

# Fire and Rescue Service

Operational guidance  
Aircraft Incidents

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Aircraft Incidents



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For the purposes of the web version of this manual we have deleted the blank pages that form the reverse of section breaks in the printed version, hence you may notice that the page numbering is sequential.

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## SECTION 1

# Foreword

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Major incidents involving aircraft in the United Kingdom are extremely rare. Such incidents place significant demands on local fire and rescue services and often require resources and support from other fire and rescue services and emergency responders. However smaller scale incidents involving aircraft are more prevalent and these may require a response from any fire and rescue service in England.

The Fire and Rescue Service Operational Guidance – Aircraft Incidents provides robust yet flexible guidance that can be adapted to the nature, scale and requirements of the incident.

The Chief Fire and Rescue Adviser is grateful for the assistance in the development in this guidance from a wide range of sources, including the fire and rescue service and the aviation industry.

It is anticipated that this guidance will promote common principles, practices and procedures that will support the fire and rescue service to resolve aircraft incidents safely and efficiently.

## SECTION 2

# Preface

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The objective of the Fire and Rescue Service Operational Guidance – Aircraft Incidents is to provide a consistency of approach that forms the basis for common operational practices, supporting interoperability between fire and rescue services, other emergency responders, the aviation industry and other groups. These common principles, practices and procedures are intended to support the development of safe systems of work on the incident ground and to enhance national resilience.

Operational Guidance issued by the Department of Communities and Local Government promotes and develops good practice within the Fire and Rescue Service and is offered as a current industry standard. It is envisaged that this will help establish high standards of efficiency and safety in the interests of employers, employees and the general public.

The Guidance, which is compiled using the best sources of information known at the date of issue, is intended for use by competent persons. The application of the guidance does not remove the need for appropriate technical and managerial judgement in practical situations with due regard to local circumstances, nor does it confer any immunity or exemption from relevant legal requirements, including by-laws. Those investigating compliance with the law may refer to this guidance as illustrating an industry standard.

It is a matter for each individual fire and rescue service whether to adopt and follow this Operational Guidance. The onus of responsibility for application of guidance lies with the user. Department of Communities and Local Government accept no legal liability or responsibility whatsoever, howsoever arising, for the consequences of the use or misuse of the guidance.



# Section 3

Introduction

## Purpose

- 3.1** This Operational Guidance is set out in the form of a procedural and technical framework. Fire and Rescue Services should consider it when developing or reviewing their policy and procedures to safely and efficiently resolve emergency incidents involving any aircraft.
- 3.2** The term aircraft is used to describe all types of flying machines:
- fixed wing
  - rotary wing (helicopters, autogyro etc)
  - balloons
  - airships
  - gliders
  - remotely piloted air systems (unmanned aerial systems)
  - microlights.
- 3.3** The above list will cover both civil and military aircraft. Non Fire and Rescue Service organisations and agencies may use other more specific definitions for their own requirements, but the above definition is the most appropriate one for Fire and Rescue Services to base their risk assessments and planning assumptions on.
- 3.4** A Fire and Rescue Service may respond to a wide range of incidents involving numerous types of aircraft. The kind of incident varies greatly and can result in fires, rescues, scene safety and environmental impact.
- 3.5** The purpose of this guidance is to assist emergency responders to make safe, risk assessed, efficient and proportionate responses when attending and dealing with operational incidents involving aircraft.
- 3.6** Whilst this guidance may be of use to a number of other agencies, it is designed to provide relevant information, planning and operations relating to aircraft incidents for UK Fire and Rescue Service.

## Scope

- 3.7** The scope of this guidance covers a wide range of incident types that Fire and Rescue Services are likely to encounter associated with aircraft. It is applicable to any event regardless of scale, from small incidents, such as an accident involving a microlight to a large incident involving a civil aircraft (e.g. Airbus A380) resulting in a large scale major incident.
- 3.8** It is focused on the tactical and technical aspects of aircraft incidents so as to assist Fire and Rescue Services with:

- the development of safe systems of work
- interoperability at large or cross border incidents where more than one Fire and Rescue Service is in attendance
- to promote interoperability at incidents with Airport Rescue and Fire Fighting Service
- multi agency working to resolve aircraft incidents.

**3.9** This guidance covers the time period from the receipt of the first emergency call to the closure of the incident by the Fire and Rescue Service Incident Commander.

**3.10** In addition to detailed tactical and technical information it also outlines the key operational and strategic responsibilities and considerations that need to be taken into account to enable the Fire and Rescue Service to train, test intervention strategies and plan to ensure effective response at an aircraft incident.

## Structure

**3.11** The operational guidance is based on nationally accepted good practice. It is written as an enabling guide based around risk critical operational principles rather than a strict set of rules and procedures. This is done to recognise local differences across the English regions and elsewhere in the UK in terms of risk profiles and levels of resources.

**3.12** Section 8 contains the bulk of the guidance and is divided into three parts:

Part A – Preplanning considerations

Part B – Operational considerations – Generic standard operating procedure

Part C – Technical considerations

### **Part A: Preplanning**

Contains information that supports Fire and Rescue Service personnel in a number of roles when undertaking preparatory work for dealing with aircraft incidents that may occur in their service area.

This section covers planning considerations at both the strategic level when planning for service wide response options and for those associated with local site specific risks.

## **Part B: Operational considerations – Generic standard operating procedure**

Provides guidance to Fire and Rescue Service personnel on responding to and resolving aircraft incidents. It is structured around six emergency response phases common to all operational incidents.

The procedure detailed in this part of the guidance uses the Incident Command System decision making model as its foundation. It is generic standard operating procedure for dealing with aircraft incidents that Fire and Rescue Services can adopt or adapt depending on their individual risk assessments and resources.

Each section of the generic standard operating procedure details comprehensive but not exhaustive lists divided into:

- possible actions
- possible operational considerations.

It should be stressed that these are not mandatory procedures. They are a 'tool box' of operational considerations which will act as an enabling guide when dealing with aircraft incidents.

The generic standard operating procedure reflects the hazards and control measures of the national generic risk assessment relevant to aircraft incidents.

## **Part C – Technical information**

This section contains technical information and operational considerations that may be required by Fire and Rescue Service personnel for planning, training and operations. It also references more detailed guidance that may be of interest to Fire and Rescue Services.

This part only contains information with an operational connotation and is not intended to be an exhaustive technical reference document.



# Section 4

Legal framework

## Introduction

- 4.1 Fire and Rescue Authorities need to be aware of the following legislation. It is relevant to command and control at operational incidents and also in the training environment.
- 4.2 This section does not contain detailed legal advice about the legislation. It is just a summary of the relevant legislation, as applied to Fire and Rescue Authority firefighting procedures. You should confirm with your legal team on your Fire and Rescue Authority's compliance with this legislation.
- 4.3 When considering this framework it is essential to recognise that any definitive interpretation of the legal roles and responsibilities imposed by legislation can only be given by a court of law.
- 4.4 For a full understanding of the responsibilities imposed by the legislation, and by the *Fire and Rescue Service National Framework*, reference should be made to the relevant legislation or the National Framework. It is also recognised that the range of legislation and guidance that could impact on the operational responsibilities of the Fire and Rescue Authority is extensive and each Authority should seek guidance from their own legal advisors.
- 4.5 The adoption of the principles set out in this guidance will assist Authorities in achieving suitable and sufficient risk assessments and appropriate corresponding risk control measures such as those referred to in this and other similar documents.

## Primary fire and rescue service legislation

### **Fire and Rescue Services Act 2004**

- 4.6 This is the main Act which affects Fire and Rescue Authorities. Among other things, it obliges Authorities (in Section 7) to secure the provision of the personnel, services and equipment that are necessary to meet all normal requirements and also to secure the provision of training for such personnel in relation to firefighting.

### **Fire and Rescue Services (Emergencies) (England) Order 2007**

- 4.7 The Order obliges Fire and Rescue Authorities to make provision for decontaminating people following the release of CBRNE (chemical, biological, radiological, nuclear) contaminants (article 2) and also to make provision for freeing people from collapsed structures and non-road transport wreckage (regulation 3). The Order also obliges Authorities to use their specialist CBRNE or USAR (Urban Search And Rescue) resources outside their own areas to an extent reasonable for dealing with a CBRNE or USAR emergency (regulation 5).

## **Civil Contingencies Act 2004**

- 4.8** Section 2(1) states, among other things, that Fire and Rescue Authorities shall maintain plans for the purpose of ensuring that if an emergency occurs or is likely to occur the Authority is able to perform its functions so far as necessary or desirable for the purpose of preventing the emergency, reducing, controlling, mitigating its effects or taking other action in connection with it.

## **The Civil Contingencies Act 2004 (Contingency Planning) Regulations 2005**

- 4.9** Fire and Rescue Authorities must cooperate with each other in connection with the performance of their duties under Section 2(1) of the Civil Contingencies Act 2004. In addition, the Regulations state that Authority may facilitate cooperation by entering into protocols with each other (regulation 7), that Authorities may perform duties under Section 2(1) jointly with one another and make arrangements with one another for the performance of that duty (regulation 8).
- 4.10** The Civil Contingencies Act 2004 (Contingency Planning) Regulations 2005 set out clear responsibilities for category 1 and category 2 responders and their need to participate in local resilience forums.
- 4.11** Most aerodrome managers will have responsibilities under civil contingency act as category 2 responders to co-operate and share relevant information with Fire and Rescue Authorities. (Airports that have passenger figures less than 50,000 passengers per year and/or less than 100,000 tonnes of air freight will not be category 2 responders).

## **Primary health and safety at work legislation**

### **Corporate Manslaughter and Corporate Homicide Act 2007**

- 4.12** The Corporate Manslaughter and Corporate Homicide Act was given Royal assent on 26 July 2007. The offence came into force on 6 April 2008, it is called corporate manslaughter in England, Wales and Northern Ireland, and corporate homicide in Scotland.
- 4.13** Fire and Rescue Authorities that take their obligations under health and safety law seriously and are not likely to be in breach of the new provisions. Nonetheless, the Authorities should keep their health and safety management systems under review, in particular, the way in which their activities are managed or organised by senior management.
- 4.14** Any alleged breaches of this act will be investigated by the police. Prosecution decisions will be made by the Crown Prosecution Service (England and Wales), the Crown Office and Procurator Fiscal Service (Scotland) and the Director of Public Prosecutions (Northern Ireland).

## **Health and Safety at Work etc Act 1974**

- 4.15** This Act applies to all employers in relation to health and safety. It is a wide ranging piece of legislation but in very general terms, imposes the general duty on Fire and Rescue Authorities to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all of their employees (section 2(1)) and to persons not in Fire and Rescue Service employment who may be affected by Fire and Rescue Service activity (section 3(1)). Fire and Rescue Service employees also have a duty to take reasonable care for the health and safety of him/her self and of other persons who may be affected by his/her acts or omissions at work.

## **Management of Health and Safety at Work Regulations 1999**

- 4.16** This Regulation obliges Fire and Rescue Authorities among other things, to make suitable and sufficient assessment of the risks to the health and safety of firefighters to which they are exposed whilst on duty (regulation 3(1)(a)). To implement any preventive and protective measures on the basis of the principles specified in the Regulations (regulation 4). To make arrangements for the effective planning, organisation, control, monitoring and review of the preventive and protective measures (regulation 5) and to provide such health surveillance as is appropriate having regard to the risks to health and safety which are identified by the risk assessment (regulation 6).

## **Safety Representatives and Safety Committees Regulations 1977 (as amended)**

- 4.17** These Regulations and Codes of Practice provide a legal framework for employers and trade unions to reach agreement on arrangements for health and safety representatives and health and safety committees to operate in their workplace.

## **Health and Safety (Consultation with Employees) Regulations 1996 (as amended)**

- 4.18** These Regulations set out the legal framework which will apply if employers have employees who are not covered by representatives appointed by recognised trade unions.

## **Provision and Use of Work Equipment Regulations 1998**

- 4.19** This Regulation obliges Fire and Rescue Authorities to ensure that work equipment is constructed or adapted as to be suitable for the purpose for which it is used or provided (regulation 4(1)). Fire and Rescue Authorities must have regard to the working conditions and to the risks to the health and safety of firefighters which exist in the premises in which the equipment is to be used and any additional risk posed by the use of that equipment (regulation 4(2)). The Regulations also contain provisions about maintenance, inspection, specific risks, information and instructions and training regarding work equipment.

## **Personal Protective Equipment at Work Regulations 1992**

- 4.20** This Regulation obliges Fire and Rescue Authorities to ensure that suitable personal protective equipment is provided to firefighters (regulation 4(1)). The Regulations contain provisions as to the suitability of personal protective equipment, compatibility of personal protective equipment, assessment of personal protective equipment, maintenance and replacement of personal protective equipment, storage for personal protective equipment, information, instruction and training regarding the personal protective equipment and its use.
- 4.21** Any personal protective equipment purchased by a Fire and Rescue Service must comply with the Personal Protective Equipment Regulations 2002 and be 'CE' marked by the manufacturer to show that it satisfies certain essential safety requirements and, in some cases, has been tested and certified by an approved body.

## **Control of Substances Hazardous to Health Regulations 2002**

- 4.22** Fire and Rescue Authorities must ensure that the exposure of firefighters to substances hazardous to health is either prevented or, where prevention is not reasonably practicable, adequately controlled (regulation 7(1)). Where it is not reasonably practicable for Fire and Rescue Authorities to prevent the hazardous exposure of firefighters, Authorities must, among other things, provide firefighters with suitable respiratory personal equipment which must comply with the Personal Protective Equipment Regulations 2002 and other standards set by the Health and Safety Executive.

## **Dangerous Substances and Explosive Atmospheres Regulations 2002**

- 4.23** Fire and Rescue Authorities are obliged to eliminate or reduce risks to safety from fire, explosion or other events arising from the hazardous properties of a 'dangerous substance'. Fire and Rescue Authorities are obliged to carry out a suitable and sufficient assessment of the risks to firefighters where a dangerous substance is or may be present (regulation 5). Fire and Rescue Authorities are required to eliminate or reduce risk so far as is reasonably practicable. Where risk is not eliminated, Fire and Rescue Authorities are required, so far as is reasonably practicable and consistent with the risk assessment, to apply measures to control risks and mitigate any detrimental effects (regulation 6(3)). This includes the provision of suitable personal protective equipment (regulation 6(5)(f)).

## **Confined Spaces Regulations 1997**

- 4.24** No firefighter must enter a confined space to carry out work for any purpose unless it is not reasonably practicable to achieve that purpose without such entry (regulation 4(1)). If entry to a confined space is unavoidable, firefighters must follow a safe system of work (SSoW) (including use of breathing apparatus) (regulation 4(2)) and put in place adequate emergency arrangements before the work starts (regulation 5).

## **The Work at Height Regulation 2005 (as amended)**

- 4.25** This regulation replaces all of the earlier regulations about working at height. The Work at Height Regulations 2005 consolidates previous legislation on working at height and implements European Council Directive 2001/45/EC concerning minimum safety and health requirements for the use of equipment for work at height (The Temporary Work at Height Directive).

## **Other subject specific matters**

### **ICAO (International Civil Aviation Organisation, Annex 14) Aerodrome**

- 4.26** The International Civil Aviation Organisation was founded at the Chicago Convention in 1944. The convention established international standards for the safe, orderly and efficient operation of global air transportation. These standards and recommended practices are promulgated in a series of annexes and encompass a range of requirements for aviation safety.
- 4.27** Annex 14 titled “Aerodromes” specifies the requirements for rescue and firefighting services at airports. In order to ensure these generic requirements are applied within countries, each country has established its own national aviation authority.
- 4.28** Within the United Kingdom this is the Civil Aviation Authority, which is sponsored by the Department for Transport.

### **European Aviation Safety Agency**

- 4.29** The European Union has established the European Aviation Safety Agency which promotes operating standards of safety and environmental protection in civil aviation within Europe and worldwide. It is the centrepiece of a new system which provides a single European regulator in the aviation industry.

### **ICAO (International Civil Aviation Organisation, Annex 18) UN Recommendations ‘Transportation of Dangerous Goods by Air’**

- 4.30** Annex 18 specifies the broad standards and recommended practices to be followed to enable dangerous goods to be carried safely.
- 4.31** The Annex contains fairly stable material requiring only infrequent amendment using the normal Annex amendment process. The Annex also makes binding upon contracting States the provisions of the technical instructions, which contain the very detailed and numerous instructions necessary for the correct handling of dangerous cargo.

### **Civil Aviation Authority**

- 4.32** The Civil Aviation Authority, which is a public corporation, was established by Parliament in 1972 as an independent specialist aviation regulator and provider of air traffic services.

- 4.33** The Civil Aviation Authority is the UK's independent specialist aviation regulator. Its activities include economic regulation, airspace policy, safety regulation and consumer protection.
- 4.34** The UK Government requires that the Civil Aviation Authority costs are met entirely from its charges on those whom it regulates. Unlike many other countries, there is no direct government funding of the Civil Aviation Authority work.
- 4.35** The Civil Aviation Authority publishes numerous guidance publications which the aviation world must adhere to. Below are two Civil Aviation Authority publications (CAP) of particular relevance.

### **CAP 168, Licensing of Aerodromes**

- 4.36** The UK Civil Aviation Authority requirements related to licensed aerodromes are contained in CAP168 – Licensing of Aerodromes. This CAP is a code of practice for licensed aerodromes. In particular, Chapter 8 defines the UK Rescue and Fire Fighting Service requirements and Chapter 9 defines the emergency planning requirements based on the ICAO Standards And Recommended Practices (SARPs).

### **CAP 403, Flying Displays and Special Events Guidance**

- 4.37** Air displays and aerial special events form a significant part of the UK leisure industry today and participation, together with their organisation and administration, needs careful consideration if the highest safety standards are to be achieved and maintained. This publication is intended as a code of practice and an indicator of good practice to provide guidance to ensure that the safety of both the participants and the spectators is not compromised.

