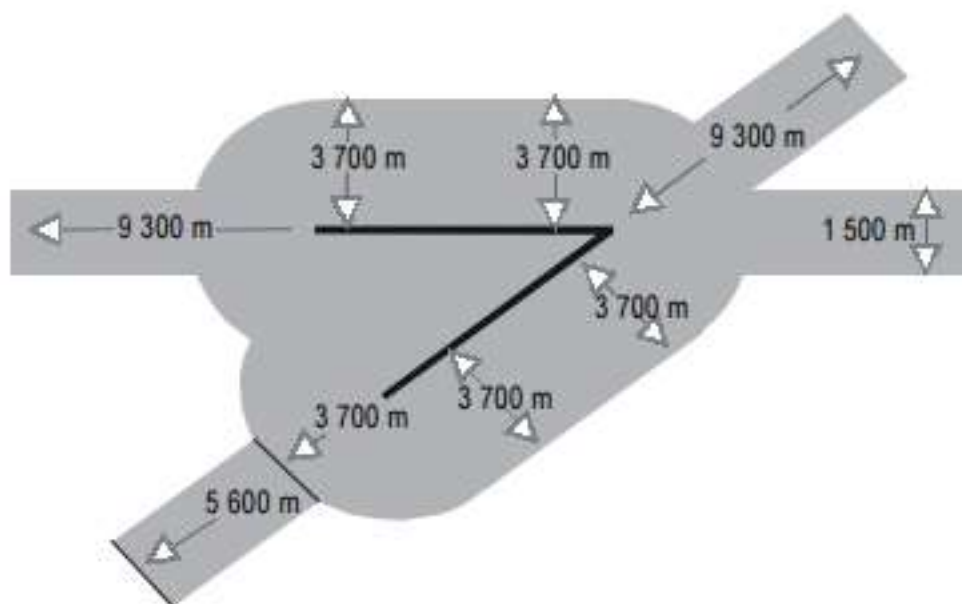


Figure 2. Laser-Beam Protected Flight Zones

