Directorate of Airspace Policy

Civil Aviation Authority

CAP 736

Guide for the Operation of Lasers, Searchlights and Fireworks in United Kingdom Airspace

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List of Effective Pages

Chapter	Page	Date	Chapter	Page	Date
	iii	5 December 2003			
	iv	5 December 2003			
Chapter 1	1	5 December 2003			
Chapter 2	1	5 December 2003			
Chapter 2	2	5 December 2003			
Chapter 2	3	5 December 2003			
Chapter 3	1	5 December 2003			
Chapter 3	2	5 December 2003			
Chapter 4	1	5 December 2003			
Chapter 4	2	5 December 2003			
Annex A	1	5 December 2003			
Annex A	2	5 December 2003			
Annex B	1	5 December 2003			
Annex C	1	5 December 2003			

Contents

Chapter 1 Introduction

1 Aim

Individuals or organisations wishing to direct light sources, pyrotechnics or fireworks into the atmosphere are obliged to do so in a safe and sensible manner, as mandated by legislation contained within the United Kingdom Air Navigation Order 2000, so that their activities may safely co-exist with aircraft operations. The CAA is responsible for policy regarding light displays, and/or permanent laser, other light source installations, fireworks and their effects on aviation. Consequently the aim of this CAP is to state existing policy and to provide individuals or organizations, wishing to conduct directed light or firework operations in the United Kingdom, with a means of notifying their activities to the CAA. This will enable the aviation community to properly assess the impact of any such proposed activity and take appropriate measures to mitigate any dangers to flight safety.

2 Structure

This document should be read in its entirety in order to appreciate the relevance of the issue to aviation. Following the introduction, Chapter 2 gives a general overview of the issues surrounding the impact of light and fireworks shows on the safety of flight operations and gives the legislative background to the subject. Chapter 3 describes the light display guidelines that indicate areas within which the UK considers it especially necessary to protect flight operations from the dangers presented by light displays. This chapter refers to light operations that are of a temporary nature. Chapter 4 describes the issues surrounding the establishment of permanent laser or searchlight sites. The Annexes provide a form for organizers to notify the CAA of their activities, together with graphical illustrations of the safety zones considered to exist in the vicinity of aerodromes. Finally a list of reference documents is attached.

Chapter 2 General

1 The Threat to Aircraft Safety

The use of lasers, searchlights and fireworks is now widespread throughout the UK. Many of these activities make use of a generated light source to produce intense and directional beams of light and create special lighting effects. Whilst the production of many light sources is important for the purposes of the research and entertainment industries, this can create a potential hazard to aircraft operations. The hazard to aviation is increased when such activities take place in the vicinity of aerodromes, and particularly during such critical phases of flight as approach and landing. The hazard is more likely to be from the unexpected dazzle rather than ocular or physical damage, although the risk of actual injury should not be discounted.

2 Light Displays and Legislation

2.1 Adequate lighting is necessary for all visual tasks. An excess of light, however, can detrimentally affect vision to the extent of rendering it ineffective. In aviation, a pilot may experience high levels of lighting when flying into the sun or looking at very bright artificial light sources such as searchlights. Sudden and intense bursts of lights can also cause distraction and confusion, especially if the occurrences are unexpected. Instances such as light displays, lasers or firework shows can be the cause of such events.

2.2 Ideally, pre-event analysis and discussion with aviation authorities should safely de-conflict flying and light display activities. Failure to take suitable or adequate measures to prevent a hazard to aircraft may result in prosecution under the Air Navigation Order 2000 that refers to endangering the safety of an aircraft, or under Article 110 of the same Order that refers to dangerous lights.

3 Lasers

3.1 The invention of the laser in particular is a significant addition to the known aviation-related problems associated with high intensity lights. The technology 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 over 10 km. At lower intensities, laser beams can seriously affect visual performance without causing physical damage to the eyes.

3.2 Protection of the pilot against deliberate or accidental laser beam strikes has been of interest to military aviation medicine specialists for many years. However, it was with the advent of the laser light display for entertainment or commercial purposes, and subsequent accidental illumination of civil aircraft from such displays, that civil aviation authorities have become increasingly concerned with the issue of projection of laser light into the air.