### **CAP 793, Safe Operating Practices at Unlicensed Aerodromes**

- 4.38** Flight training activities are now permitted at unlicensed airports/airstrips and this CAP gives guidance on the emergency procedure that such operations will be expected to provide. This is of relevant to Fire and Rescue Service planners who will need to assess the scale of the risks involved and make suitable planning provision accordingly.

### **Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996**

- 4.39** Statutory Instrument 1996 no 2798, gives the Secretary of State for Transport the powers to undertake investigations into aircraft accidents and incidents. The sole objective of the investigation of an accident or incident under these regulations shall be the prevention of accidents and incidents. It shall not be the purpose of such investigation to proportion blame or liability.

## Further reading

**4.40** Operational Guidance on the management of risk in the operational environment has been issued in the past. In particular, refer to:

- Fire Service Manual Volume 2 (3rd edition) Incident Command
- Fire and Rescue Operational Assessment Toolkit 2009
- Integrated Risk Management Plan (IRMP) Guidance Notes
- HSEs guidance booklet HSG53: Respiratory protective equipment at work: A practical guide
- Fire Service Manual Volume 2 – Safe Working Near, On or In Water
- Fire Service Manual Volume 2 – Safe Working at Height
- Fire Service Manual Volume 2 – Firefighting Foam (Operational)
- Fire Service Manual Volume 2 – Environmental Protection
- Guidance on Aerodrome Safety Standards – [www.caa.co.uk](http://www.caa.co.uk)
- Guidance from AAIB – [http://www.aaib.gov.uk/guidance\\_and\\_regulations/guidance\\_for\\_police\\_\\_emergency\\_services\\_and\\_airfield\\_operators\\_2008.cfm](http://www.aaib.gov.uk/guidance_and_regulations/guidance_for_police__emergency_services_and_airfield_operators_2008.cfm)
- CAP 393 Air Navigation Order.

**4.41** The Fire Service College maintain a bibliography of technical guidance to which Fire and Rescue Services can refer (Fire Service Manuals, Fire Service Circulars, Dear Chief Officer Letters, Dear Firemaster Letters, Technical Bulletins, British and European Standards, Approved Codes of Practice, Health and Safety Executive guidance). In addition, technical guidance is available on the Department for Communities and Local Government website and at the Chief Fire and Rescue Adviser (CFRA) library. However, Fire and Rescue Services should maintain up to date copies of these documents within their own libraries.



# Section 5

Strategic role of operational guidance

## Strategic perspective

- 5.1** Strategic managers and Fire and Rescue Service are responsible for ensuring that their organisation and personnel operate safely when dealing with incidents involving aircraft. Their legal duties and responsibilities are contained in Section 4.
- 5.2** Fire and Rescue Services should continually strategically assess the risk, in terms of the foreseeable likelihood and severity, of aircraft incidents occurring within their areas. This assessment should form part of their integrated risk management plan. The findings will help them to ensure they have appropriate organisation, policy, procedures and resources in place for dealing with aircraft incidents.
- 5.3** How do strategic managers know if they are providing, at least, the minimum level of acceptable service or possibly meeting their 'duty of care'? The following principles will assist strategic managers in answering the question:
- operations must be legal and within the requirements of regulations
  - actions and decisions should be consistent with voluntary consensus standards and nationally recommended practices and procedures
  - actions and decisions to control a problem should have a technical foundation
  - actions and decisions must be ethical.
- 5.4** The response phase of an incident can be defined as the actions taken to deal with the immediate effects of an emergency. In many scenarios it is likely to be relatively short and to last for a matter of hours. It encompasses the effort to deal not only with the direct effects of the emergency itself (e.g. fighting fires, rescuing individuals) but also the indirect effects (e.g. disruption, media interest).
- 5.5** The generic key roles of the Fire and Rescue Services attending aircraft incidents are:
- save life
  - fight and prevent fires
  - manage hazardous materials and protect the environment
  - mitigate damage from fires or fire fighting
  - ensure the health and safety of fire service responders and the general public
  - safety management within the inner cordon.
- 5.6** When called to attend a significant aircraft incident the Fire and Rescue Service has strategic multi-agency responsibilities. These are additional, and in the main complementary, to the specific fire and rescue functions that the Fire and Rescue Service performs at the scene. The strategic intention is to co-ordinate effective multi-agency activity in order to:
- preserve and protect lives
  - mitigate and minimise the impact of an incident

- inform the public and maintain public confidence
- prevent, deter and detect crime
- assist an early return to normality (or as near to it as can be reasonably achieved).

**5.7** Other important common strategic objectives flowing from these responsibilities are to:

- participate in judicial, public, technical, or other inquiries
- evaluate the response and identify lessons to be learned
- Fire and Rescue Service involvement in the restoration and recovery phases of a major incident.

## Values

**5.8** The Fire and Rescue Service expresses its values and vision of leadership in the form of a simple model. The model has been named Aspire and is fully described in the Fire and Rescue Manual (Volume 2 Fire Service Operations, 3rd edition, 2008) Incident Command. It has at its heart the core values of the service, which are:

- diversity
- our people
- improvement
- service to the community.

**5.9** These values are intrinsic to everything Fire and Rescue Services strive to achieve at an operational incident, with the safety and well being of their crews at the forefront of their policies and procedures. It is important that core values are recognised and promoted by all Fire and Rescue Services strategic managers.

**5.10** This guidance has been drafted with a view to ensure that equality and diversity issues are considered and developed and has undergone full Equality Impact Assessment in line with priority one of the Equality and Diversity Strategy.

## Operational guidance review protocols

**5.11** This operational guidance will be reviewed for its currency and accuracy three years from date of publication. The Operational Guidance Programme Board will be responsible for commissioning the review and any decision for revision or amendment.

**5.12** The Operational Guidance Programme Board may decide that a full or partial review is required within this period.



# Section 6

Generic Risk Assessment

## Introduction

- 6.1** Due to the size and nature of the Fire and Rescue Service and the wide range of activities in which it becomes involved, there is the potential for the risk assessment process to become a time consuming activity. To minimise this and avoid having inconsistencies of approach and outcome, the Department for Communities and Local Government have produced a series of generic risk assessments. These generic risk assessments have been produced as a tool to assist individual Fire and Rescue Services in drawing up their own assessments to meet the requirements of the Management of Health and Safety at Work Regulations 1999.
- 6.2** There are occasions when the risks and hazards cited in any of the generic risk assessments may need to be considered at an aircraft incident. However there are specific generic risk assessments that Fire and Rescue Services should consider when developing their policy and procedures for dealing with aircraft incidents. They have been used as the foundations of the information and guidance contained in this operational guidance.
- 6.3** Generic risk assessments of particular relevance to aircraft incidents are:
- 4.3. Incidents involving transport systems – Air <http://www.communities.gov.uk/publications/fire/gra43>
  - 4.5. Working with helicopters <http://www.communities.gov.uk/publications/fire/gra45>
- 6.4** Fire and Rescue Services should use these generic risk assessments as part of their own risk assessment strategy not as an alternative or substitute for it. They are designed to help a Fire and Rescue Service make a suitable and sufficient assessment of risks as part of the normal planning process. It is suggested that an Fire and Rescue Services:
- check the validity of the information contained in the generic risk assessment against their current practices and identify any additional or alternative hazards, risks and control measures
  - evaluate the severity and likelihood of hazards causing harm, and the effectiveness of current controls, for example, operational procedures, training and personal protective equipment etc., by using the Service's methodology
  - consider other regulatory requirements
  - identify additional measures which will be needed to reduce the risk, so far as is reasonably practicable
  - discuss with Rescue and Fire Fighting Service to ensure consistency, gap analysis, interoperability and complete a memorandum of understanding
  - record findings.

- 6.5** Once a suitable and sufficient assessment of the risks has been made, any additional measures and arrangements put in place have to be reviewed as part of the Health and Safety Executive 65 model.
- 6.6** To ensure the risk assessment remains suitable and sufficient Fire and rescue Services should review the assessment to take into account, for example the learning outcomes from operational incidents, accidents etc.
- 6.7** Generic risk assessments provide a guide to the type of information, arrangements and training that should be given to the Incident Commander, firefighters and any other personnel likely to be affected.
- 6.8** Full guidance on the generic risk assessment is contained in *Occupational health, safety and welfare: Guidance for fire services: Generic risk assessments*.



# Section 7

Key principles

## Introduction

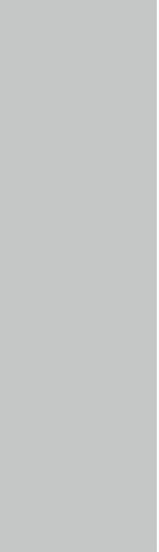
- 7.1** Fire and Rescue Services will be called to attend aircraft incidents and has an obligation to attend.
- 7.2** Each Fire and Rescue Service should develop clear policy and direction for personnel to follow at foreseeable incidents.
- 7.3** Safe systems of work should be developed based on the generic risk assessment and operational guidance, but should be geared towards individual Fire and Rescue Service's risk and resources, as identified within the integrated risk management plan.
- 7.4** Fire and Rescue Services have the statutory responsibility under the *Fire and Rescue Services Act 2004* (Act) to undertake firefighting and rescue operations at an aircraft incident on or off airport. However, at an incident which occurs on airport it is usual for the Airport Incident Commander to initially command the incident. However, once the Fire and Rescue Service are in attendance they are obliged to exercise their obligations under the Act and take command of joint fire and rescue operations.
- 7.5** Fire and Rescue Service joint working with the rescue fire fighting service should be documented in a memorandum of understanding and should form part of the airport emergency plan.
- 7.6** Fire and Rescue Service officers attending an on airport incident will not without good cause or reason alter the tactical plans of the rescue fire fighting service.
- 7.7** In the event of an aircraft accident occurring adjacent to a licensed airport with a Rescue and Fire Fighting Service, both the Fire and Rescue Service and the rescue fire fighting service will attend. The senior Fire and Rescue Service officer in attendance will have full tactical control and will take technical and tactical advice from the attending Airport Incident Commander.
- 7.8** Due to the complex and specialised nature of aircraft incidents, effective liaison at an early stage is essential. Incident commanders must ensure that timely and appropriate liaison is established with responding rescue fire fighting service, police, ambulance services and air traffic control.
- 7.9** In the case of an accident involving a military aircraft, liaison should be established with the Royal Air Force, Aeronautical Rescue Coordination Centre (ARCC), based at RAF Kinloss. The Aeronautical Rescue Coordination Centre maintain the RAF crash hazards data base, which will include all military aircraft and will prove invaluable in managing a military related incident.
- 7.10** A significant feature for Fire and Rescue Services attending aircraft incidents is access, egress and evacuation of the public. Incident Commanders should quickly assess the incident and relay information back to the mobilising centres and oncoming appliances. (See GSOP Section 8 Part B).

- 7.11** Aircraft incidents off airport are often in remote and difficult locations, which can result in Fire and Rescue Service personnel working in very difficult and dangerous environments. Incident commanders must therefore consider the effects of the incident location in regard to operational equipment, water supplies, logistics and welfare of personnel.
- 7.12** All crash sites are to be deemed a crime scene, until the police state otherwise. Therefore Fire and Rescue Services must ensure wherever possible, evidence is preserved and records kept of all actions undertaken during firefighting and rescue operations.
- 7.13** Once all firefighting and rescue operations have ceased the post crash scene should be handed over to the appropriate person/agency.
- 7.14** Fire and Rescue Services will not normally become involved in post accident clean up operations or aircraft recovery.

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# Section 8

Fire and Rescue Service Operations



# Part A

Pre-planning considerations

## Strategic planning

**8A.1** Planning at a strategic level to ensure that Fire and Rescue Service develop and maintain an appropriate and proportionate response to aircraft incidents is fundamental to protecting the public, Fire and Rescue Service responders and mitigating the wider impact of any incident. For the purposes of this guidance an aircraft is defined as:

- fixed wing
- rotary wing (helicopters, gyro planes etc)
- balloon
- airship
- glider
- remotely piloted air systems
- microlight.

**8A.2** The aviation industry in this country forms part of the critical national infrastructure and consists of a range of both civil and military airports that in many instances are integrated within the wider transportation infrastructure:

- large international airports incorporating passenger services and cargo
- small/large licensed airports
- small/large unlicensed airports/airstrips
- helipads/decks both medical and commercial
- military air bases.

**8A.3** The management of an airport and its operation will be the responsibility of:

- airport owners/management – who will maintain and control the airport infrastructure
- airline operators – who operate the aircraft and are responsible for any passengers or goods
- air freight operating companies
- the Ministry of Defence (MOD).

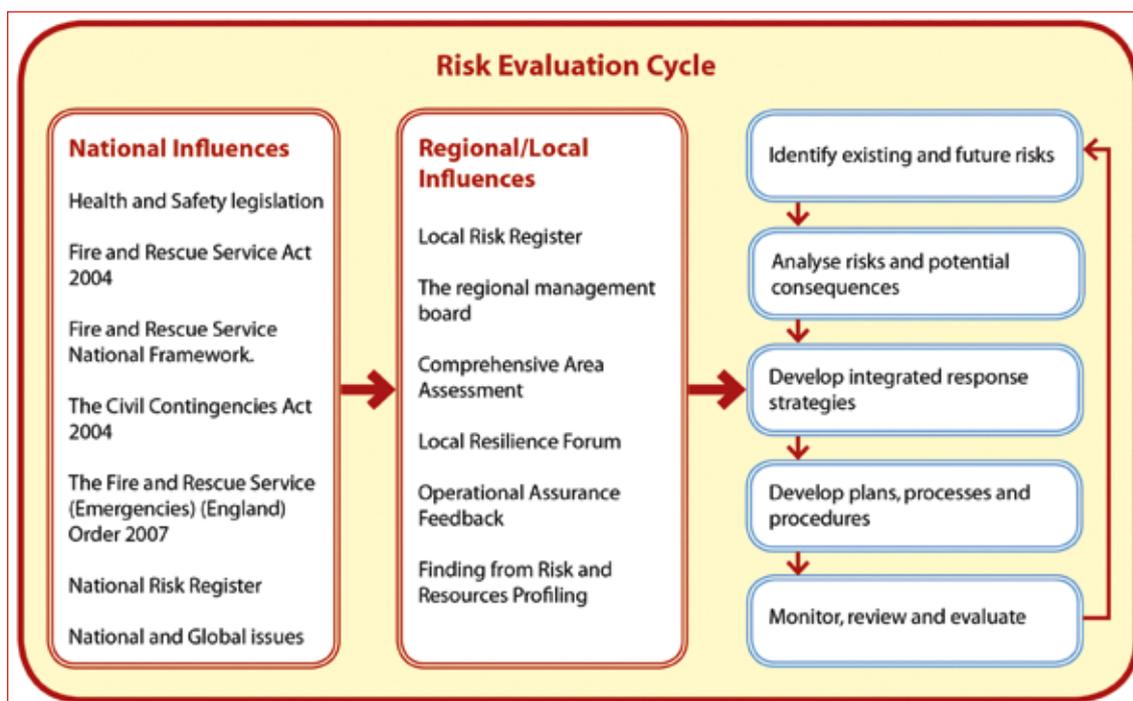
## Strategic planning considerations and duties

**8A.4** Even a relatively minor aircraft incident has the potential to create significant disruption over a wide area, with potential for national or international implications on commerce, tourism and travel.

- 8A.5** Planners should recognise that due to the complex and diverse nature of aircraft design; construction and use, incidents may result in other related emergencies. Airports form part of the UK's critical transportation infrastructure and therefore if an airport operation has to close, terminal buildings become overcrowded and the road network gridlocked within a matter of hours. Therefore this could result in the possibility of further injuries to the public, unrelated to the aircraft incident itself.
- 8A.6** Due to the nature of aircraft incidents and the hazards associated with them, the potential for injury applies not only to Fire and Rescue Service personnel but also to members of the public and other responding emergency agencies.
- 8A.7** In order to ensure incident response is appropriate and proportionate, Fire and Rescue Services must ensure that preplanning is undertaken. This planning should ensure that dialogue takes place between the Fire and Rescue Service and the airport manager/s for the airports to which they are likely to respond, both civil and military. This will involve establishing structures to ensure appropriate liaison at bronze, silver and gold levels.
- 8A.8** Fire and Rescue Services will determine the appropriate and proportional response to aircraft incidents. This will reflect:
- the size, complexity and relative importance of the airport within its area
  - integrated risk management plan response options
  - discussions at the regional Resilience Forum e.g. threat level
  - the hazards associated with an individual airport, the type and size of aircraft that use the facility and the likely severity and impact of any incident <sup>1</sup>
  - information received from liaison with the airport operators and licensing authority (Civil Aviation Authority), this equally applies to military air bases, as it does to civil airports.
- 8A.9** It will be necessary to ensure the suitability and sufficiency of the response is tested. The Civil Aviation Authority requires a licensing exercise to be held at all airports on a regular basis. Fire and Rescue Services should play a key part in the planning and execution of such exercises.
- 8A.10** Not all airports are licensed by the Civil Aviation Authority and therefore there will be no requirement for these airports to run regular exercises. Good practice would be for Fire and Rescue Services to liaise with unlicensed airports and carry out local exercises on a regular basis.
- 8A.11** The general duties of the Fire and Rescue Service in responding to emergency incidents are contained within the *Fire and Rescue Services Act 2004*.

<sup>1</sup> *Guide to Risk Assessment Tools, Techniques and Data – Fire Research Series 5/2009*

- 8A.12** The *Civil Contingencies Act 2004 (Contingency Planning) Regulations 2005* set out clear responsibilities for category 1 and category 2 responders and their need to participate in local resilience forums.
- 8A.13** Most aerodrome managers will have responsibilities under *Civil Contingency Act* as category 2 responders to co-operate and share relevant information with Fire and Rescue Services. (Airports that have passenger figures less than 50,000 passengers per year and/or less than 100,000 tonnes of air freight will not be category 2 responders).
- 8A.14** When developing Fire and Rescue Service's response plans it is essential that planners are cognisant of existing regional multi agency 'major incident procedures' and that these complement neighbouring Fire and Rescue Service procedures.
- 8A.15** The diagram below shows a risk evaluation cycle:



## Underpinning strategic knowledge

- 8A.16** To inform and support strategic planning it is essential that Fire and Rescue Service personnel tasked with developing emergency response plans should have some underpinning knowledge with regard to:
- the geographical locations of airports in relation to other Fire and rescue Services
  - the Civil Aviation Authority category of the airport concerned
  - the off airport response distances and geographical boundaries with regard to airport rescue fire fighting services
  - the number and location of the air traffic control centres within their area

- the different types of aircraft that are likely to use local airports and local airspace
- the nature and range of hazards associated with airports, both civil and military and other associated hazards with this type of infrastructure
- rescue fire fighting service resources and capability
- Rescue and Fire Fighting Service intervention tactics.