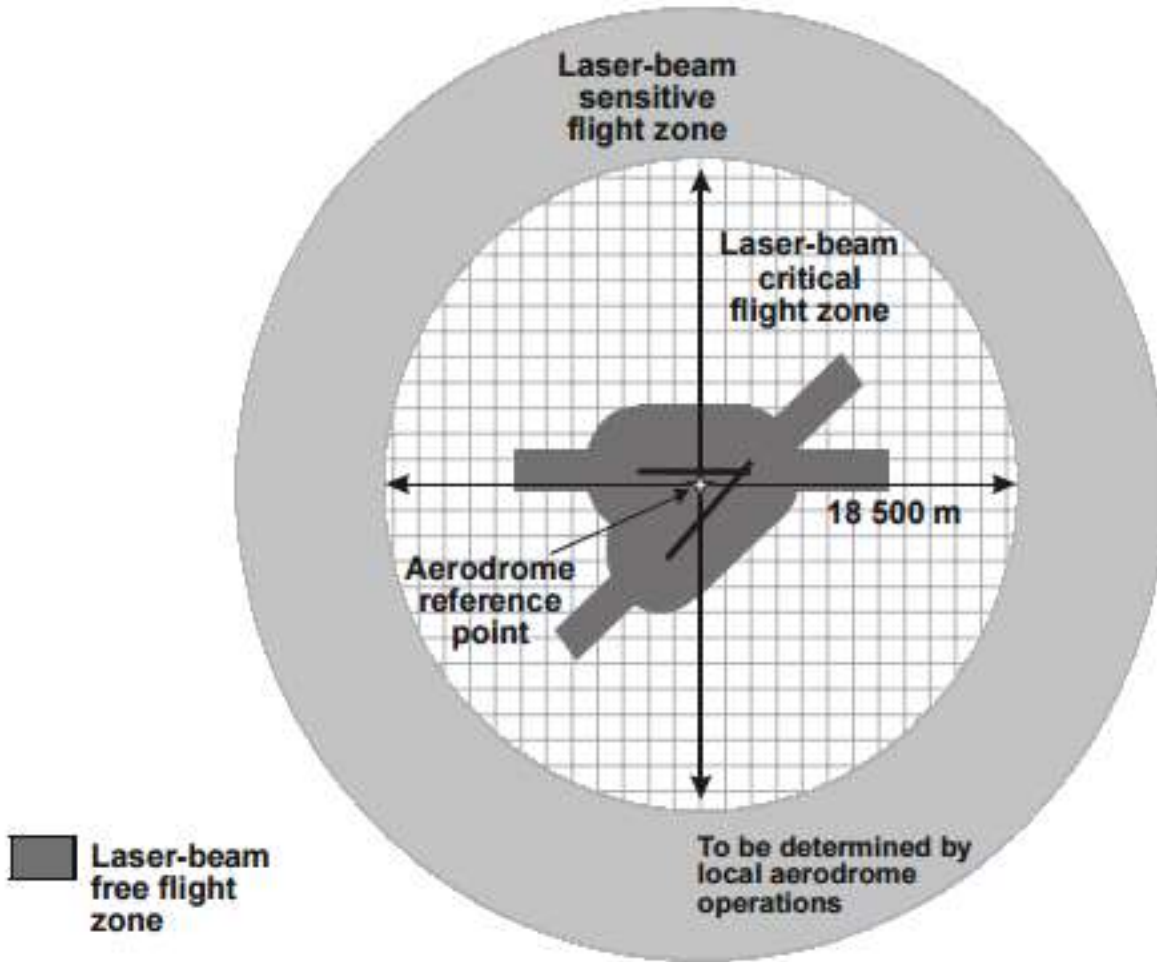
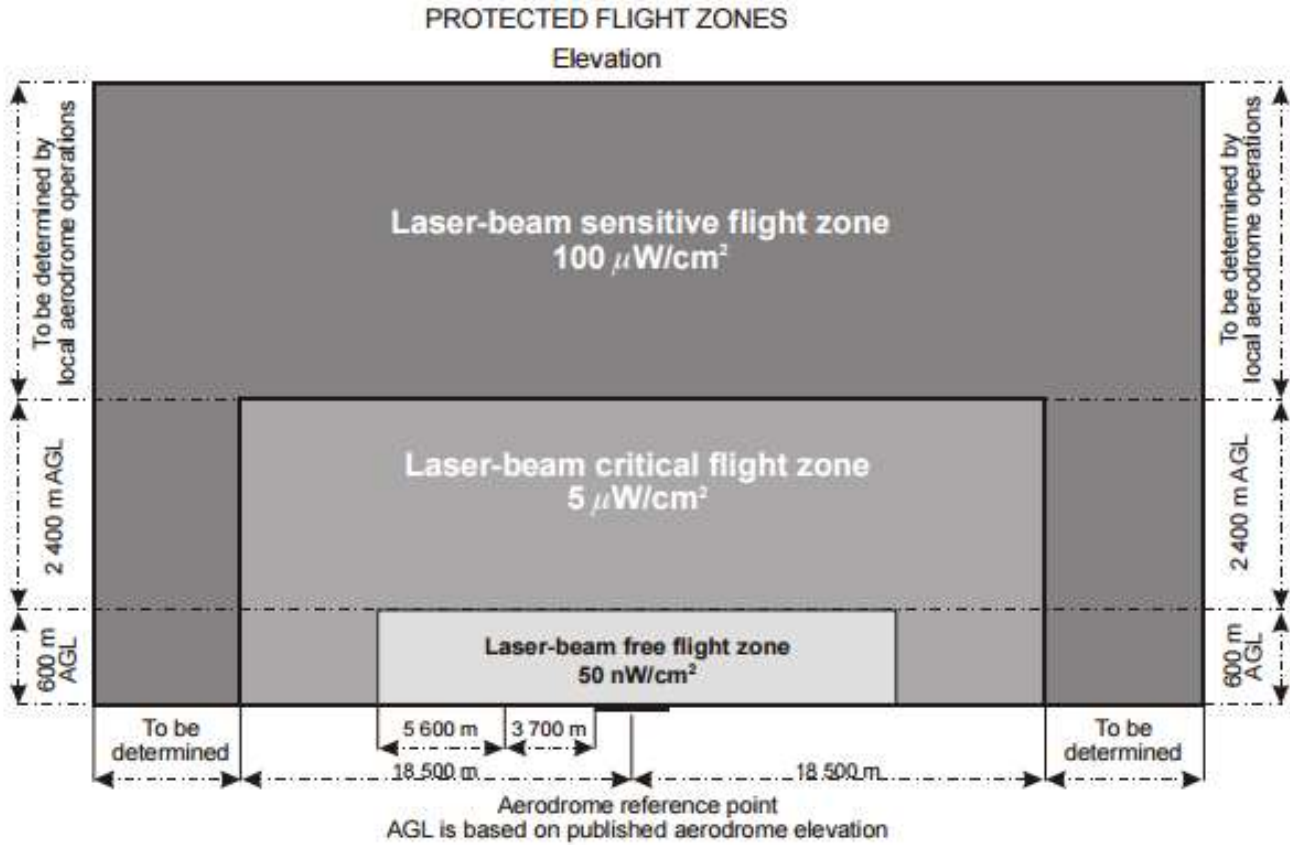