3.3 An event recorded in 1995 related the experience of a pilot on a commercial flight in the USA. Shortly after take-off the pilot was hit in the eye by a laser beam. He was completely flash-blinded in his right eye and suffered impaired vision in his left eye. He was unable to see for 30 seconds and for another two minutes was unable to interpret any of his flight instruments. Such an event has obvious safety implications

in imperilling the lives of aircrew, passengers and those living in the vicinity of aerodromes.

3.4 Lasers used in outdoor Light Displays produce an intense, coherent, directional beam of light with wavelengths covering the visible spectrum of 400-700 nanometers. Such concentrated energy creates not only the potential for permanent eye injury to pilots, crew and passengers, but also loss of night vision. When such Light Displays are projected or reflected into airspace and intercept aircraft, unplanned exposure (incidents of illumination, startle and glare) may cause pilot distractions or create temporary vision impairments (flash blindness, afterimage). These effects may pose significant flight safety hazards during critical phases of flight, in particular during approach and landing operations.

3.5 In view of the increasing risk to flight safety posed by the more widespread use of laser emitters around airports, the International Civil Aviation Organization (ICAO) formed a study group in 1999 to evaluate the laser risk. During 1999 and 2000, the Aviation Medicine Section of the ICAO Secretariat developed the laser-related Standards or Recommended Practices (SARPs) which are now included in Annexes 11 and 14 to the Convention on International Civil Aviation. These standards, to which the UK subscribes, require states to take adequate steps to prevent laser beams from adversely affecting flight operations and recommends establishing zones around aerodromes within which the use of lasers should be restricted.

3.6 Safety regulations for laser displays are already taken into consideration by Local Government Authorities when carrying out risk assessments for associated planning applications or entertainment licences. Aviation risk assessments are carried out along similar lines to establish Hazard Zones. ICAO Recommended Practices suggest the establishment of Laser Beam Free Flight Zones, Laser Beam Critical Flight Zones and Laser Beam Sensitive Flight Zones. The UK approach, which has been established for several years, does not prescribe precise dimensions for such zones around each UK airport, but considers that a Notification Zone exists around every UK aerodrome within which laser emissions must be controlled.

3.7 A Nominal Hazard Zone is considered to exist around any laser within which visible and invisible laser beams can pose a potential threat to safety by exceeding the Maximum Permitted Exposure. Assessment of lasers producing visible beams will also take into account the additional risks from dazzle and distraction in order to calculate a Sensitive Level and Visual Interference Level that determine whether the installation can safely co-exist with aircraft operations and, if appropriate, what restrictions or limitations should be applied. This assessment will depend on the range and bearing of the installation from any nearby aerodrome. If the proposed display or installation is particularly complex or contentious, a Local Laser Working Group may be convened to assess the implications of the proposal and produce a final assessment.

4 Searchlights

Searchlights are frequently used to provide spectacular backdrops to individual events. They are also used to provide lighting displays for structures or special events over periods of weeks or even months. Apart from the potential to distract aircrew, they may also appear similar in appearance and position to airfield lighting, hence their position and operation must be considered with care.

5 Fireworks

Firework displays can vary from the small-scale garden event to a major commercial or ceremonial occasion. As with laser or searchlight displays, fireworks have the potential to distract and confuse aircrews or damage aircraft during flight operations. A unique feature of fireworks displays is that solid objects are physically launched into the air to create the full visual effect. Whilst most household type fireworks do not have the ability to reach more than a few feet into the air, many fireworks associated with large-scale events can dispense canisters several hundred feet into the air. Whilst the risk of collision with aircraft is small, the existence of such projectiles needs to be borne in mind when carrying out an assessment for fireworks displays in the vicinity of aerodromes.

Chapter 3 Light and Firework Display Guidelines (Temporary Displays)

1 Action by Light and Firework Display Organisers

1.1 This chapter refers to procedures concerned with temporary light and firework displays. Refer to Chapter 4 if the light display is designed as a permanent (longer than one month) installation.

1.2 Light and Firework Display Organisers should notify the CAA of their proposed activity by completing the proposal to conduct outdoor laser, searchlight or firework operations at Annex A. **Notification needs to be given at least 28 days in advance.** This is to allow time to adequately warn the aviation community of the event and establish any control measures considered necessary.

1.3 The CAA will examine the proposal based on the following guidelines. If no further information is required then appropriate warning action will be carried out and the Display Organiser will receive written confirmation of this. If further information or action is required from the Display Organiser, the CAA may contact the originator of the proposal to discuss suitable future courses of action.