**8A.17** Multi agency liaison will facilitate the development and maintenance of plans and procedures that support a strategy to deliver an effective and efficient operational response to aircraft incidents to which Fire and Rescue Services are likely to respond. This may include:

- Fire and Rescue Service/Rescue and Fire Fighting Service combined intervention and evacuation strategies for aircraft incidents on or adjacent to airports
- agreed operational response to aircraft incidents with neighbouring Fire and Rescue Services, ensuring uniformity of intervention strategies
- strategic liaison with airport managers and other agencies
- strategies for information gathering to facilitate Fire and Rescue Service planning and scene management
- methods to exchange information at a national/regional level for improving emergency response to aircraft incidents for Fire and Rescue Services, emergency services and other agencies based on operational experience e.g. debriefs and shared learning outcomes.

**8A.18** Any strategy developed must provide safe systems of work to allow Fire and Rescue Service operations to commence with or without the attendance of Rescue and Fire Fighting Services, military specialists or other technical advisers.

**8A.19** A range of activities may be undertaken by Fire and Rescue Services to examine performance of plans following exercises or significant incidents. This may include the development of systems and processes to analyse and review the performance of plans, the effectiveness of liaison and training exercises (outcomes/learning) at gold, silver and bronze levels within their service. This process should not be undertaken in isolation but may include consultation and multi agency debriefs involving:

- local airport managers, both civil and military
- Rescue and Fire Fighting Service, both civil and military
- airline operating companies
- other emergency services
- other statutory agencies.

## Future developments

- 8A.20** Fire and Rescue Services will be consulted during the planning of airport facilities and infrastructure or the significant upgrading of existing infrastructure that may affect emergency response or Service intervention strategies.
- 8A.21** As part of consultation on future developments, it is important for Fire and Rescue Services to actively participate during the development of emergency planning assumptions and on appropriate intervention strategy. This will ensure that Fire and Rescue Services, airport managers/owners and Civil Aviation Authority expectations are realistic and reasonable.
- 8A.22** To ensure a consistent approach to Fire and Rescue Service operations, it is highly desirable that intervention strategies are agreed with the Rescue and Fire Fighting Service, particularly in areas of incident command for on or off airport incidents and they maintain a commonality of approach in terms of responsibilities and actions.
- 8A.23** This is particularly important for issues such as:
- a clear understanding of the Fire and Rescue Service statutory responsibility for the safe management of the incident, as imposed by the *Fire and Rescue Services Act 2004*
  - local memorandums of understanding with regard to standard operating procedures and handover protocols
  - interoperability of equipment and standard operating procedures
  - implementation of the incident command system
  - facilities provided for Fire and Rescue Service response e.g. provision and maintenance of rendezvous points, holding areas etc
  - communications between the Rescue and Fire Fighting Service and the Fire and Rescue Service
  - continuous and consistent liaison between the airport operator/ Rescue and Fire Fighting Service at bronze, silver and gold level.

## Local planning responsibilities

- 8A.24** This section is intended to inform and advise at silver and bronze levels on the development of local plans. Local plans will need to dovetail into and form part of, the airport's emergency plan and may include site specific pre-determined on arrival tactics.
- 8A.25** The development of local plans should reflect the Fire and Rescue Service policies, procedures and regional/local risk assessments developed at the strategic level. Local plans should also reflect other guidance within this manual.

- 8A.26** Suitable arrangements should be put in place to gather relevant information to facilitate the development of local plans for all foreseeable/predictable aircraft incidents and types of aircraft that Fire and Rescue Services may be called to deal with.
- 8A.27** Plans should also be developed and flexible enough to accommodate any significant temporary activity. In particular, those affecting size and type of aircraft operating from the airport or temporary loss of water supplies on or around the airport. Consideration should also be given to the effect of those changes on weight of attack, tactics and previous agreements.

## Liaison

- 8A.28** Liaison with various stakeholders is essential to ensure that the necessary information is secured to inform plans for adequate, timely and effective response and to create safe systems of work when planning for and attending incidents.
- 8A.29** Key to efficient and effective operational response to aircraft incidents is good and robust airport liaison. The level of airport liaison needs to be proportionate to the size and type of risk associated with the particular airport in question.

## Airport emergency planning group

- 8A.30** The Civil Aviation Authority requires all airports to promulgate emergency plans, which among other things include the arrangement for summoning externally based emergency services. The Authority also recommends the establishment of an emergency planning group or liaison panel. The airport liaison officer together with other representatives from this group must ensure that each are fully aware of the arrangements for mobilising external based emergency and supporting services to the airport in the event of an emergency.
- 8A.31** The resultant plan from the emergency planning group must be agreed by all agencies and tested on a regular basis as required by the Civil Aviation Authority.
- 8A.32** The Civil Aviation Authority requires that licensed category 3 airports and above have a full scale emergency exercise every two years.
- 8A.33** The exercise should involve the attendance of all externally based emergency and supporting services. It is the role of the emergency planning group to arrange and coordinate the exercise to ensure their respective agencies play a full and active part.
- 8A.34** If an airport operates at night it is a requirement of the Civil Aviation Authority that the airport's plan is tested in hours of darkness on alternate exercises.

**8A.35** If an emergency/incident occurs in the time between airport exercises and the airport emergency plan is utilised, it is possible for the emergency planning group to request that the incident is used in lieu of a licensing exercise or part of the exercise. This request must be submitted to the Civil Aviation Authority for consideration and supported with detailed logs of all activities undertaken by category 1 and category 2 responders and all interagency debrief learning outcomes.

**8A.36** The exercise will compose of two principle parts:

1. the operational response to an on/off airport aircraft accident, this will involve front line services dealing with a simulated accident – firefighting, rescues, casualty triage, scene management gold/silver/bronze – multi agency incident command
2. testing the airport plan for organising a survivor reception centre, friends and family centre, police casualty bureau, Emergency Procedures Information Centre (See appendix A), media management etc

**8A.37** Below is an example of an Emergency Planning Group for Gatwick Airport. Membership of these emergency planning groups at airports will vary depending on risk and could include Maritime and Coastguard Agency, Ministry of Defence, Primary Care Trusts Representatives etc.

<p><b>Gatwick Resilience Planning Group</b></p> <p>Sussex Police</p> <p>Gatwick Airport Ltd</p> <p>West Sussex Fire and Rescue Service</p> <p>Surrey Fire and Rescue Service</p> <p>Gatwick Airport Fire Service</p> <p>South East Coast Ambulance Service</p> <p>Port Health</p> <p>Local Authority Emergency Planning Officer</p> <p>Airline Operators Committee (AOC)</p> <p>Co-opted Members</p>
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**8A.38** Each year there are over 300 air shows in the UK and these events require detailed planning and a dedicated plan, which will be over and above the airport's emergency plan. It is essential that Fire and Rescue Service airport liaison/ planning officers are part of this planning process, which can start many months or years prior to the event. See appendix B for more details on air show planning.

## Planning information

**8A.39** Following relevant research, Fire and Rescue Services should ensure that detailed local plans are prepared to include some or all of the following information. It is imperative that this information is made available to all relevant personnel prior to and upon arrival at incidents. This will ensure that work activity is planned, supervised and carried out safely.

1. airport location and topography (including airport crash maps)
2. access
3. rendezvous points and marshalling areas
4. water supplies and drainage systems
5. Rescue and Fire Fighting Services response and capability (civil and military)
6. communications
7. air traffic control
8. aircraft associated hazards
9. complex locations/difficult environments
10. 7(2) (d) familiarisation visits required by the *Fire and Rescue Services Act 2004*.

### 1. Airport location and topography (including airport crash maps)

**8A.40** Detailed airport maps should be available to personnel prior to and during any aircraft incident on airfield. Airport maps should include:

- access points
- rendezvous points
- marshalling areas
- secondary access points
- water supplies
- airport infrastructure
- principal hazards, fuel storage facilities, armament stores etc
- airport crash map covering runway, overshoot and undershoot areas normally overlaid with a broad grid reference system.

### 2. Access

**8A.41** All practical and reasonable areas of access to the airport infrastructure and aircraft manoeuvring areas (airside):

- designated access gates and access points

- blue light routes
- landside to airside security gates
- provision of airport escort vehicles
- tunnels/roads/bridges that may restrict access due to height restrictions, width restrictions and weight restrictions
- access to cargo areas
- access to airport infrastructure.

### **3. Rendezvous points on airport**

**8A.42** When determining the most suitable position for rendezvous points, consideration must be given to:

- personnel safety
- access to airside and other difficult locations.
- suitable and sufficient access for appliances and other responding agencies
- effective communication location (landlines – fire ground radios)
- shelter (inclement weather) with access to airport maps, general airport information
- access to suitable and effective water supplies.

### **4. Water supplies and drainage systems**

**8A.43** Emergency plans should identify all suitable and usable water sources on or adjacent to airports. Preplanning should account for seasonal variations in water levels and augmented water supplies organised as and when or where appropriate:

- public hydrants
- private hydrants
- dirty water mains
- open water supplies
- elevated water tanks
- drainage facilities on airfield including interceptors and differentiation between foul water and surface water drainage
- water relay strategy where required.

## **5. Rescue and Fire Fighting Service response and capability (civil and military)**

**8A.44** Preplanning must include the type and design of equipment that can be expected to be provided by the Rescue and Fire Fighting Service and this should include:

- interoperability with Fire and Rescue Service equipment
- interoperability of standard operating procedures
- memorandum of understanding with regard to incident command procedures and hand over protocols
- Fire and Rescue Service familiarisation of personnel with regard to familiarisation of Rescue and Fire Fighting Service's appliances and equipment carried
- clear expectation of initial actions by both the Rescue and Fire Fighting Service and the Fire and Rescue Service.

## **6. Communications**

**8A.45** As with any type of operational incident communications play a key role in the successful management of the incident:

- interoperability of radio channels between the Fire and Rescue Service, the Rescue and Fire Fighting Service and other responding agencies
- land line provision at rendezvous points to the Rescue and Fire Fighting Service watch room or air traffic control where possible
- dedicated radio channels where necessary
- communication assessment of the airport and airport infrastructure to identify blind spots; corrective action should be taken where necessary to overcome poor communication areas such as base stations, booster stations and leaky feeders.

## **7. Air traffic control**

**8A.46** Air traffic control will be a key agency in any emergency plan and site specific plan. Air traffic control should be a focus for any airport familiarisation visit 7(2) (d). Air traffic control will be able to provide critical information to the incident commander and the Fire and Rescue Service mobilising centre from the outset of the emergency. This will include:

- number of persons on board
- type of emergency
- type of aircraft
- airline involved

- crash location (utilising airport crash map) for accidents on or adjacent to airports
- access to handling agent reference hazardous cargo's.

## **8. Aircraft associated hazards**

- 8A.47** There are many different types of aircraft in use across the country with wide variations in physical dimensions, capabilities and construction materials. This degree of variation can significantly affect the risks to firefighters, and it is therefore imperative that plans and training strategies include the risk critical aspects of aircraft that are likely to be encountered.
- 8A.48** The use of the Department for Communities and Local Government Generic Risk Assessment 4.3 and 4.5 should be incorporated into the planning process for aircraft incident and associated hazards.

## **9. Complex locations/difficult environments**

- 8A.49** Planning should take into consideration all possible locations for aircraft accidents on or off airfield and the difficult environments in which Fire and Rescue Service personnel will be asked to operate. Liaison with rescue and the Rescue and Fire Fighting Service in regard to equipment and capabilities and interoperability with Fire and Rescue Services about difficult environments is essential. This may include:
- water and mud rescues
  - rescue from height
  - access to remote locations
  - access to exposed locations such as hillsides and cliffs
  - aircraft into buildings/highly populated areas.

## **10. 7 (2) (d) Familiarisation visits required by the Fire and Rescue Services Act 2004**

- 8A.50** Section 7(2)(d) requires Fire and Rescue Authorities to make arrangements for obtaining information. This will normally involve site visits. When arranging for visits to airports, Fire and Rescue Service personnel need to be mindful of the limitations that may apply to accessing the infrastructure and airside locations. When developing detailed plans, arrangements should be made to ensure visits are arranged to limit, as far as possible, the impact on airport operations. Collaboration with the Rescue and Fire Fighting Service in gathering critical safety information is key in this process.

# Availability of plans/training/review

## Availability of plans

**8A.51** Local plans should be readily available in appropriate formats to support the needs of first strike personnel, incident commanders, command support and elsewhere within the Fire and Rescue Service incident management chain. Where appropriate, consideration should also be given to sharing plans with other agencies and organisations and should form part of the airport's emergency plan, as required by the Civil Aviation Authority.

## Training and exercising

**8A.52** Effective and realistic training programmes will prepare Fire and Rescue Service personnel for the variety of challenges, which may be encountered when dealing with aircraft incidents. Training takes many forms and can include:

- 7(2) (d) familiarisation visits, lectures and presentations for Fire and Rescue Service responders
- on site testing of Fire and Rescue Service aspects of the airport's emergency plan in conjunction with Rescue and Fire Fighting Services, other emergency responders and airport operators
- table top exercises
- full scale multi agency exercises testing gold, silver and bronze commanders.

**8A.53** Where possible Fire and Rescue Service responders should be involved in training that includes the participation of the Rescue and Fire Fighting Service, other emergency services and airport operators in order that personnel from the relevant services develop a greater understanding, confidence and awareness of their roles and functions.

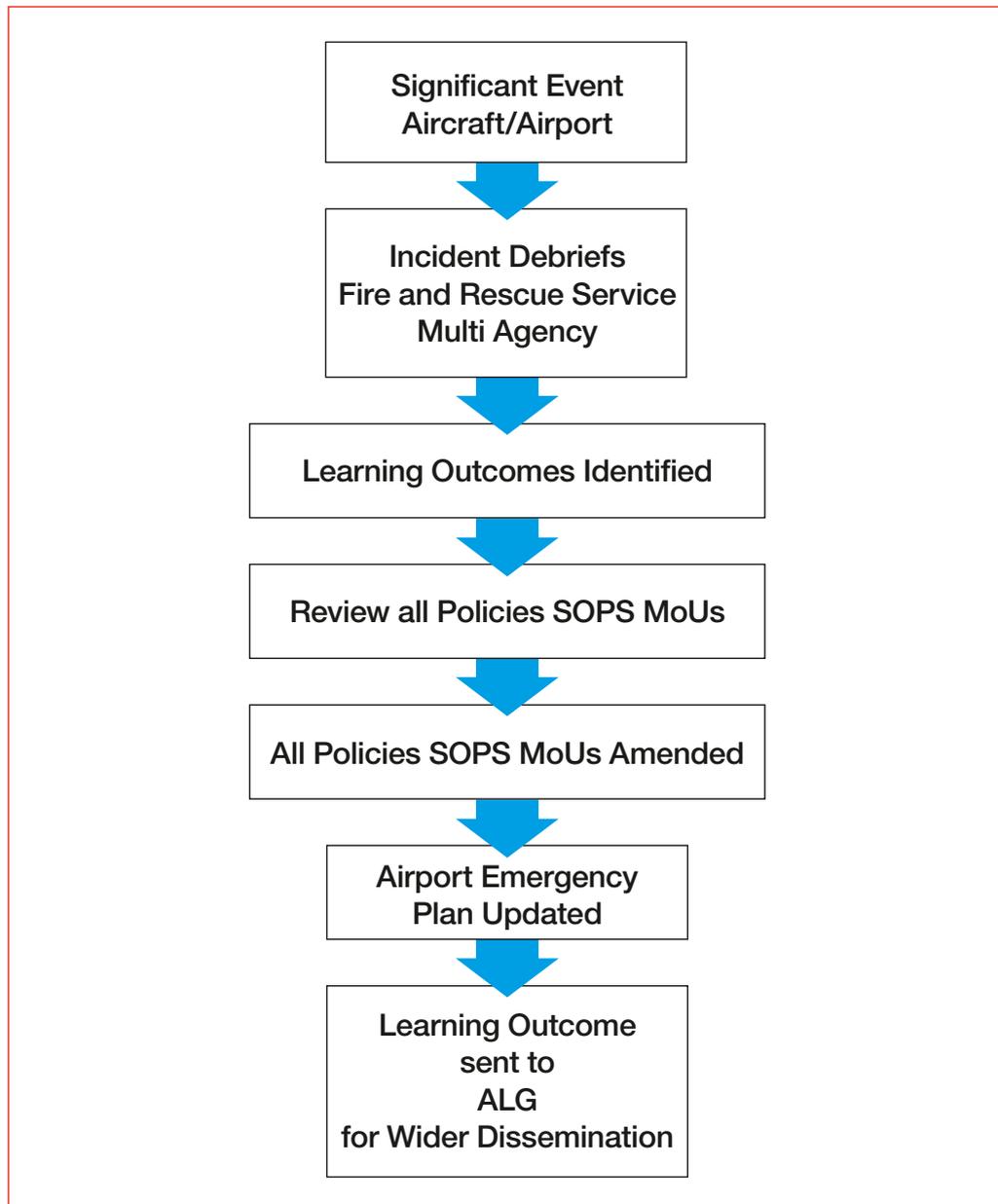
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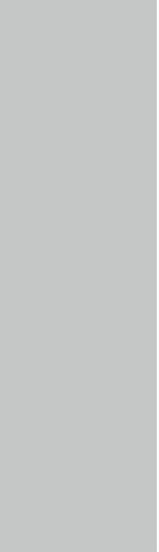
**8A.54** Large parts of the airport are subject to significant on-going change and modification. Therefore Fire and Rescue Services should ensure that local plans are regularly reviewed and updated. This may be either periodically or at key milestones in the case of refurbishment/construction projects.