Figure 3. Laser-Beam Protected Flight Zones with Indication of Maximum Irradiance Levels for Visible Laser Beams



CHAPTER 3 – NOTIFICATION TO PROJECT DIRECTED BRIGHT LIGHTS INTO NAVIGABLE AIRSPACE

3.1 General.

GACAR Part 77 addresses the broad subject area of the preservation of the navigable airspace. Within Subpart E of GACAR Part 77 there are two sections that specifically address the projection of directed bright lights (e.g. lasers) into the navigable airspace. The two specific sections are repeated below:

GACAR § 77.61 Projection of Directed Bright Light Sources at an Aircraft.

No person will project or cause to be projected a bright light source into navigable airspace in such a manner as to create a hazard to aviation safety or cause damage to an aircraft or injury to any person on board an aircraft.

GACAR § 77.63 Notice Requirements for Projecting Directed Bright Light Sources Into Navigable Airspace.

(a) Any person intending to project or causing to be projected a directed bright light source into navigable airspace that may create a hazard to aviation safety must provide written notification to the President no less than 5 working days before the projection.

(b) The President will issue an authorization when the projection of the directed bright light source is not likely to create a hazard to aviation safety.

As prescribed in GACAR § 77.63(a), any person who intends to project directed bright lights (including lasers) into the navigable airspace that may create a hazard to aviation safety must notify the President in advance of the projection. Section 3.2 below includes a listing of the information that should be included in the notification to the President. The notification should be sent to Airports and Airspace Department of the Safety, Security and Air Transport Sector of GACA. Further details on how to contact this department are contained in Chapter 4 of this advisory circular.

3.2 Contents of Notification.

The information provided by the person making the notification will be used by the GACA to perform an aeronautical study to evaluate the safety of a proposed laser operation. Provide all information noted below as this is the minimum data that the GACA will need to perform the study.

A. APPLICANT CONTACT INFORMATION.

Identify the name, address, phone and fax and E-mail of the applicant. This is the party primarily responsible for the laser safety of the intended operation. In some cases, the applicant is a manufacturer or a governmental agency, and the laser is located at a different site. In such a case,

list the both the contact information for the applicant and the site location.

B. GENERAL INFORMATION.

NAME.

Identify the event name (for temporary shows) or the facility name (for permanent installations).

GEOGRAPHIC LOCATION.

Identify the latitude and longitude of the laser source. Identify the ground elevation at site. If the laser is on a building or other elevated structure, specify the laser's height above the ground.

DATE(S) AND TIME(S) OF LASER OPERATION.

Testing and alignment: Specify the proposed date(s) and time(s) during which testing and alignment procedures will take place.

Operation: Specify the proposed the date(s) and time(s) during which laser light will enter navigable airspace.

C. BRIEF DESCRIPTION OF OPERATION. Provide a general overview of the proposed operation and a general description of each of the lasers involved. If a particular set-up operates with more than one laser, with different beam characteristics (power settings, pulse modes, divergence, etc.) or has multiple output devices (example: projector heads), then each should be listed separately. You may need to add attachments such as maps, diagrams and details of control measures. Include whatever materials you feel are necessary to assist the GACA in sufficiently evaluating your proposal

D. BRIEF DESCRIPTION OF CONTROL MEASURES.

Describe the control measure(s) used to protect airspace; for example, termination on a building (where the beam path is not accessible by aircraft including helicopters), use of observers, use of radar and imaging equipment, physical methods of limiting the beam path, etc. The more that the operation relies on the control measures to ensure safety, the more detailed the description should be.

E. DESIGNATED CONTACT PERSON.

Provide the name and contact information for the designated contact person. This is the person whom the GACA will contact if additional information is needed. This should be the person with the most knowledge about laser safety at this operation. However, it could also be a central contact person who interfaces between the GACA and the laser operation personnel.

CHAPTER 4 – FOR FURTHER INFORMATION

4.1 Responsible Department(s).

The Airports and Airspace Department of the GACA Safety, Security and Air Transport Sector is the department responsible for the protection of the navigable airspace including the prevention of dangers to civil aviation resulting from lasers.

4.2 Contact Details.

The Airports and Airspace Department can be contacted at the following coordinates:

In person:

General Authority of Civil Aviation
Airports and Airspace Department
Safety, Security and Air Transport Sector Building
KAIA, Jeddah

By mail:

General Authority of Civil Aviation
Airports and Airspace Department
Safety, Security and Air Transport Sector
P.O. Box 887
Jeddah, 21421