2 Guidelines for Light and Firework Displays

2.1 It is of prime importance that light displays and fireworks are never directed at or towards aircraft or aerodromes. The Light Display organiser should also nominate a single point of contact, known as a Light Display Operator (LDO), who will be directly responsible for the conduct of the actual event. Display organisers should be aware of the following geographical zones, also illustrated at Annex B, within which the CAA considers it necessary to impose restrictions in order to protect flight operations:

2.1.1 **Within 3 Nautical Miles (5.5 kilometres) of an Aerodrome, or within 10 Nautical Miles (18.5 kilometres) radius of the Extended Runway Centreline of an Aerodrome.** For Light Displays within 3 nm of an Aerodrome but not on the extended runway centre-line, or within 10 nautical miles (nm) of an aerodrome but within 500m either side of the extended runway centreline, the following procedures should be adhered to:

a) Ideally, beams are to be below the horizontal, or a physical barrier such as a building or a land feature is to be in place to prevent light escaping towards the aerodrome or along the extended runway centre-line.

b) If this proves impractical, other precautions are to be taken to ensure that light displays do not impinge on safe flight operations, such as arranging for a direct telephone or radio communications link between the LDO and relevant aerodrome, through which the Light Display can be terminated immediately on request from either an aircraft or the affected aerodrome.

NOTE: If this is not possible, then the light display may represent a threat to flight safety and should not proceed.

2.1.2 **Elsewhere.** Although the light display is unlikely to affect aerodrome flight operations, the Light Display organiser should notify the CAA to ascertain if there are any other aviation activities that may be affected by the display.

3 Additional Guidelines for Firework Displays

3.1 Aerial fireworks displays should be limited to a height of 1500 ft above ground level. Any firework conforming to BS7114 will not exceed this height.

3.2 Displays within 10nm (18.5 km) radius of an active aerodrome or within an ATZ may require notification and coordination action and must be notified by the event Supervisor to the CAA for consideration.

3.3 If the fireworks display is planned to take place near the coast, the organisers should pass all the relevant details to HM Coastguard.

4 Further Advice

4.1 Further advice on the use of lasers and fireworks for display purposes can be obtained from the following Health and Safety Executive publications:

HS(G)95 - 'The Radiation Safety of Lasers Used for Display Purposes'
ISBN 0-7176-0691-0.

HS(G)123 - 'Working Together on Firework Displays: Guide to Safety for Firework Display Organisers and Operators'.
ISBN 071-7608352.

4.2 Laser safety guidance can be obtained from the National Radiological Protection Board at the following telephone numbers:

Chilton (Oxfordshire):	Tel: 01235 822670 Fax: 01235 822650
Leeds:	Tel: 0113 267 9041 Fax: 0113 261 3190
Glasgow:	Tel: 0141 440 2201 Fax: 0141 440 0820

Chapter 4 Permanently Sited Lasers and Searchlights

1 Permanent Laser and Searchlight Sites

1.1 Any laser or searchlight site that is likely to remain in position for more than a month is considered a permanent site. Not every site will be significant to aviation, but the CAA should be consulted during the initial planning process for any such installation.

1.2 An initial approach should be made to the Off Route Airspace Department in the Directorate of Airspace Policy at the CAA. The Section will examine the proposal and advise the originator of whether it is likely to affect aircraft operations and if so, what measures to take to mitigate its effect. The guidelines given in Chapter 3 and Annex B will be utilised to make an initial assessment of the likely risk to aircraft operations. Further advice may be sought from the National Radiological Protection Board and the ATS Standards Department of the Safety Regulation Group of the CAA.

2 Lasers, Searchlights and Other Lights Used for Air Traffic Control Purposes

Several types of laser, searchlights and other lights are used on or near airfields for Air Traffic Control (ATC) or meteorological purposes. These include cloud and visibility measurement, communications, and navigation aid calibration tasks. It is the responsibility of individual aerodrome licensees to ensure that equipment used for such purposes is operated in accordance with the manufacturer's instructions, international, national and local ATC procedures, and in a manner that will neither endanger any aircraft nor prejudice flight safety.

3 Use of Lasers by Military Units

The use of lasers by military units is widespread across all 3 services. Lasers are commonly used for range finding, target designation and weapon guidance. This document does not cover the use of lasers, searchlights or other light sources by the military as MoD, and their subordinate organisations, produce separate regulations concerning the safe use of lasers by the military. However, such regulations do not absolve any person from using best judgement to ensure the safety of aircraft and aircrew while operating equipment employing lasers, searchlights or other light sources.