**8A.55** Following any significant incident involving an aircraft, a full and robust review of all Fire and Rescue Service policies, standard operating procedures and memorandums of understanding should be undertaken. The outcome of these reviews should result in all Fire and Rescue Service policies, standard operating procedures and memorandum of understandings being amended and the airport's emergency plan updated.

**8A.56** Key lessons learnt should be shared through Chief Fire Officers Association via the Aircraft Liaison Group to enable wider dissemination to all UK Fire and Rescue Services.

## Significant incident review chart





# Part B

Operational Considerations – Generic  
Standard Operating Procedure

## Introduction

**8B.1** It is useful to see the emergency incident response phases in the context of the typical stages of an incident as referred to in *Volume 2 Fire Service Operations Incident Command Operation Guidance and the Fire Service Guide – Dynamic Management of Risk at Operational Incidents*, this is shown below:

Stages of an incident (Dynamic management of risk)	Incident Command System Decision Making Model Links	GSOP Response Phases
		1. Mobilising and en-route
Initial Stage	<ul style="list-style-type: none"> <li>• Incident information</li> <li>• Resource information</li> <li>• Hazard and safety and information</li> </ul>	2. Arriving and gathering information
Development Stage	<ul style="list-style-type: none"> <li>• Think</li> <li>• Prioritise objectives</li> <li>• Plan</li> </ul>	3. Planning the tactical plan
	<ul style="list-style-type: none"> <li>• Communicate</li> <li>• Control</li> </ul>	4. Implementing the tactical plan
	<ul style="list-style-type: none"> <li>• Evaluate the outcome</li> </ul>	5. Evaluating the tactical plan
Closing Stage		6. Closing the incident

**8B.2** The generic standard operating procedure (GSOP) has been derived by breaking down an incident into six clearly identified phases which have been taken directly from the decision making model.

**8B.3** The purpose of this section is to cover possible actions that may need to be undertaken at each of the six stages of the incident and then offer up some possible considerations that the Incident Commander and other Fire and Rescue Service personnel may find useful in tackling the challenges and tasks that they are faced with.

**8B.4** This GSOP is not intended to cover every eventuality however it is a comprehensive document that can be used by planning teams, who need to write standard operating procedures, and responding personnel alike.

**8B.5** Further detailed and technical information on specific aircraft related hazards are covered in Section 8 part C of this operational guidance.

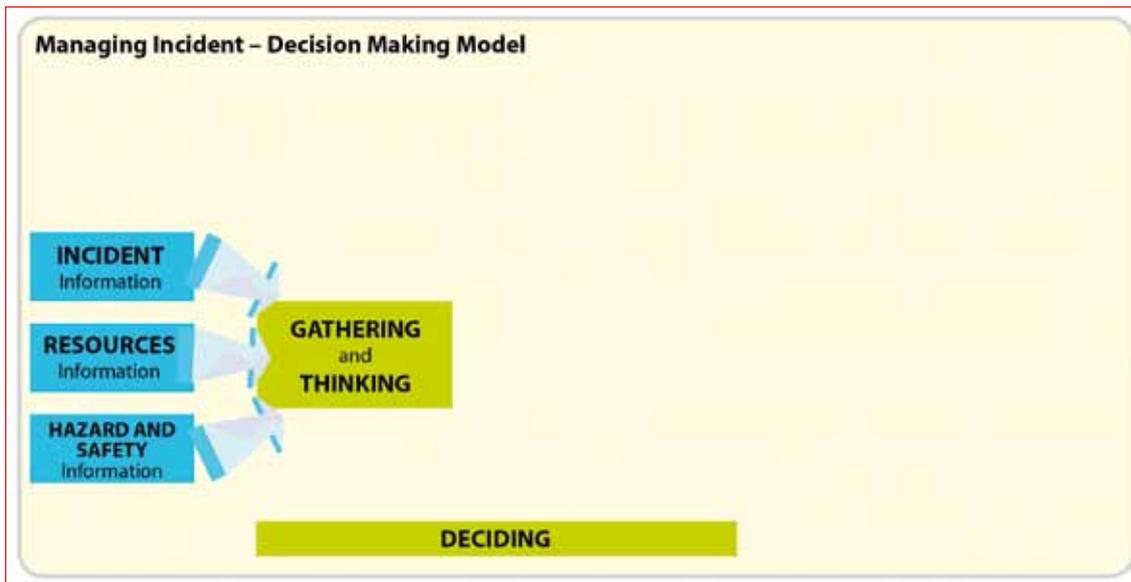
**8B.6** The decision making model comprises of two major components. These are the deciding and acting stages.

**8B.7** In seeking to resolve an incident involving aircraft the Incident Commander will use their knowledge and experience to identify the objectives to be achieved and formulate an appropriate tactical plan of action.

## Emergency incident response phases

1	Mobilising and en-route
2	Arriving and gathering information
3	Formulating the tactical plan
4	Implementing the tactical plan
5	Evaluating the tactical plan
6	Closing the incident

## Phase 1: Mobilising and en-route



### Phase 1 – Actions

#### Mobilising and en-route

1.1	Initial call handling
1.2	Assess the level and scale of the incident
1.3	Mobilise appropriate resources to the incident, marshalling areas and/or predetermined rendezvous points
1.4	Access incident specific information en-route
1.5	Notify relevant agencies

## Considerations

### 1.1 Initial call handling

**8B.8** As with any incident the handling of the initial call is of critical importance to ensure that the correct predetermined attendance is mobilised. In handling the call the mobilising centre operator will need to gather as much information from the caller as possible. If there is any doubt as to the size and scale of the incident, the predetermined attendance should be scaled up rather than down. In determining the correct predetermined attendance the following may be considered:

- informed call, coming from reliable source such as air traffic control or other category 1 responder (Civil Contingencies Act)
- uninformed call, vague call from the member of the public, or hoax call.

## 1.2 Assess the level and scale of the incident

**8B.9** Fire and Rescue Service's mobilising controls should try to assess the scale, size, and location of the incident prior to and during the mobilisation of Service personnel. This will provide quality information for the first Fire and Rescue Service personnel on the scene. Information may be received from:

- Rescue and Fire Fighting Service personnel
- Air traffic control
- the airport control centre (larger airports)
- the caller or subsequent callers
- other emergency control centres (police, ambulance, Maritime and
- Coastguard Agency, military (Ministry of Defence (MOD), Royal Air Force (RAF), Royal Navy, Army))
- local knowledge of responding Fire and Rescue Service crews
- information based on what can be seen visually.

## 1.3 Mobilise appropriate resources

### ON AIRPORT SCENARIO

**8B.10** Fire and Rescue Service control centres should utilise any site specific plans to enhance mobilising information to personnel, particularly when mobilising to complex locations within the airport boundaries or adjacent to airports. This will often form part of predetermined intervention strategies for known locations on and around airport sites.

### OFF AIRPORT SCENARIO

**8B.11** Fire and Rescue Service control centres may decide to mobilise to a geographical rendezvous points/location until further information has been received to confirm incident location.

**8B.12** Specific incident types will attract a range of different mobilising solutions; these will normally be determined in the planning stage and will include variations in speed and weight of attack, attendance to specific locations, dual attendances. For example:

- aircraft incident large/small
- military aircraft
- aircraft incident on airport
- aircraft incident off airport.

## 1.4 Access incident specific information en-route

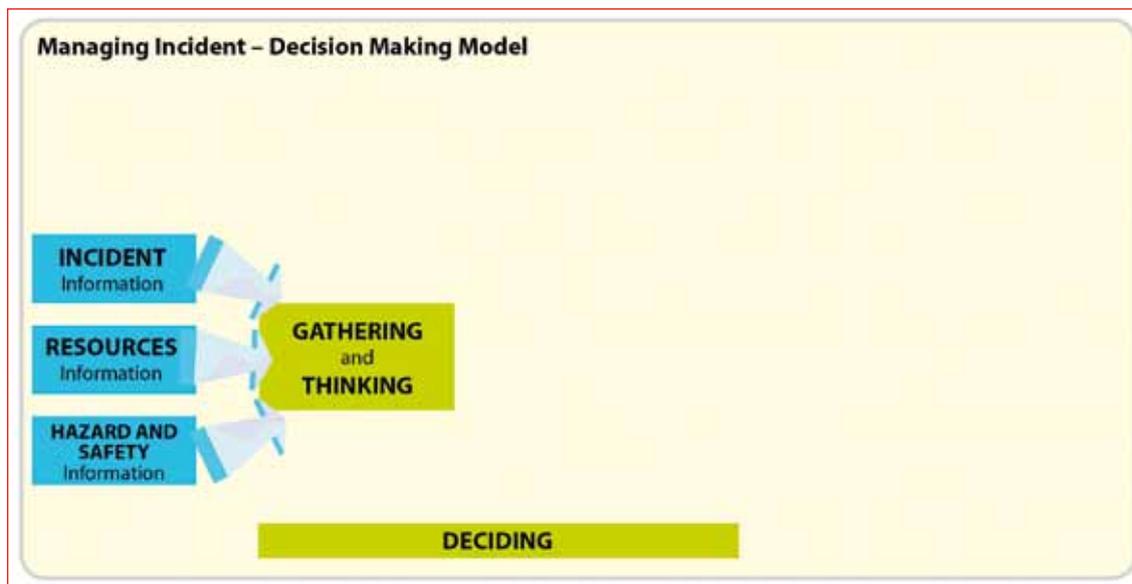
- 8B.13** A key aspect for dealing with aircraft incidents is securing effective access to the scene. However, aircraft incidents are not always on or near to airports and it is therefore essential to narrow down the possible location so that an appropriate access point can be identified.
- 8B.14** Mobilised personnel should access site/incident specific information from on board systems whilst en route to identify:
- rendezvous points and marshalling areas
  - strategic holding areas, should a regional response be required
  - site specific plans, crash maps, blue routes
  - predetermined on arrival tactics as per memorandum of understanding
  - points for initial information gathering on arrival
  - water supplies
  - access/egress with a view to achieving one way systems
  - 7(2) (d) familiarisation visits.
- 8B.15** Mobilised personnel should request information on and begin to think about, the hazards and control measures they are likely to face when mobilised to different types of aircraft incidents.

## 1.5 Notify relevant agencies

- 8B.16** Fire and Rescue Services should maintain contact details of all airports/air traffic controls and be familiar with airport emergency plans for all airports that are within their area.
- 8B.17** On most occasions airport managers will be aware of incidents occurring on their airport, however it is good practice for Fire and Rescue Service control centres to inform/confirm with the relevant airport for any incidents being attended by their Service.
- 8B.18** Resolving aircraft incidents will involve a multi agency effort. Fire and Rescue Service control centres should share relevant details about calls being attended by their Service with other relevant agencies.
- 8B.19** Fire and Rescue Service control centres should have early dialogue with:
- airport control centres
  - category 1 responders
  - air traffic control
  - military – MOD, RAF, Royal Navy, army
  - Aeronautical Rescue Coordination Centre

- Air Accidents Investigation Branch.
- The above liaison will assist with the identification of:
- location/crash map coordinates
- incident type
- aircraft type and registration number
- seating capacity, passenger numbers and aircraft crew
- nature of incident
- hazards and/or potential hazards involved
- actions currently ongoing
- possible multi-site large area involvement.

## Phase 2: Arriving and gathering information



Phase 2 – Actions		<ul style="list-style-type: none"> <li>• Incident information</li> <li>• Resource information</li> <li>• Hazard and safety information</li> </ul>
Arriving and gathering information		
2.1	Confirm location of incident and incident type	
2.2	Approach the incident safely	
2.3	Assess hazards and risks and the implementation of an inner cordon (this will be continuously reviewed subject to risk assessment)	
2.4	Cordon considerations	
2.5	Liaison with Rescue and Fire Fighting Service and other category 1 responders if already in attendance	
2.6	Consider possible chemical, biological, radiological, nuclear, explosives (CBRNE) – terrorist involvement	
2.7	Estimate the resource requirements	
2.8	Implement the Incident Command System	
2.9	Crime scene	

# Considerations

## 2.1 Confirm location of incident and incident type

**8B.20** The first Fire and Rescue Service personnel in attendance will need to confirm an accurate location of the incident and confirmation of incident type, this information will be broadcast to on-coming Fire and Rescue Service appliances and to mobilising control centres. Mobilising control centres will inform other emergency service control centres and category 1 and 2 responders of:

- the incident location
- incident type
- rendezvous points
- marshalling areas
- safe access and egress routes
- best approach routes, nature of ground conditions.

## 2.2 Approach the incident safely

**8B.21** The following points may need to be taken into consideration at aircraft incidents:

- Fire and Rescue Service drivers should approach the incident slowly and with great care
- avoid driving across slide paths or debris strewn areas, keeping appliances to one side of debris trail where possible
- there may be a considerable amount of debris to be avoided and there is a possibility that casualties may have been thrown from the aircraft or wandering on or around the crash site
- spectators/bystanders will gather quickly and will present an additional hazard that will need to be managed
- consideration must be made of the terrain and wind direction
- appliances should be parked upwind and uphill to avoid the danger of free flowing fuels and smoke plumes
- large amounts of toxic smoke and fumes may be produced by an aircraft fire with the possibility of smoke within its flammable range drifting downwind of the crash site
- keep clear of recognised exclusion zones around aircraft
- consider additional hazards that may be associated with military aircraft
- preservation of scene

- in general aviation aircraft consider ballistic parachute systems
- the necessity to commit personnel into the inner cordon.

**8B.22** On airport – Rescue and Fire Fighting Service in attendance  
(additional considerations)

- go forward to the incident under the supervision of air traffic control/police or other authorised airport vehicles from rendezvous point
- make immediate contact with the Airport Incident Commander – do not self deploy
- although the Fire and Rescue Service have a statutory responsibility for the incident inner cordon management, under normal circumstances the Rescue and Fire Fighting Service will be responsible for firefighting and rescue operations in the early stages of the incident
- Fire and Rescue Service will not ordinarily alter the tactical plan of the Rescue and Fire Fighting Service unless there are overriding reasons to do so
- park appliances upwind and clear of aircraft fuselage, wings and aircraft escape chute deployment areas
- avoid parking between passenger management systems and the evacuating aircraft
- keep appliances on hard standing whenever practicable
- be aware of other aircraft movements.

## **2.3 Assessing hazards and risks and the implementation of an inner cordon (This will be continuously reviewed subject to risk management)**

**8B.23** In assessing the demands of the incident and reaching a decision regarding the application of control measures, the incident commander should pay particular attention to the following:

- resources available (to include number of appliances/personnel in attendance or en route) and resources available from the rescue Fire Fighting Service or other agencies
- undertake an assessment of risk and declare a tactical mode for the inner cordon, taking into account the necessity to commit personnel into the inner cordon (offensive tactical mode) or to adopt a defensive mode of operation
- manage the safe evacuation of passengers away from the inner cordon
- need for rescues to be undertaken and the likely number of people requiring rescue
- extent of fire and/or fuel spillage, taking into account the quantity and type of fuel likely to be carried

- observation of any hazard information on the aircraft (hazard warning symbols)
- experience, knowledge and training of the personnel attending.

## 2.4 Cordon considerations

- The inner and outer cordon will need to be established as quickly as is reasonably practicable by the first responding Fire and Rescue Service appliances. It will provide a means of facilitating (controlling, safeguarding and coordinating) the immediate response and adds an element of control to the incident
- The inner and outer cordon must be flexible and be able to be moved if necessary
- The outer cordon may be identified by police personnel, objects such as traffic cones or geographical boundaries such as fence lines, hedgerows etc
- Cordon distances will depend on many different factors such as smoke plume, wind direction, fuel spillages, aircraft debris, aircraft slide path, military weapons, ejection seats, hazardous material, cargo's etc.

**8B.24** Therefore the Incident Commander will need to take cognisance of many possible hazards and take early advice from the Rescue and Fire Fighting Service, military advisers, hazardous material advisers and the Aeronautical Rescue Coordination Centre.

## 2.5 Liaison with the Rescue and Fire Fighting Service and other Category 1 responders if already in attendance

**8B.25** If the incident occurs on or near a military or licensed airport it is most probable that the Rescue and Fire Fighting Service will be in attendance and actively engaged in firefighting and rescue operations. Therefore early liaison and communications with the Airport Incident Commander should occur as soon as practicable.

**8B.26** The first Fire and Rescue Service appliance in attendance should assume command of the incident (following a formal and detailed handover from the Airport Incident Commander) and discharge their obligations under the *Fire and Rescue Services Act 2004*. Any memorandum of understanding between the Fire and Rescue Service and the Rescue and Fire Fighting Service, or any standard operating procedure of a Fire and Rescue Service should confirm that the initial personnel attending an aircraft accident will not redeploy or alter Rescue and Fire Fighting Service personnel or assets unless there are overriding operational reasons to do so.

**8B.27** The rapid support by the Fire and Rescue Service to the Rescue and Fire Fighting Service is vital when attending an aircraft incident with the airport fire service in attendance. Fire and Rescue Services may need to provide:

- augmented water supplies for the Rescue and Fire Fighting Service's vehicles in order to sustain firefighting operations and to ensure post-fire security

- personnel to assist with the evacuation of passengers to a safe location upwind and uphill from the incident
- breathing apparatus teams to assist with firefighting and rescue operations
- if the escape slides are still in use, Fire and Rescue Service personnel should be located at the base of each slide to assist the evacuating passengers and personnel.

## **2.6 Consider possible chemical biological radiological nuclear explosives (CBRNE) – Terrorist involvement**

**8B.28** The possibility that the aircraft incident has been caused by a terrorist attack cannot be overlooked or ruled out until the police have carried out a full investigation and therefore, should be considered by the incident commander from the outset of the incident.

## **2.7 Estimate the resource requirements**

**8B.29** The Fire and Rescue Service Incident Commander will need to consider requesting additional Fire and Rescue Service's resources based on the information gathered by their scene assessment. They will need to consider:

- the size and location of the crash site
- number of casualties/rescues required
- the magnitude of firefighting operations and firefighting media required
- specialist rescue equipment e.g. Urban Search And Rescue (USAR) teams
- cordoning and possible evacuation of premises that may be at risk
- environmental protection
- Hazardous Materials Detection Identification Monitoring (DIM) teams
- additional levels of personal protective equipment and/or respiratory protective equipment.

**8B.30** The Fire and Rescue Service Incident Commander will also need to consider requesting additional non-Fire and Rescue Service resources:

- police for outer cordon requirements
- ambulance hazardous area response teams (HART)
- specialist support from Rescue and Fire Fighting Service
- military – MOD, RAF, Royal Navy, Army via the Aeronautical Rescue Coordination Centre
- Aircraft Accident Investigation Branch
- specialist hazardous materials advisers

- Maritime and Coastguard Agency
- aircraft operators
- aircraft engineering teams
- environmental agency
- local authority emergency planners
- voluntary organisations e.g. Women's Royal Voluntary Service (WRVS).

**8B.31** If the incident commander declares a 'major incident' this will mobilise significant Fire and Rescue Services and other agency resources.

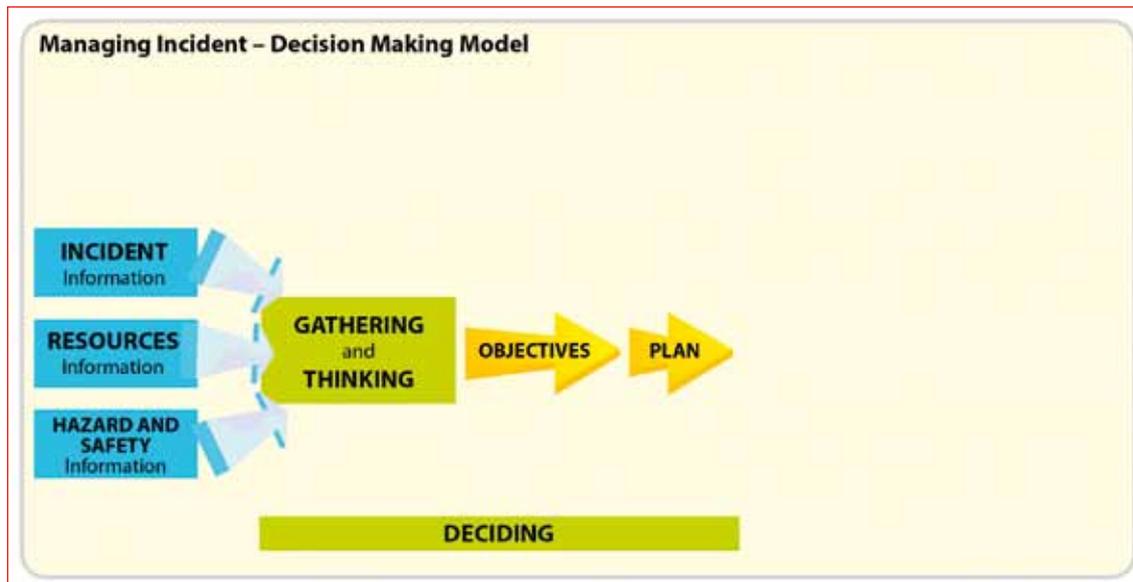
## **2.8 Implement the incident command system**

**8B.32** Whether the incident is on or off airport the Incident Commander should initiate the incident command system system, as detailed in the *Operational Guidance Manual, Fire Service Operations Incident Command*.

## **2.9 Crime scene**

**8B.33** All aircraft incidents must be treated as a crime scene and therefore the preservation of evidence is crucial for post incident investigations. Early liaison with the police, AAIB or in the case of a military aircraft MOD/RAF, is of critical importance in the preservation of evidence.

## Phase 3: Formulating the tactical plan



Phase 3 – Actions		<ul style="list-style-type: none"> <li>• Think</li> <li>• Prioritise objectives</li> <li>• Plan</li> </ul>
Formulating the tactical plan		
3.1	Identify and prioritise objectives	
3.2	Develop tactical plan	

## Considerations

**8B.34** It is very difficult to detail the development of a tactical plan due to the large variation of incident scenarios:

- large passenger aircraft on/off airport
- cargo aircraft
- military aircraft
- general aviation aircraft.

### 3.1 Identify and prioritise objectives

**8B.35** In identifying objectives the Fire and Rescue Service Incident Commander will need to take into consideration the objectives that have been achieved prior to the arrival of Fire and Rescue Service (Rescue and Fire Fighting Service activity if in attendance) and the objectives that are yet to be achieved. The following may need to be considered:

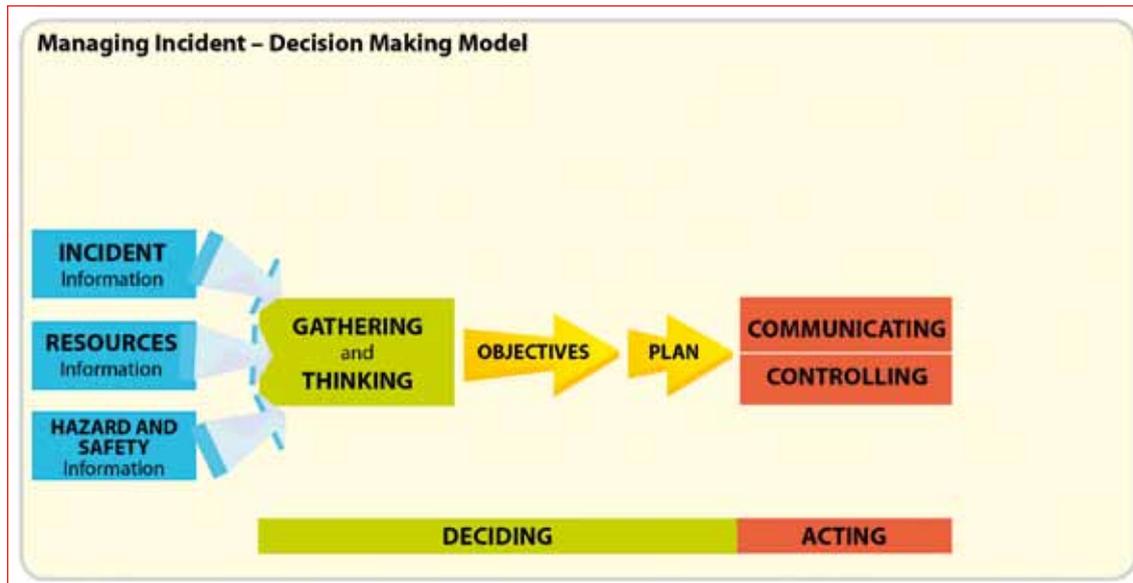
- firefighter safety
- life risk
- prioritising tasks
- creating/maintaining survivable conditions within the aircraft
- extinguishing/controlling external fires
- prevent escalation of incident
- mitigation of hazards
- environmental considerations
- scene preservation
- implement incident command system proportionate to size of incident
- resources required to achieve objectives for both the Fire and Rescue Service and other responding agencies.

### **3.2 Develop tactical plan**

**8B.36** Having identified the objectives and priorities the tactical plan will need to be created, communicated and implemented, this may include:

- declaration of tactical mode
- appropriate control measures to develop safe systems of work
- appropriate personal protective equipment/respiratory protective equipment
- allocation of tasks
- comprehensive briefing of personnel
- appropriate sectorisation depending upon size of incident
- existing and required resources
- inter agency working and interoperability (Rescue and Fire Fighting Service/hazardous area response team).

## Phase 4: Implementing the tactical plan



Phase 4 – Actions		<ul style="list-style-type: none"> <li>• Communicate</li> </ul>
Implementing the tactical plan		<ul style="list-style-type: none"> <li>• Control</li> </ul>
4.1	Implement effective firefighting and rescue operations	
4.2	Communicate the tactical plan	
4.3	Implement deliberate reconnaissance to gather further incident information	
4.4	Communicating with other agencies	
4.5	Controlling the tactical plan	

## Considerations

### 4.1 Implement effective firefighting and rescue operations

**8B.37** The firefighting and rescue operations at an aircraft incident will be challenging and dynamic and outside normal Fire and Rescue Service operations familiar to most personnel. Therefore particular care and consideration by the Incident Commander will be required when implementing the tactical plan, considerations will be:

- correct resources and equipment appropriate to the tasks
- comprehensive and concise briefing to Fire and Rescue Service personnel, paying particular attention to the hazards identified with this incident
- the limited experience of Fire and Rescue Service personnel with aircraft firefighting and rescue techniques
- tactical plan needs to be realistic and achievable, balancing risk against benefit

- plan may include joint working with other agencies e.g. Rescue and Fire Fighting Service/Hazardous Area Response Team
- the plan needs to comply with Fire and Rescue Service standard operating procedures and Fire and Rescue Service policies, based on *Generic Risk Assessment 4.3 Incidents involving transport systems – Air*.

## 4.2 Communicate the tactical plan

**8B.38** The plan will need to be communicated to all Fire and Rescue Service personnel at the scene and other responding emergency services in line with incident command system protocols:

- confirm understanding of the tactical plan with Fire and Rescue Service personnel and broadcast tactical mode to all Service personnel
- disseminate information to other responding agencies and confirm understanding with reference to tactical plan and identified hazards of the incident
- implement liaison protocols/procedures with other emergency services to assist in the communication of Fire and Rescue Service activities and other agency activities
- consider skills, knowledge, competency, capabilities and resources of other agencies.

## 4.3 Implement deliberate reconnaissance to gather further incident information

**8B.39** Utilising industry experts to gain additional information will be of paramount importance to develop safe systems of work and to ensure safety for all category 1 and 2 responders working within the inner cordon, when formulating and implementing the tactical plan. Information may be available from:

- Rescue and Fire Fighting Service
- air traffic control
- Civil Aviation Authority
- Aeronautical Rescue Coordination Centre
- Air Accident Investigation Branch – 24/7 (accident reporting line – available from the Air Accident Investigation Branch website)
- police/ambulance
- Joint Aircraft Recovery and Transport Squadron (JARTS)
- UK military bases – MOD, RAF, Royal Navy, Army
- military visiting forces
- airline operator

- airport operator
- airport engineers
- Detection Identification Monitoring Team hazardous materials adviser
- aircraft manufacturers.

#### **4.4 Communicating with other agencies**

**8B.40** The majority of all aircraft incidents will require a multi agency response to achieve a satisfactory conclusion. Historically communications both internal and external are often areas of weakness highlighted in post incident investigations and debriefs. Therefore the Fire and Rescue Service Incident Commander should consider carefully their methodology of communication with other agencies (category 1 and 2 responders). Areas for consideration will be:

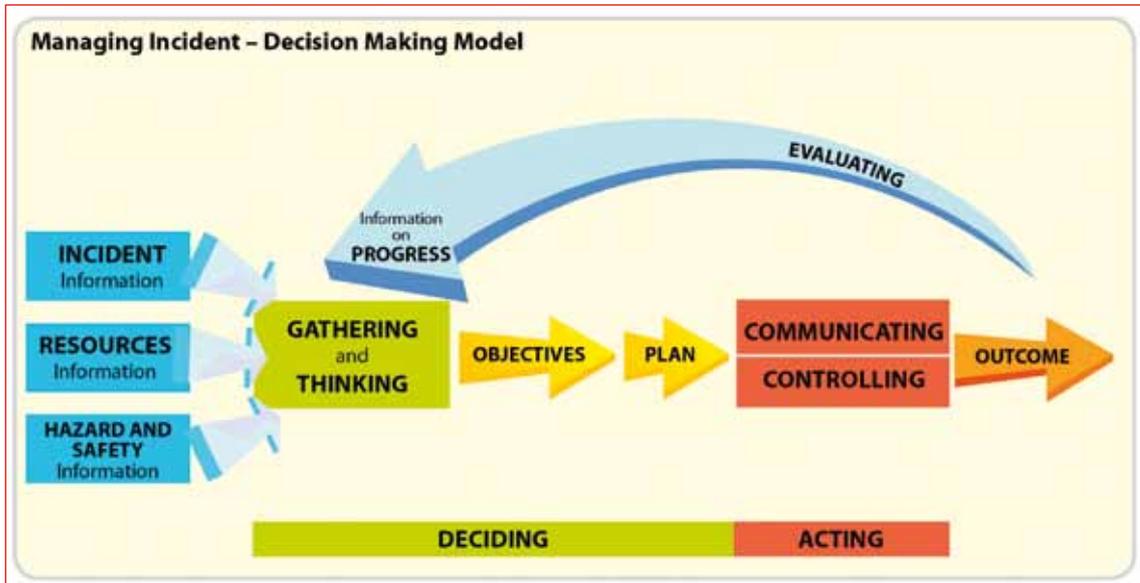
- airwave radio system
- correct allocation of radio channels
- dedicated inter agency radio channels
- danger of reliance on mobile telephone networks
- the use of field telephones between emergency service control vehicles
- the use of runners if appropriate
- the allocation of inter service liaison officers
- the preplanned agreed protocols in the memorandum of understanding/ airport emergency plan.

#### **4.5 Controlling the tactical plan**

**8B.41** Once the tactical plan is in place, the Incident Commander will need to control its implementation to ensure the objectives are being met in accordance with the plan. The control is achieved by the use of the appropriate command structure.

**8B.42** Without effective communications the control of activities to meet objectives will be compromised.

## Phase 5: Evaluating the tactical plan



Phase 5 – Actions Evaluating the tactical plan		• Evaluate the outcome
5.1	Evaluate the effectiveness of the tactical plan	
5.2	Obtain and utilise specialist advice	
5.3	Assessment of safe systems of work	
5.4	Tactical plan not meeting objectives	

## Considerations

### 5.1 Evaluate the effectiveness of the tactical plan

**8B.43** With all tactical plans there will need to be a continuous review of the priorities and objectives of the plan balanced against the risks being taken by Fire and Rescue Service personnel. Undertaking this review the following questions may be considered:

- is personnel safety and welfare being maintained?
- are the risks being taken by Fire and Rescue Service personnel proportional to the benefit?
- have comprehensive analytical risk assessments been completed and appropriate control measures implemented?
- are the resources appropriate and adequate to achieve the tactical plan?
- has there been a change in the level of risks pertaining to the incident?
- has the fire spread, been contained or extinguished?

- is the extinguishing media having the intended effect?
- have the operational tasks achieved the tactical plan, if not why not and what needs to be altered to achieve the tactical plan?
- what are the environmental impacts with regards to fire service operations?  
e.g. foam, water run off, etc.

## 5.2 Obtain and utilise specialist advice

**8B.44** Do not underestimate the range of expertise that is available to the Incident Commander from the industry experts detailed in 4.3. The Incident Commander should consider using the industry experts to confirm that the decisions and assumptions within the tactical plan are valid and appropriate for the incident type, size, scale, location and associated hazards.

**8B.45** Any new information or change in circumstances will require the IC to evaluate the impact of that information on identified objectives and as such the tactical plan may need to be amended.

## 5.3 Assessment of safe systems of work

**8B.46** In the assessment of the safe systems of work that are being undertaken by Fire and Rescue Service personnel and possibly other responding agencies working in the same location, the following may need to be considered.

- the information received from specialist advisers confirms the justification of continued Fire and Rescue Service activity
- a change in weather, tide and sea conditions may have an affect on the suitability of the safe systems of work
- the configuration of the airframe and structural stability as the incident develops, being affected by Fire Service operations or the result of fire/crash damage, resulting in aircraft swing and structural collapse
- if a safe system of work is not possible, evacuate all personnel to a place of safety.

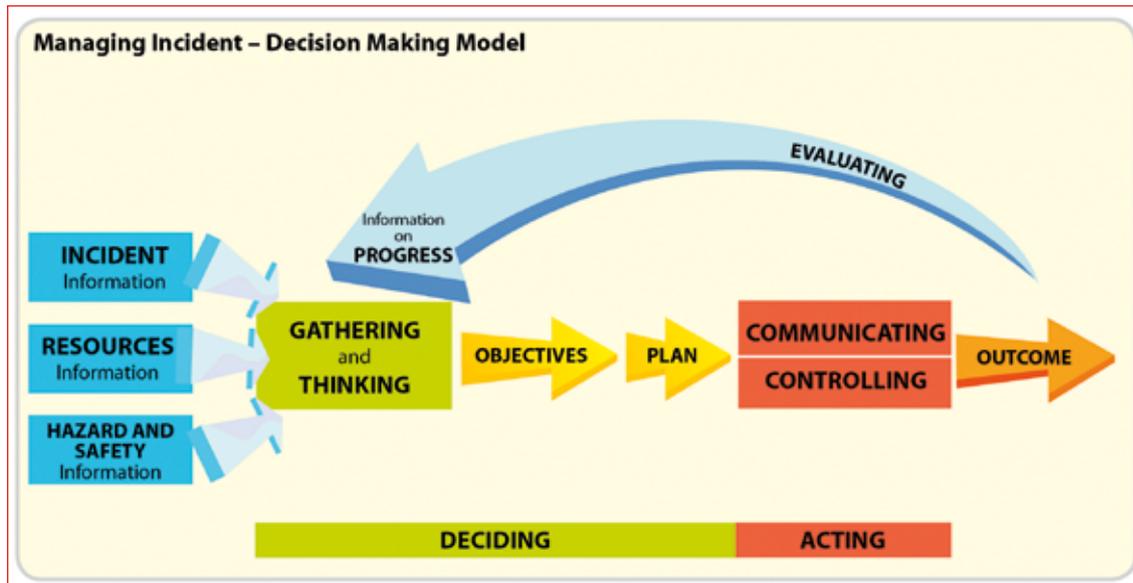
## 5.4 Tactical plan not meeting objectives

**8B.47** Evaluating the progress of the tactical plan against the considerations in 5.1 will lead the Incident Commander to decide on the effectiveness of the tactical plan. If progress is not being achieved this will provide information for the incident commander to consider. A plan not meeting its objectives will need to be amended, which may lead to:

- a decision to reallocate/re-task Fire and Rescue Service and Rescue and Fire Fighting Service resources
- request additional resources

- change the prioritisation of the objectives
- communicate the changes in the tactical plan and consider who will need to be informed of these
- is an emergency evacuation of all personnel to a safe area required?