4 Further Contacts and Advice

4.1 Initial guidance and advice on the impact of light sources on aviation can be obtained from:

Off Route Airspace
Directorate of Airspace Policy
CAA House
45-59 Kingsway
London WC2B 6TE

Tel: 0207 453 6543
Fax: 0207 453 6565

4.2 Advice on the use of lasers, searchlights and other lights for the purposes of ATC operations can be obtained from:

ATS Standards Department (ATSSD)
Civil Aviation Authority
Safety Regulation Group
Aviation House
Gatwick Airport South
West Sussex
RH6 0YR

Tel: 01293 573423
Fax: 01293 573974

4.3 Any questions concerning the military use of lasers, searchlights or other light sources should be addressed to:

Chairman, Military Laser Safety Committee

Tel: 0117 91 35384
Fax: 0117 91 31920

5 Laser Safety Guidance

Laser safety guidance can be obtained from the National Radiological Protection Board at the following telephone numbers:

Chilton (Oxfordshire):	Tel: 01235 822670 Fax: 01235 822650
Leeds:	Tel: 0113 267 9041 Fax: 0113 261 3190
Glasgow:	Tel: 0141 440 2201 Fax: 0141 440 0820

Annex A Notification of Outdoor Laser, Searchlight or Firework Operations

To: Airspace Utilisation Section Directorate of Airspace Policy K1 CAA House 45-59 Kingsway London WC2B 6TE Tel: 0207 453 6599 Fax: 0207 453 6593 Email: ausops@dap.caa.co.uk	From: (Applicant)	Date: (this form requires submission at least 28 days in advance of the date of the event given in paragraph 1)

1 GENERAL INFORMATION

Event or facility		
Customer	Site address (must include postcode)	
GEOGRAPHIC LOCATION		
Latitude ___ *deg (°)* ___ *min (')* ___ *sec (")*	Longitude ___ *deg (°)* ___ *min (')* ___ *sec (")*	
Grid Ref :		
Ground elevation at site *(Above Mean Sea Level)*	Elevation above ground (if on buildings, etc.)	For Firework Displays – maximum height of display (Above Ground Level)
DATE(S), TIME(S) AND DURATION OF EVENT		
Testing and/or alignment	Operation	

2 BRIEF DESCRIPTION OF OPERATION

3 ON-SITE OPERATION INFORMATION

Operator(s)	
On-site phone 1 (Emergency Contact)	On-site phone 2
BRIEF DESCRIPTION OF CONTROL MEASURES	