## Phase 6: Closing the incident



### Phase 6 – Actions

#### Closing the incident

6.1	Scaling down Fire and Rescue Service operations
6.2	Hand over control of the inner cordon
6.3	Post crash management group
6.4	Facilitate debriefs
6.5	Prepare and organise reports and documents
6.6	Post incident considerations

## Considerations

### 6.1. Scaling down Fire and Rescue Service operations

**8B.48** This is an important phase of the incident and statistically a phase when accidents and injuries are prevalent and therefore there is a need to maintain the highest attention to command and control throughout this phase of the operations.

**8B.49** Possible considerations:

- continued dynamic management of risk and a record of Incident commander decisions
- post incident security must be maintained
- scene preservation in conjunction with advice from police/Air Accident Investigation Board

- decontamination of equipment and personnel e.g. fuel, foam, oils, blood borne pathogens etc
- personnel welfare
- safe recovery of Fire and Rescue Service equipment
- stability of airframe and other structures whilst removing Fire and Rescue Service equipment e.g. urban search and rescue (USAR) shoring and propping equipment.

## 6.2 Hand over control of the inner cordon

**8B.50** Following the scaling down of Fire and Rescue Service operations the incident will need to be handed over to a responsible authority/person. This may be:

- police
- Air Accident Investigation Board
- Military Air Accident Investigation Branch (MAAIB)
- Military Aircraft Post Crash Management Officer
- Joint Aircraft Recovery and Transport Squadron (JARTS).

**8B.51** The Incident Commander will need to consider the following points upon hand over:

- relevant risk assessments and identified hazards and controls
- Fire and Rescue Service actions and activities in relation to scene preservation and casualty identification/location
- location of flight recorders and aircraft documentation
- resources required for the responsible agency to safely manage the next phase of the incident.

## 6.3 Post crash management group

**8B.52** At any significant aircraft incident there is a high likelihood that a post crash management group will be formed to manage the post crash clear up and aircraft recovery. The make up of this group will vary dependent on incident type but may be made up of the following:

- police (who will have primacy of the scene)
- Air Accident Investigation Branch
- disaster victim identification teams (police unit)
- airline operator
- airline engineers
- military post crash management officer

- military advisers (Joint Aircraft Recovery and Transport Squadron)
- hazardous materials advisers
- Fire and Rescue Service adviser
- local authority emergency planning officers
- environment agency
- water authority
- land/property owners
- insurance investigators.

## 6.4 Facilitate debriefs

**8B.53** As with similar types of major incident the Incident Commander will need to ensure the relevant records and information are made available for internal, inter service and inter agency post incident debriefs, debriefs may include:

- on scene hot debriefs
- structured Fire and Rescue Service internal debriefs
- structured mutli-agency debriefs
- critical incident debriefs (trauma aftercare).

## 6.5 Prepare and organise reports and documents

**8B.54** Depending upon the type and scale of the incident the post incident investigations will require a range of reports and documents from the Fire and Rescue Service, these may include:

- Internal documents:
- statements from Fire and Rescue Service personnel
- recordings of all messages and information exchanges between the incident ground and Fire and Rescue Service control centres
- record of information utilised as part of the decision making process (computer in cab information accessed by the Incident Commander and information supplied by industry experts)
- decision making logs/contemporaneous logs
- inner cordon logs
- internal investigation reports
- photographs
- copy of analytical risk assessments.

**Note:**

Any internal debrief reports or other documentation may be disclosable and may be used in Coroners Courts or criminal court proceedings, military service enquires, Air Accident Investigation Branch investigations and be open to public scrutiny.

**8B.55** External documents:

- police statements
- reports for the coroner.

## **6.6 Post incident considerations**

**8B.56** At incidents where persons may or may not have been injured, the conduct of attending Fire and Rescue Service and/or individuals may be subject to a criminal investigation by the relevant enforcing authority. Other organisations/individuals may also be subject of criminal investigations.

**8B.57** The Fire and Rescue Service itself will need to learn from the incident for the purpose of identifying and applying remedial measures to promote a cycle of improvement, measures such as review of:

- elements within the management system
- provisions for resource
- training for and maintaining competence
- procedure
- risk assessment
- provision of information and instruction
- equipment failures and successes.

**8B.58** Nature of the incident could give rise to wider learning for both the Fire and Rescue Service and the aviation sector.



# Part C

Technical information

## PART C-1

# Introduction to airport terminology and topography

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## Introduction

- 8C1.1** Airports form part of the UK's critical transportation infrastructure and are controlled by rules and regulations that set strict controls as to what can and cannot happen within the curtilage of the airport boundaries.
- 8C1.2** Access to areas is restricted, vehicle movements controlled and therefore this section will act as an introduction to terminology, topography and facilities that can be found at airports around the country.

## General terms

### Airport

- 8C1.3** Airport is an area where aircraft take off and land or where aircraft are stored or maintained. The term aerodrome, airfield, heliport and airstrip may also be used to refer to airports. For the purpose of this manual the principle term used will be airport.

**Picture 1: Aerial view of Gatwick Airport**



Source Gatwick Airport Ltd

## Runway

- 8C1.4** A defined rectangular area for the landing and take off run of aircraft along its length.
- 8C1.5** Runways are laid out to take advantage of the prevailing wind conditions as wind strength and direction are critical factors whilst aircrafts are taking off or landing. Runways derive their numbering from the nearest compass bearing (relative to the magnetic north plus or minus 10 degrees). The runway may also be given a designated letter L (left) R (right).

## Runway threshold

- 8C1.6** The beginning area of the runway, used for landing.

## Runway incursion

- 8C1.7** Any occurrence at an airport involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for the landing and take-off of aircraft.

## Instrument Landing System (ILS)

- 8C1.8** This is a ground based instrument approach system that provides precision guidance to an aircraft approaching and landing on a runway. It uses a combination of radio signals to enable a safe landing during instrument meteorological conditions (IMC) such as low cloud or reduced visibility due to fog, rain or snow.

**Picture 2: Instrument Landing System (ILS) Farnborough Airport**



Source WSFRS

## Aircraft stand

- 8C1.9** A designated area on an airport intended to be used for parking an aircraft. Stands are remote from terminal buildings or piers and passengers are transported to and from the aircraft via buses or on foot.

**Picture 3: Aircraft stand**



Source Ron Puttock GFS

## **Air bridge**

**8C1.10** Is a movable bridge that allows passengers to embark and disembark their aircraft direct to the terminal building.

**Picture 4: Air bridge attached to an aircraft**



Source Ron Puttock GFS

## **Apron**

**8C1.11** A defined area on a land airport provided for the stationing of aircraft for the embarkation and disembarkation of passengers, the loading and unloading of cargo, fuelling, and for parking.

**Picture 5: Apron**



Source WSFRS

**8C1.12** These areas tend to be very congested depending on the time of day and number of aircraft movements. The type of functions, equipment and vehicles which utilise these areas are as follows:

- aircraft servicing vehicles
- baggage handling vehicles
- refuelling vehicles
- pedestrian traffic
- high-voltage electrical feeds provided by mobile ground power units (GPUs)
- aircraft maintenance vehicles/engineers
- cargo/hazardous goods.

### **Manoeuvring area**

**8C1.13** That part of an airport provided for the take off and landing of aircraft, or for the movement of aircraft on the surface, excluding the apron and any part of the airport provided for the maintenance of aircraft.

### **Movement area**

**8C1.14** That part of an airport intended for the surface movement of aircraft including the manoeuvring area, aprons and any part of the airport provided for the maintenance of aircraft.

**Note:**

Manoeuvring area and movement area are generic terms intended to describe the 'airside' part of an airport.

## Taxiway

- 8C1.15** A defined path on an airport established for the taxiing of aircraft and intended to provide a link between one part of the airport and another.
- 8C1.16** Foreign object debris (FOD)
- 8C1.17** FOD is any substance, debris or article alien to the aircraft which would possibly cause damage by being ingested into engine intakes, or which can cause considerable damage to fuselage, undercarriage or wings. Runways are inspected regularly for FOD.

## Airside/Landside security

- 8C1.18** Airports are divided into two clear areas, airside and landside.

### 1. AIRSIDE

- 8C1.19** Part of an airport nearest the aircraft, which is a controlled area by security checks, customs, passport control etc. Airports will have a number of emergency access gates around the perimeter of the secure airside area. Fire and Rescue Service appliances and personnel will need clearance and supervision to enter into this restricted and controlled location.

- 8C1.20** Fire and Rescue Service personnel who are required to drive their vehicles onto airside locations of airports will require an additional driving permit; this is controlled by the airport operator. If a Fire and Rescue Service driver does not have the required driving permit, in an emergency situation they will be escorted to the scene of operations by 'follow me' vehicles or other designated vehicles.

### 2. LANDSIDE

- 8C1.21** Landside generally refers to all areas outside the control areas of the airport where members of the public have free movement without passing through a security gate. Some areas around the airport will still have restrictions on access such as cargo areas.
- 8C1.22** When driving airside all vehicles must display an amber flashing light on the roof of the vehicle. If this is not possible or when responding to an emergency, a flashing blue light must be used.

**Picture 6: Follow me vehicle at Shoreham Airport**

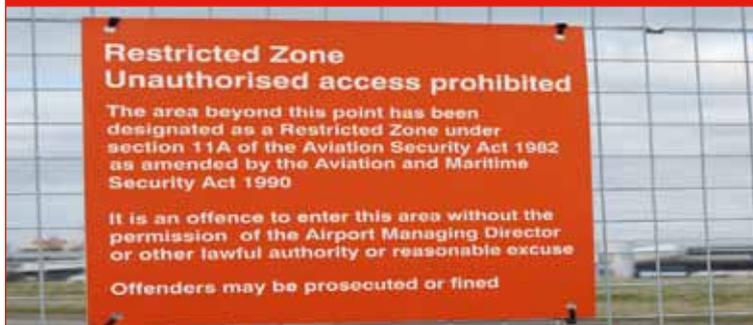


Source WSFRS

## Fences and gates

- 8C1.23** Airport facilities require the protection from unauthorised members of the public from entering restricted areas. The purpose of these fences and gates are to prevent members of the public/animals maliciously or inadvertently entering the airports restricted areas.
- 8C1.24** These security fences pose a problem to responding Fire and Rescue Services, therefore detailed maps of agreed access points need to be available to all responding personnel and should be included in the airport emergency plans.

**Picture 7: Example of security notice on the airside/ landside security fence at an international airport**



Source WSFRS

## Emergency rendezvous points

- 8C1.25** Located around the airport and included in the airport emergency plan will be designated rendezvous points for responding emergency services attending the airport. These areas will be designated for emergency services only and should be kept clear at all times. Depending on the size of the airport the facilities will vary but may include:

- immediate access to airside areas via an access gate or equivalent
- designated parking area for all emergency services
- shelter/control room facilities
- radio communications with the airport fire service/air traffic control
- telephones
- detailed airport crash maps and additional critical information
- aircraft hazard sheets and seating configuration for the aircraft that regularly use the airport
- tabards and associated incident command facilities.

**Picture 8: Access Point Gatwick Airport**



Source WSFRS

**Picture 9: Typical rendezvous point road signage and the north rendezvous point at Gatwick Airport with a dedicated command pod**



Source WSFRS

**8C1.26** The management of this area is a critical part of any aircraft incident on or around an airport. For further information on rendezvous points see the On Airport Incidents chapter.

## Airport terminal buildings

**8C1.27** Airport terminal buildings range in size from small passenger terminals at regional airports to large complex buildings designs, which are the size of small towns.

**8C1.28** The buildings are made up from conventional buildings and office facilities to state of the art large uncompartmented areas that are reliant on fire engineered solutions and modern fire detection/suppression systems, to ensure safe evacuation of passengers, staff and public.

**8C1.29** The life risk and fuel loading within terminal buildings varies dependant on time of day and airport activity. Fire and Rescue Service personnel dealing with incidents involving these buildings will be challenged with difficult environments due to the complexity of the building design. Regular 7 (2) (d) familiarisation visits to these buildings are an important Fire and Rescue Service activity to ensure that Service personnel are fully conversant with building designs and integrated fire safety strategies e.g. airport evacuation strategies reliant on fire engineering solutions.

**Picture 10: Terminal buildings**



Source WSFRS

**Picture 11: Inside a terminal building**



Source WSFRS

## **Airport piers**

**8C1.30** The term pier is used to describe a long narrow building with aircraft parked on one or both sides. One end connects to the airport terminal with passenger processing and baggage reclaim areas. Piers offer high aircraft capability and simplicity in design but often result in a long distance from the check in counter to the gate. Most large airports have piers.

**Picture 12: Pier 6 at Gatwick Airport**



Source WSFRS

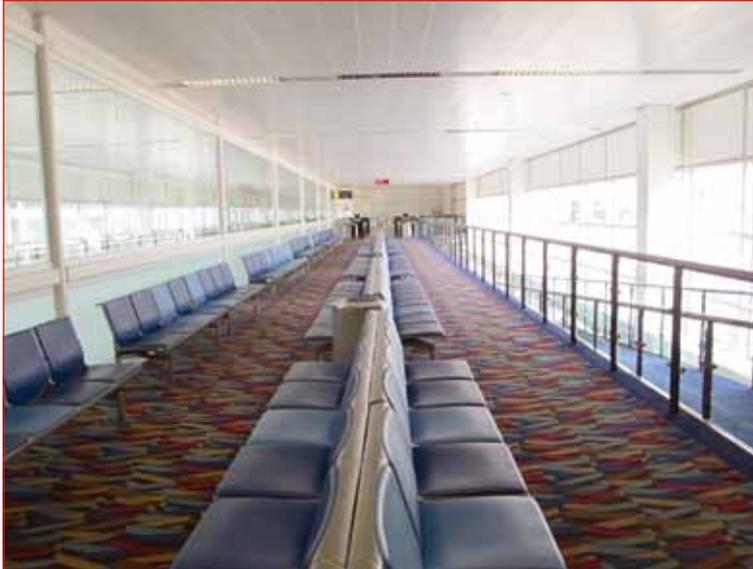
## **Gates and gate rooms**

**8C1.31** This is an area where passengers sit waiting to embark the aircraft.

## **Satellite terminal**

**8C1.32** A satellite terminal is a building detached from other airport buildings so that aircraft can park around its entire circumference.

**Picture 13: Gate room at Gatwick Airport**



Source WSFRS

## **Baggage farms/baggage handling systems**

**8C1.33** These can be large complicated areas of an airport or a simpler configuration. In large international airports the conveyer systems form a complex matrix throughout the terminal building.

**Picture 14: Baggage farm Gatwick Airport**



Source WSFRS

## **Maintenance facilities**

**8C1.34** Aircraft maintenance hangars conduct a variety of operations on both large and small airports. They present a significant hazard, which should form part of any preplanning for airports.

**Picture 15: Maintenance**



Source Ron Puttock GFS

**Picture 16: Fixed installation foam tower which forms part of a foam fire suppression system in a large maintenance hanger**



Source WSFRS

**8C1.35** Typical activities may include:

- maintenance, repair and refit of aircraft
- maintenance and repair of fuel tanks and systems
- maintenance and overhaul of engines
- storage of flammable and hazardous chemicals
- hot cutting operations and fabrication of aircraft components.

**8C1.36** Aircraft hangars may or may not be provided with fixed installations/firefighting and fire suppression systems.

**8C1.37** Picture 16 shows a foam monitor tower for the maintenance facility at Gatwick. The system is supplied with a foam production pump house and elevated water tank. The system can produce large amounts of finished foam which is directed onto and under aircraft that are housed within the maintenance hangar. The system can be manually operated or triggered by smoke and flame detection systems.

## Fuel storage and distribution systems

**8C1.38** Airports will use a variety of methods for refuelling aircraft and the volume of stored fuel on the airport will vary tremendously depending on the category of the airport concerned.

**8C1.39** Fire and Rescue Service personnel should be aware of the type and quantity of aircraft fuel and fuel storage systems relevant to their local airport.

**8C1.40** Facilities may include:

- large bulk storage facilities
- supply pipelines/underground fuel hydrant systems
- small surface fuel tanks and underground fuel tanks
- refuelling tankers
- refuelling vehicles which use underground fuel hydrants



Source WSFRS

**Picture 18 and 19: Fuel farm pump raft and apron fuel hydrant**



Source WSFRS

**Picture 20: Fuelling station at Shoreham Airport**



Source WSFRS

**Picture 21: Refuelling vehicle at Shoreham Airport**



Source WSFRS

**Picture 22: Refuelling vehicle at Gatwick using the fuel hydrant system**



Source Ron Puttock GFS

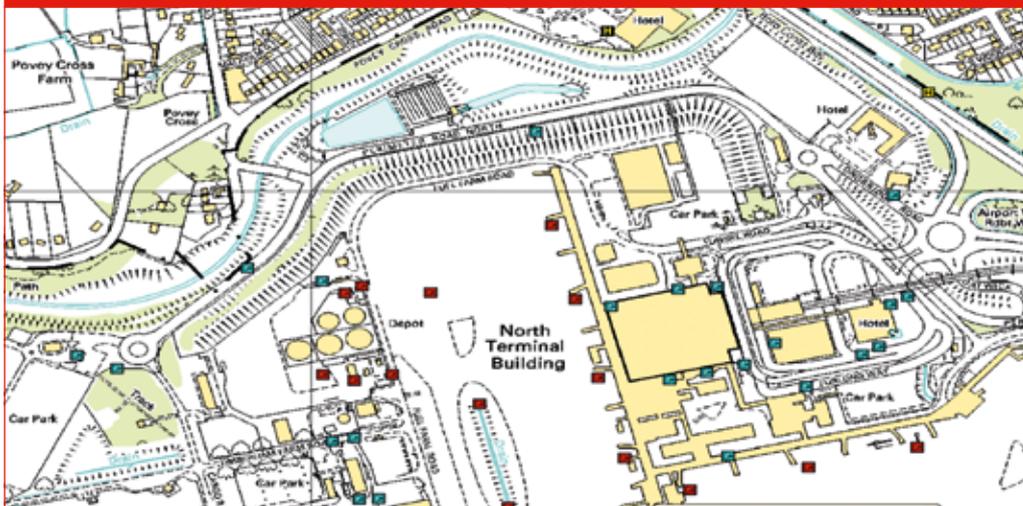
## Water supplies on airports

**8C1.41** Water supplies on airports fall into four possible categories:

- open water supplies such as rivers, ponds or lakes
- town main hydrants, ordinarily found around terminal buildings and internal and external road infrastructure, these can be public or private hydrants
- dirty water main hydrants, internal hydrants system ordinarily located around airport aprons and runways and supplied by local open water source and pumping station
- storage tanks or mobile water tankers (including Rescue and Fire Fighting Service vehicles)

**8C1.42** On some airports, dirty water pillar hydrants are located within insulated boxes to prevent freezing.

**Picture 23: Map showing open water locations, town main hydrants (blue) and dirty water hydrants (red)**



Source WSFRS

**Picture 24 and 25: Pillar hydrant and control valves with insulated boxes**



Source WSFRS

## PART C-2

# Fixed wing aircraft design and construction

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## Introduction

**8C2.1** This chapter will focus upon large passenger carrying fixed wing aircraft and will cover:

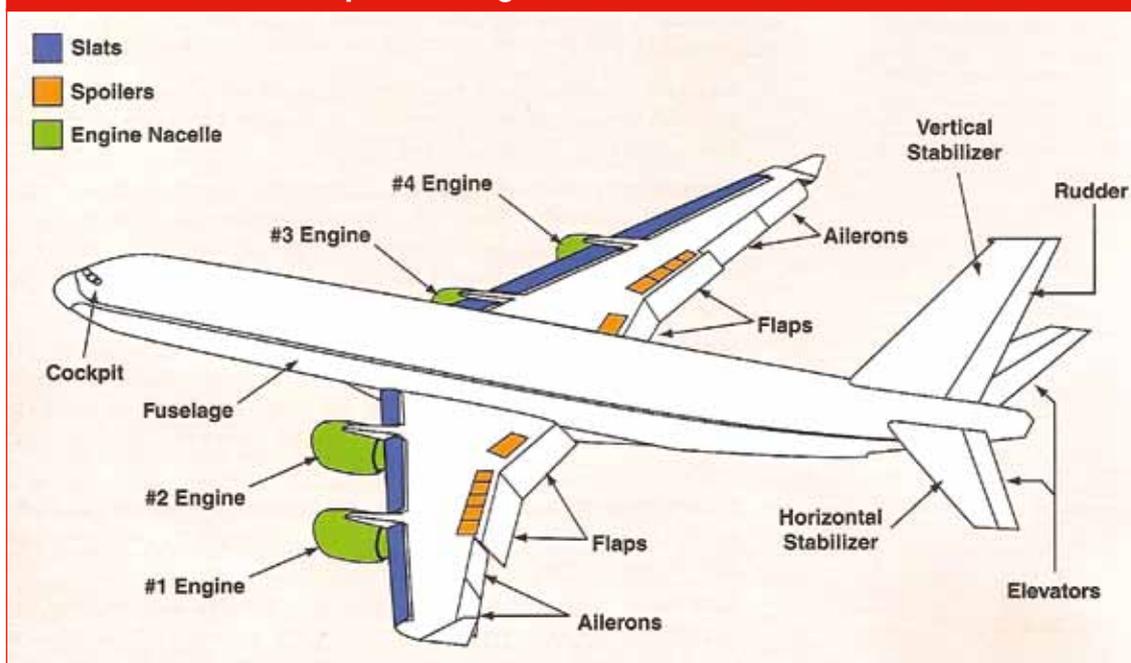
- general terminology
- component parts
- material used in construction
- electrical systems
- defence suites.

**8C2.2** Modern passenger aircraft are capable of carrying large numbers of passengers and crew, in single (Boeing 787 Dreamliner) or multi (Airbus A380) deck configurations. However, with the increase in size, the general principles of construction remain broadly similar to all passenger aircraft. The principal differences are the advancement in the types of material used in construction, for example a greater reliance on composite materials.



Source BAA LHR

Picture 2: Aircraft component diagram



Source IFSTA USA

## Fixed wing aircraft

### Fuselage

**8C2.3** The main structural body of the aircraft, excluding the mainplane (wings), tail and fin, provides accommodation for passengers and cargo. Due to pressurisation, the fuselage of most modern aircraft consists of a double skin (the outer skin being the pressure skin) with an insulating material interposed. The system of construction described is usually referred to as 'Semi-Monocoque', a structure in which the loads are carried partially by the frame and stringers and partially by the skin.

**8C2.4** In larger passenger carrying aircraft the fuselage is often referred to as wide or narrow bodied.

### Narrow bodied

**8C2.5** The internal cabin of a narrow bodied aircraft will have a single aisle approximately 46cm to 51cm wide and may seat up to 240 passengers. The cargo and luggage hold doors are normally located on the right side of the aircraft. Some smaller narrow body aircraft have cargo and luggage holds that have to be loaded manually as they are too small to carry standard freight containers.

**Picture 3: Internal layout of a typical narrow bodied aircraft**

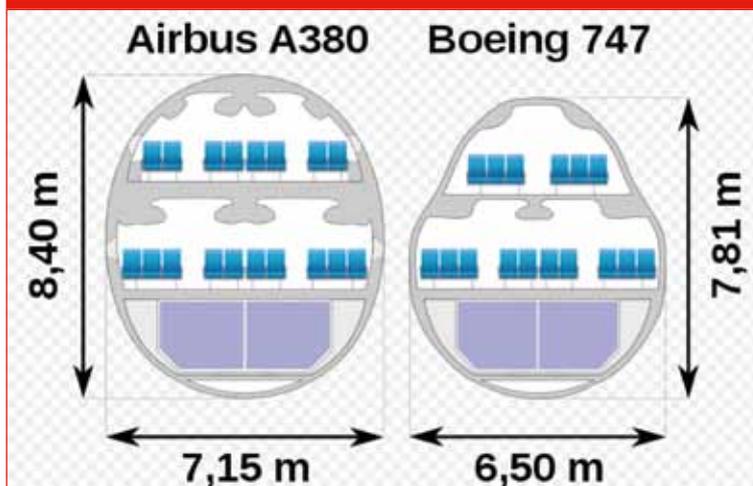


Source WSFRS

## Wide bodied

**8C2.6** Wide body aircraft will have dual aisles to create a centre section of seating, allowing aircrafts to carry up to 560+ passengers if the aircraft has a double deck, such as the Airbus A380 (economy seating configuration). Luggage and cargo will be preloaded onto pallets or containers before being unit loaded into the cargo compartments.

**Picture 4: Seating configurations on a wide bodied aircraft**



Source Anon

## Fuselage construction

**8C2.7** Fuselage construction of aircraft differs between aircraft manufacturers and aircraft use, however they follow the same basic principles of construction. The fuselage is made up from:

- skin
- vertical frames
- longerons
- stringers
- cabin floors
- insulation material
- cabin trim.

**8C2.8** Depending on the aircraft involved access through the fuselage will be difficult due to its design and construction and materials involved. On passenger aircraft there are areas of the fuselage that may be marked as cutting points (see access chapter for more details). Within the fuselage construction will be aircraft services such as:

- fuel lines
- hydraulic lines
- electrical wiring looms
- pressurised systems.

**8C2.9** These services will make cutting through the fuselage construction hazardous and in most scenarios, almost impossible.



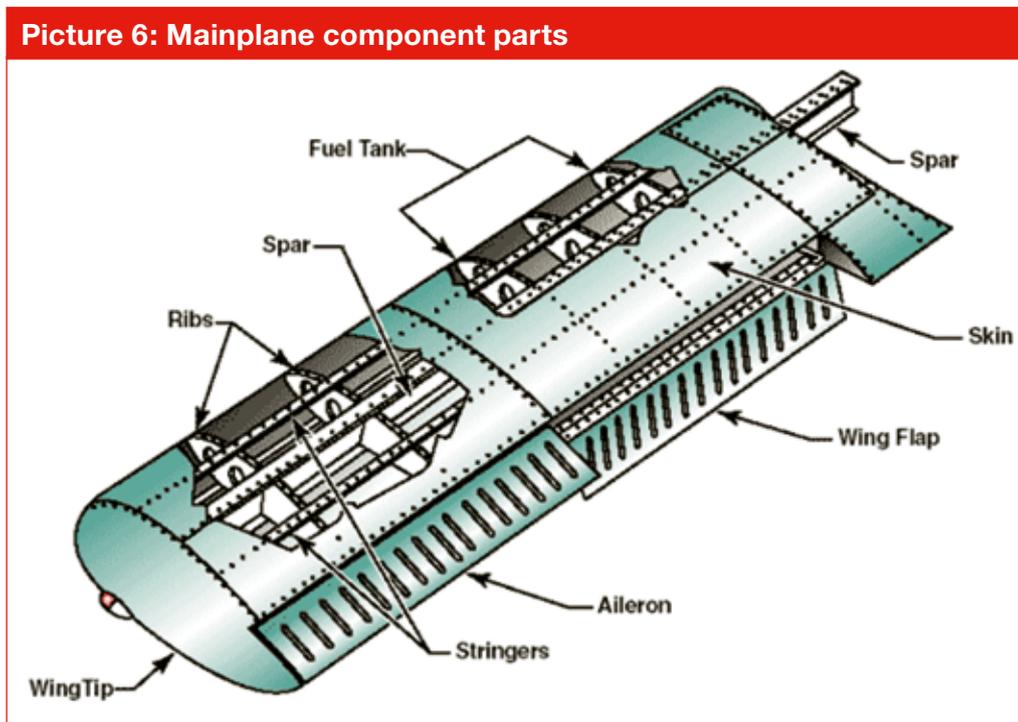
Source WSFRS

## Cockpit (flight deck)

- 8C2.10** This is the compartment occupied by the pilot and flight crew. Access to the flight deck on passenger aircraft is via a secure door system, which will present Fire and Rescue Service personnel with access difficulties in an emergency situation.
- 8C2.11** In a rescue situation, if the flight deck door is secure, Fire and Rescue Service personnel should not waste time in gaining access but continue with the search of the passenger cabin.
- 8C2.12** The cockpit in a military fast jet aircraft will be equipped with an ejection seat system and emergency canopy release system (see military chapter for more details). Cockpits on general aviation aircraft may be open or closed with a variety of canopies and access doors.

## Mainplane (wings)

- 8C2.13** The mainplane is the major lifting surface of the aircraft, which may contain fuel and incorporates housing for engines, control surfaces, and undercarriage units.
- 8C2.14** The wing in civil aircraft is constructed from load carrying spars along the length of the wing onto which are fitted ribs to produce the required aerofoil shape of the outer skin. Materials used may be metal or composite or combinations of these and can be riveted or bonded.



Source Online Private Pilot Ground School

**8C2.15** Before going on to explain the different aircraft components it is useful to understand what is meant by the terms:

- roll
- yaw
- pitch.

**8C2.16** The diagram below gives a pictorial explanation of the above terms.

## Leading edge

**8C2.17** A term used to describe the front edge of the mainplane or aerofoil surface.

## Trailing edge

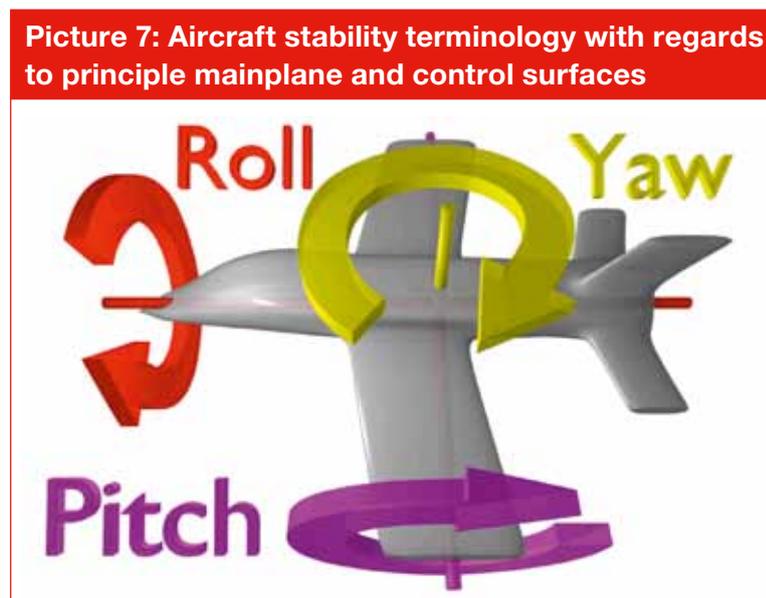
**8C2.18** A term used to describe the rear edge of the mainplane housing the flaps and ailerons.

## Ailerons

**8C2.19** These are the primary control surfaces, located on the trailing edge of the mainplane. These controls operate differentially (one goes up and the other down) providing lateral (rolling) control.

## Flaps control

**8C2.20** These are the hinged surfaces on the trailing edge of the mainplane; they provide extra lift and drag during take-off and landings.



Source Anon

## Tailplane

**8C2.21** This is the horizontal stabiliser surface located towards the rear of the aircraft. This may be 'all flying' or have a moveable 'elevator' surface, both of which are designed to control the aircraft in pitch. Military jet aircraft often have an 'all flying' tailplane where the whole surface moves to control pitch especially at high speed.

## Tail fin

**8C2.22** This is the fixed vertical surface towards the rear of the aircraft used to provide yaw (directional) stability.

## Rudder

**8C2.23** This is a moveable surface attached to the vertical fin used to control the aircraft in yaw.

## Elevator

**8C2.24** This is a movable surface attached to the tailplane which provides control in pitch.

## Spoilers and speed breaks

**8C2.25** These are movable panels located on the upper surface of the wing and raised up into the air flow to increase drag and decrease lift. Speed break devices are located on the wing, along the rear or underside of the fuselage and when extended, help to reduce the aircraft speed by creating drag.

## Elevons

**8C2.26** This is a combination of ailerons and elevators found on delta wing aircraft. These provide both roll and pitch control of the aircraft.

### Caution

If working on or around the control surfaces of an aircraft, Fire and Rescue Service personnel must take particular care as these areas are often light weight and not designed to be walked on. They can also move unexpectedly and therefore should be treated with extreme caution.

## Undercarriage

**8C2.27** The landing gear, incorporating wheels, legs, struts and shock absorbers which will include the main wheels and nose wheel and on some older aircraft a tail wheel. Most undercarriage systems on large aircraft are fully retractable in order to reduce drag.

## Oleo

**8C2.28** These are undercarriage legs which absorb the shock on landing by a piston moving up a cylinder containing hydraulic fluid or compressed air.

## Bogie

**8C2.29** This is an undercarriage unit containing four or more wheels on each leg.

## Engines

**8C2.30** These are designed to produce the thrust required to propel the aircraft forward and drive the various systems that support the operation of an aircraft. They can either be internal combustion reciprocating engines or gas turbines. All engines vary in size and capacity dependent on use and type of aircraft.

## Engine nacelle

**8C2.31** This is an enclosed structure housing the engine. On propeller aircraft it may also contain the undercarriage wheel bay.



Source Ron Puttock GFS

## Rotary wing aircraft components

**8C2.32** Please see Helicopters chapter.

## Materials used in aircraft construction

### Polymer composite material

**8C2.33** Please see appendix C.

## Metals used within aircraft construction

- 8C2.34** Aluminium alloys are the most common metals used in airframe structures. The composition of the alloys varies depending on where they are to be used, i.e. skin surfaces, formers, stringers, spars etc, but the following broad descriptions are typical:
- Duralumin – this is an alloy of aluminium with about 4 per cent copper and about 1 per cent each of magnesium, manganese and silicon
  - Alclad – this is duralumin with a surface finish of pure aluminium
  - Magnalium – this is a lighter alloy of aluminium with about 2 per cent of copper and about 2 to 10 per cent of magnesium
  - Aluminium itself will burn at about 800°C, however the melting point of aluminium alloy used in aircraft construction is around 600°C.
- 8C2.35** As a general guide, in a fire situation aluminium alloy will:
- start to be affected at 200°C
  - buckle and distort at 400°C
  - melt at 600°C.
- 8C2.36** Therefore it is common for major airframe alloys (Duralumin, Alclad etc) not to ignite in aircraft fires, because it has melted long before its ignition temperature, it will have fused or dripped to the ground before it can ignite.
- 8C2.37** Holes will appear in the skin panels, followed by the partial or complete collapse of the frames. Holes in the fuselage will admit external flames to the interior and at the same time allow the venting of flames and hot gases from an internal fire.
- 8C2.38** Fire damaged aircraft structures will contain an unknown variety and quantity of metals and oxides within the wreckage. Aluminium and aluminium oxides will be present as structural materials in significant quantities and where fire has occurred, in variable particle sizes.
- 8C2.39** Aluminium alloy can be readily cut with an axe, hacksaw or power operated cutting tools. Practice has shown that stone cutting blades are more resistant to this and therefore give better cutting results. Care should be taken with sharp jagged edges resulting from a crash situation and personnel should be warned of the danger of the needle sharp, stalactites formations resulting from the melting and cooling metal. These stalactites are capable of penetrating even the best protective clothing.
- 8C2.40** Aluminium alloy will be affected very quickly by the heat, but will also cool rapidly when a cooling agent such as water or foam is applied.

## Magnesium alloy

- 8C2.41** Magnesium alloy is a light, strong metal which can be found in undercarriage wheel hub assemblies, engine mounting brackets, crank cases in piston engines, compressor cases in turbine engines and various strengthening brackets throughout the aircraft.
- 8C2.42** As a general guide in a fire situation magnesium alloy will:
- start to melt at around 700°C to 800°C
  - begins burning at 900°C to 1000°C.
- 8C2.43** When it is ignited it burns with a brilliant glare and is often difficult to extinguish, as it will react with most firefighting media.
- 8C2.44** Class 'D' chemical powders are designed to isolate and contain the fire, and can be used if available. However, normal firefighting action with foam and/or water will create an increase in the already brilliant glare and cause sporadic, spectacular flashes showering glowing particles around the area.
- 8C2.45** If the firefighting stream is maintained, it may cool the magnesium alloy until it solidifies and the fire is extinguished. If this action fails it may be necessary to isolate the burning magnesium and allow it to burn itself out.