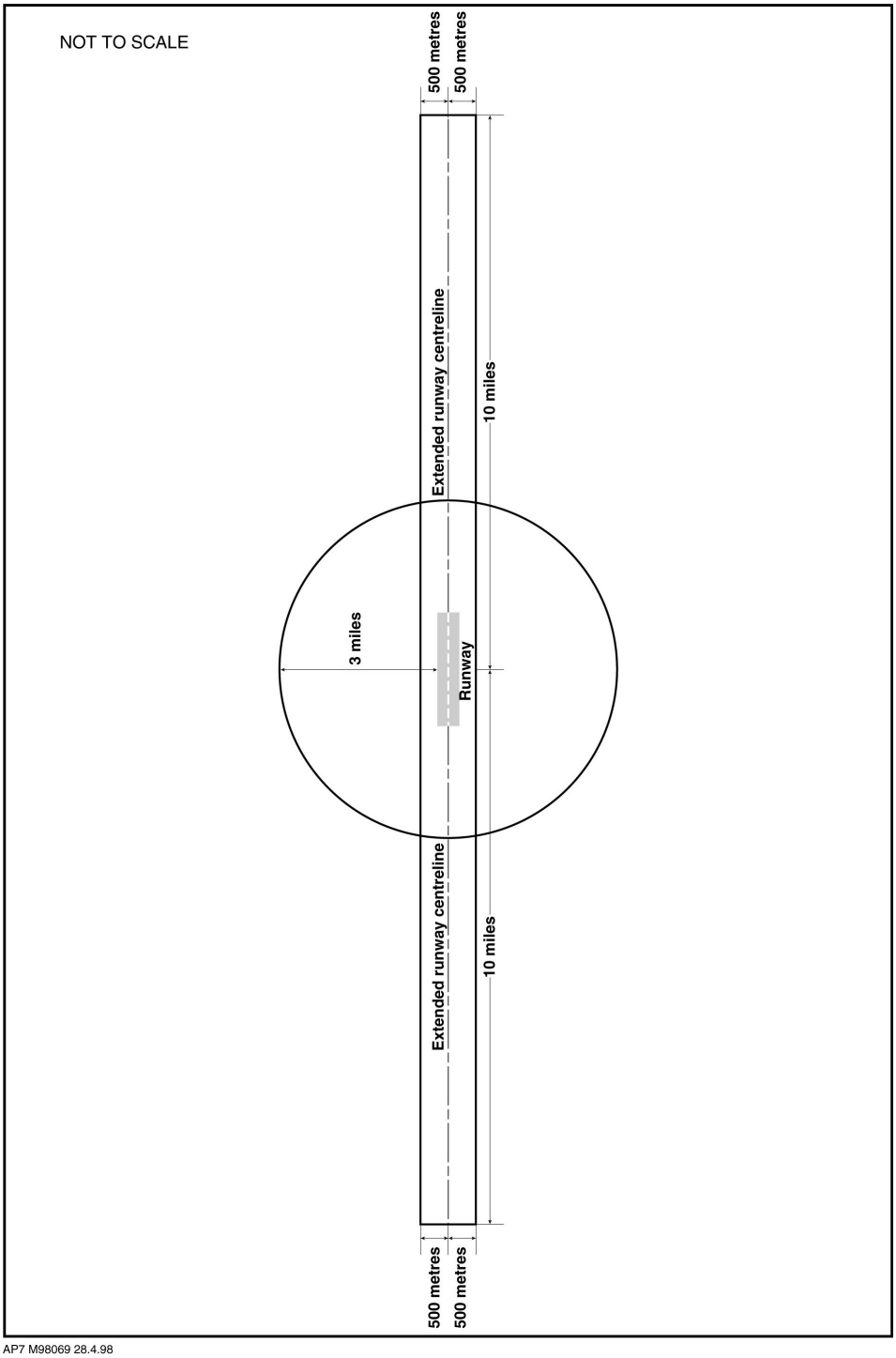
4 ATTACHMENTS

List any additional attachments needed to evaluate this operation *(could include maps, diagrams, and details of control measures)*

5 DESIGNATED CONTACT PERSON *(if further information is needed)*

Name		Position
Phone	Fax	E-mail
STATEMENT OF ACCURACY To the best of my knowledge, the information provided in this Notice of Proposal is accurate and correct.		
Name *(if different from contact person)*		Position
Signature		Date

Annex B Notification Zones for Light Displays (Diagram)



(Note: miles = nautical miles)

Annex C Reference Documents

The following documents contain further specific guidance on the risks, notification and conduct of Light Displays:

CAP 168 Appendix 6E to Chapter 6.

AIP ENR 5 - 3 – 11 Permanently Sited Lasers.

AIC 33/2002, Yellow 79 (Notification of UAA).

Eurocontrol Safety Regulation Commission Document – SRCDOC 7 (Outdoor Lasers in the Navigable Airspace) 2001.

ICAO Annex 11 Chapter 2 and Annex 14 Chapter 5.

ICAO document 'Laser Protection at Aerodromes (AN5/19.3-01/56).

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

UK H&S - HS (G) 95 - 'The Radiation Safety of Lasers Used for Display Purposes'. (ISBN 0-7176-0691-0).

UK H&S - HS (G) 123 - 'Working Together on Firework Displays: Guide to Safety for Firework Display Organisers and Operators'. (ISBN 071-7608352).

US SAE Aerospace Standard AS497*0, 'Human Factors Considerations for Outdoor Laser Operations in the Navigable Airspace*', December 1999.
(Published document).

US FAA 7400.2E Order, Chapter 28 and 29 *'Outdoor Laser Operations'* and *'High Intensity Light Operations'.*

Transport Canada, User Guide for Directed Bright Light Operations in Airspace.
(Available on Transport Canada web site).

NASA Aviation Safety Reporting System, '*More than Meets the Eye – Problems with Laser Light Shows'* by Marcia Patten. ASRS Directline Issue 7, September 1995,
(Available on the NASA ASRS web site).