## Titanium alloy

- 8C2.46** Titanium alloy is used where great strength or resistance to heat is required. Its main use is in engine firewalls, tailpipe casing and turbine engine blades. It may also be used to make major components in high speed aircraft.
- 8C2.47** Although not easily ignited, it will begin to melt and burn between 1300°C to 1450°C.
- 8C2.48** Titanium alloy when involved in fire will react with most firefighting media. However, if class 'D' chemical dry powders are available they may be used, and normal firefighting streams will generally flood the area enough to bring the burning metal below its ignition temperature.

## Stainless steel

- 8C2.49** Stainless steel is used where greater strength and rigidity is required, such as frames which act as attachments for the mainplane or beams to support engines, nuts and bolts, parts of the undercarriage and in some cases to reinforce skin surfaces or the mainplane on high speed aircraft and control cables in light aircraft.
- 8C2.50** While stainless steel is not likely to be affected by the heat of a crash fire situation, it will conduct heat to other combustible materials and will retain its heat for some time. Stainless steel begins to melt at approximately 1450°C and in order to ignite it needs a sustained temperature of 2000°C.

**8C2.51** After the bulk of the fire has been suppressed with normal firefighting media, cooling with a water spray will be needed to reduce the temperature of the steel.

## Cabin furnishing materials

**8C2.52** Over the years a number of incidents involving internal fire situations have occurred throughout the world. Although some were technically survivable, many people lost their lives from asphyxiation due to the toxic substances given off from the materials used in the cabin furnishings.

Material Used	Uses	Toxic Gases
Wool	Seats, curtains and carpets	Cyanide Ammonia Nitrogen Dioxide
Silk	Headcloth and curtains	Cyanide Ammonia
Nylon	Seats, curtains and carpets	Cyanide Ammonia
Acrylics	Glazing	Cyanide
Urethanes	Seating and insulation	Cyanide Ammonia Nitrogen Dioxide
Melamine	Decorative laminates	Cyanide Ammonia
Polyvinyl Chloride (PVC)	Wiring, insulation, panelling and trim	Nitrogen Dioxide Hydrogen Chloride Carbon Dioxide Carbon Monoxide Halogen Acids
Polystyrene	Insulation	Benzene
Rubber	Wiring systems	Sulphur Dioxide Hydrogen Sulphide
Acrylonitrile-butadiene-styrene (ABS)	Window surrounds, seating and panelling	Cyanide

- 8C2.53** Post mortem examinations reveal the majority of deaths were due to poisoning with high concentrations of carbon monoxide and to a lesser degree hydrogen cyanide.
- 8C2.54** The furnishings used inside an aircraft cabin are mostly synthetic and when involved in fire will readily give off dense smoke and toxic vapour. During combustion they will generate high temperatures within the cabin.
- 8C2.55** All of these substances have relatively low melting points and will give off vapours freely. The vapours given off will not only affect the respiratory system but also considerably reduce visibility. In turn this will make both passenger evacuation and firefighting difficult.

## Aircraft electrical systems

**8C2.56** As aircraft fly higher, faster and grow larger, the services that the power supply has to satisfy also grow more complex. In civil aircraft this means more power to the galley units, environmental control and passenger entertainment systems, while military aircraft require more power sensors and weapon systems. Both have increased power demands for actuators, lighting systems, avionics and heating.

**8C2.57** There are several different power sources on aircraft to power the aircraft electrical systems. These power sources include:

- batteries – both lead acid and alkaline batteries are used
- engine driven generators which provide the main power for the aircraft systems in flight
- Auxiliary power units (APU) which provide essential power for the aircraft systems when the aircraft is on the stand

**Picture 9: Battery**



Source WSFRS

**Picture 10: Engine**



Source WSFRS

**Picture 11: APU**



Source WSFRS

- Fixed electrical ground power (FEGP) which is used in lieu of the auxiliary power unit to supply electricity for the essential power requirements of the aircraft whilst on the stand
- Ram Air Turbines (RAT) used on both civil and military aircraft used to supply electrical capacity whilst in flight, RATs are only deployed if the aircraft electrical systems fail, however if working under the fuselage at an incident these units could drop down unexpectedly if there is a loss of hydraulic pressure, causing a potential hazard.



Source WSFRS

**Pictures 13 and 14: RAT on Tornado F3 RAT and on a 737 passenger aircraft**



Source MOD & WSFRS

**8C2.58** The primary function of an aircraft electrical system is to generate, regulate and distribute electrical power throughout the aircraft. The aircraft electrical power system is used to operate:

- aircraft flight instruments
- essential systems such as anti-icing etc (essential power is power that the aircraft needs to be able to continue safe operation)
- passenger services (passenger services power is the power that is used for cabin lighting, operation of entertainment systems and preparation of food)
- ignition systems in light aircraft.

**8C2.59** Aircraft electrical components operate on many different voltages both AC and DC. However, most of the aircraft systems use 115 volts (V) AC at 400 hertz (Hz) or 28 volts DC. 26 volts AC is also used in some aircraft for lighting purposes.

**8C2.60** When isolating the batteries, the method of disconnecting the supply from aircraft batteries is as follows:

- most aircraft have a battery isolation switch, this isolates the battery from nearly all electrical circuits but some emergency services such as the fire extinguishing systems, may not be isolated
- manual disconnecting of the terminals from the batteries is recommended where possible.

**8C2.61** To save environmental impact of auxiliary power units, aircraft parked on the apron of an airport often receive their electrical supply from a fixed electrical ground power. Therefore it is pointless to use battery isolation switches while an aircraft remains connected to an external power supply.

**Picture 15: Fixed ground auxiliary power unit connected to the electrical intake of a civil aircraft**



Source Ron Puttock GFS

## Aircraft defence suites

- 8C2.62** A new development in civil passenger carrying aircraft is the introduction of aircraft defence suites, this applies to both fixed and rotary wing aircraft.
- 8C2.63** Although information on which aircraft have these systems is vague, it is widely believed that some passenger airlines operating out of the Middle East and some privately owned aircraft may be fitted with military style aircraft defence suites.
- 8C2.64** These will comprise of chaff and flair dispensers, which is covered in more detail in the military section of this operational guidance.
- 8C2.65** The probability of Fire and Rescue Service personnel having to deal with this risk at an aircraft incident involving passenger or private civil aircraft within the UK is minimal.

**Picture 16: Helicopter deploying countermeasure flares**



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## PART C-3

# Aircraft engines

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## Introduction

**8C3.1** This section will look at the different engine types used to power aircraft and hazards associated with these. Principally there are two types of power units associated with aircraft, both are internal combustion engines. The two types are:

- piston engines
- gas turbine engines.

## Piston engines

**8C3.2** Piston engines come in a variety of sizes, designs, and can be two stroke or four stroke in operation. Piston engines are now used primarily on general aviation (GA) (aircraft below 5700kg), although there are a small number of military and vintage aircraft fitted with piston engines.

**Picture 1: Typical piston engine on a light aircraft with a fire resisting bulkhead separating the engine compartment from the cockpit**



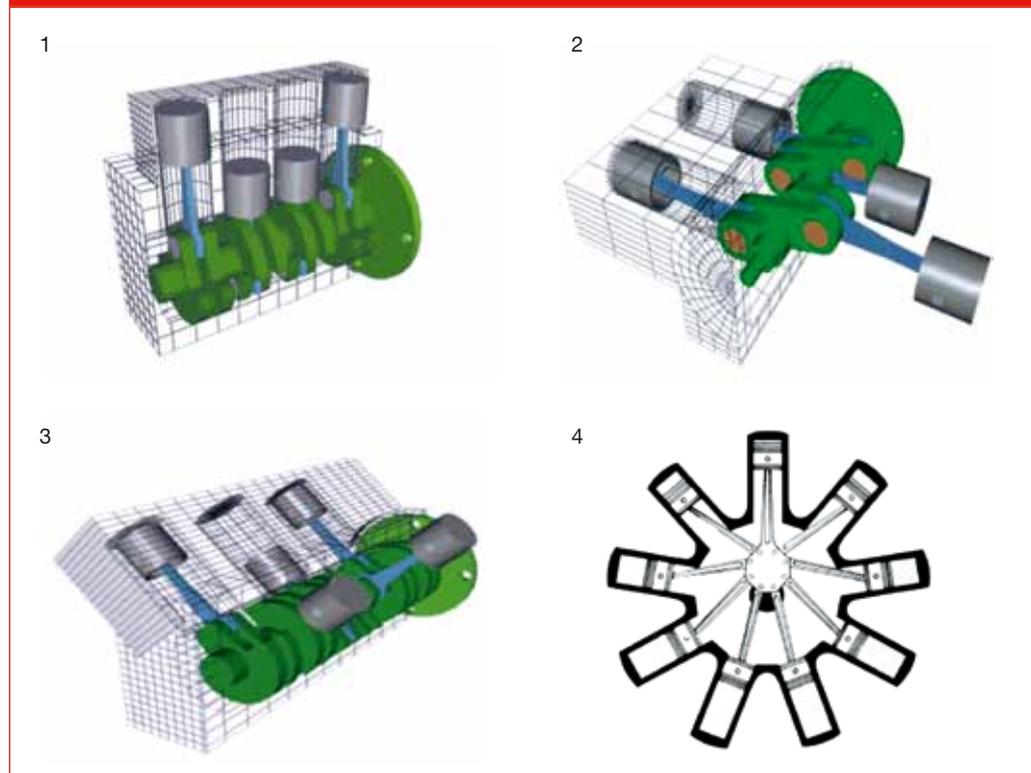
Source WSFRS

## Types of piston engine

**8C3.3** The engines generally will incorporate two, four or six cylinders, although there are vintage aircraft in use that incorporate a larger number of cylinders. In piston engines, the linear motion of pistons is turned into reciprocating motion via a crankshaft. The crankshaft is used to drive a propeller directly, or through a gearbox. Piston engines can be designed with the pistons in line or radially mounted. The piston cylinders are most often installed horizontally opposed, but can also be installed in a 'v' layout. See diagrams below.

1. In-line
2. Horizontally opposed
3. V-type
4. Radial

**Pictures 2, 3, 4 and 5: Piston engine types**



Source BAA AFS

**8C3.4** Piston engines follow the standard induction, compression, ignition, exhaust cycle. Put simply, fuel mixture is drawn in as the piston descends in the cylinder and is then compressed as the piston moves up the cylinder. Just before it reaches the top, it is ignited, pushing the piston back down the cylinder where it is then exhausted to atmosphere.

- 8C3.5** Piston engines use Avgas or Mogas fuel, which due to its low flashpoint is a primary hazard; it is easily ignited as a consequence of an accident or through post-crash activities. Broken fuel or oil lines, especially if they are close to exhausts, or damaged electrical wiring are the most likely cause of fires in this type of engine.
- 8C3.6** Spinning propellers and hot engine parts will also produce hazards for responding Fire and Rescue Service.
- 8C3.7** Aircraft with piston engines will be designed with a fire resisting bulkhead which separates the engine from the adjoining parts of the aircraft. Provided that the fire has not penetrated the fire resistant bulkhead, fires can ordinarily be extinguished using CO<sub>2</sub>, water fog or dry powder.
- 8C3.8** Piston engines will generally utilise magneto ignition systems which do not require battery power for operation. In post-accident situations, rotating the propeller, even by small amounts, can result in electrical impulses being generated with subsequent risks of electrical shock, engine starting/turning over or a fire situation occurring due to the resultant spark.

**Caution**

Disconnecting the battery does not prevent the magneto from functioning therefore extreme caution must be exercised at all times when working around the propeller.

The safety zone should be established around engines keeping or personnel clear of engines.

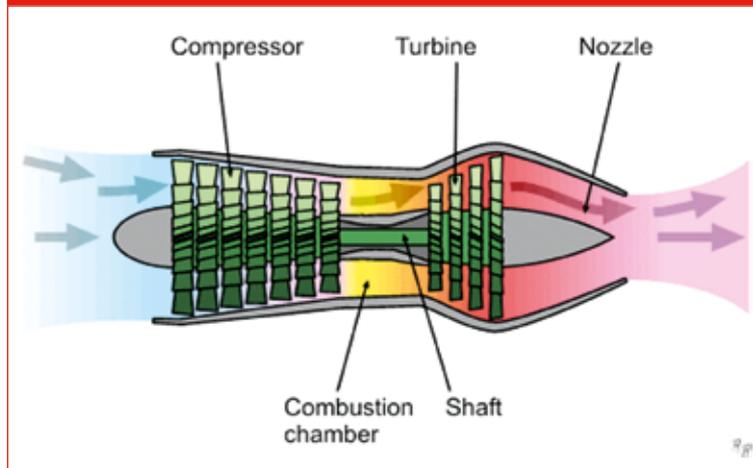
## Gas turbine engines

- 8C3.9** There are four main types:
- turbojet
  - turbofan
  - turboprop
  - turboshaft.
- 8C3.10** Gas turbine engines operate on the same principles as a four stroke engine, but the four processes (of induction, compression, ignition and exhaust) take place in distinct sections of the engine, simultaneously.
- 8C3.11** The energy created by gas turbine engines can be used to provide thrust directly through the use of exhaust gases (turbojet/turbofan), or it can be used to drive turbines within the engine which in turn drives the shafts to operate the propellers (as in turboprop), gearboxes (turboshaft), rotors, etc.
- 8C3.12** Gas turbine engines use jet fuel commonly referred to as Jet A1 (Avtur).

## Turbojet engines

- 8C3.13** Turbojet engines are the forerunner of the more modern turbofan engines; they are no longer in general use in the commercial sector. However, they are still used on older military aircraft such as the VC10 and can be found on vintage jet aircraft.
- 8C3.14** They consist of an air inlet, an air compressor, a combustion chamber, a gas turbine (that drives the air compressor) and a nozzle. The air is compressed into the chamber, heated and expanded by the fuel combustion and then allowed to expand out from the turbine into the nozzle where it is accelerated to high speed to provide propulsion. The engine extracts only sufficient energy from the gas stream to drive the compressor, leaving the remaining energy to drive the thrust.

**Picture 6: Axial flow turbojet engine, the working fluid principally flows parallel to the axis of rotation**



Source BAA AFS

**Picture 7: Turbojet engine on a VC10**

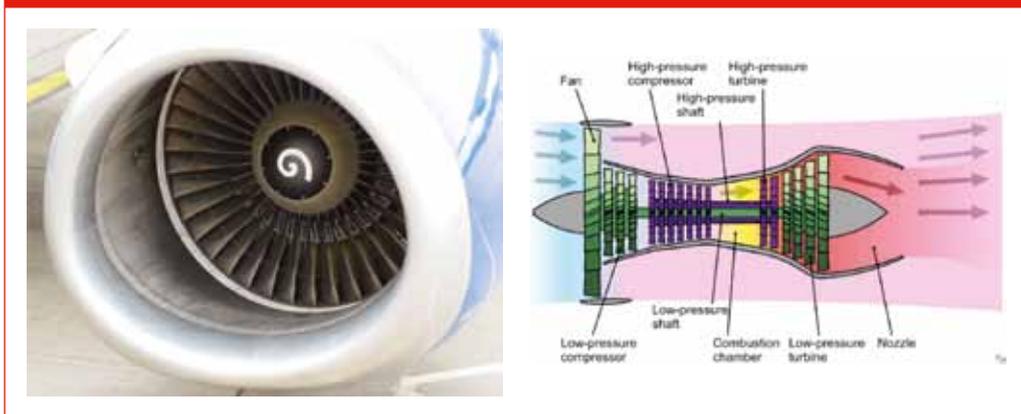


Source MOD Crown Copyright

## Turbofan engine

- 8C3.15** Turbofan engines are the most commonly found jet engines on aircraft today, especially large civil and military aircraft. They contain a large fan at the front of the engine, which the turbojet does not have.
- 8C3.16** The fan helps increase the engine's thrust by increasing the total airflow of the engine; this makes the engine one of the most efficient.

**Pictures 8 and 9: Fan at the front of a modern turbofan engine**

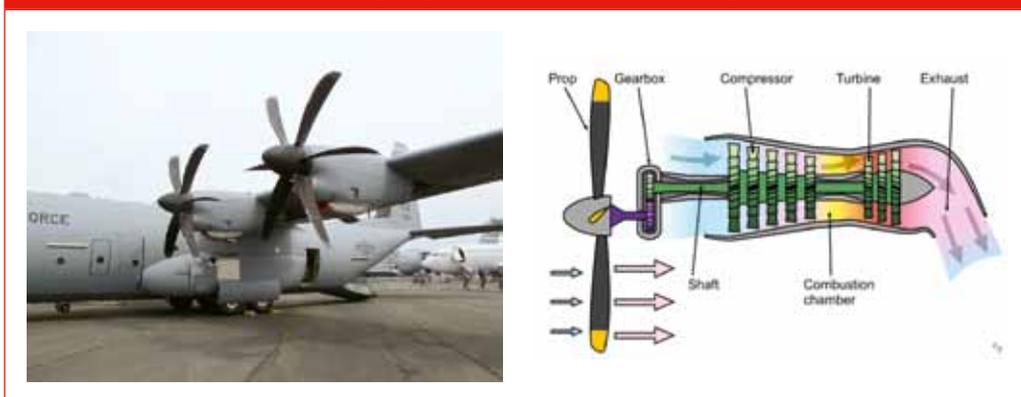


Source Ron Puttock GFS

## Turboprop engine

- 8C3.17** The turboprop engine is widely used in small and medium sized passenger, general aviation and cargo aircraft. Instead of the fan previously discussed, the turboprop consists of a propeller that is driven by a small turbojet engine. This type of engine can be found on some passenger aircraft operating out of principal airports around the country today and on the newest military transporters aircraft.

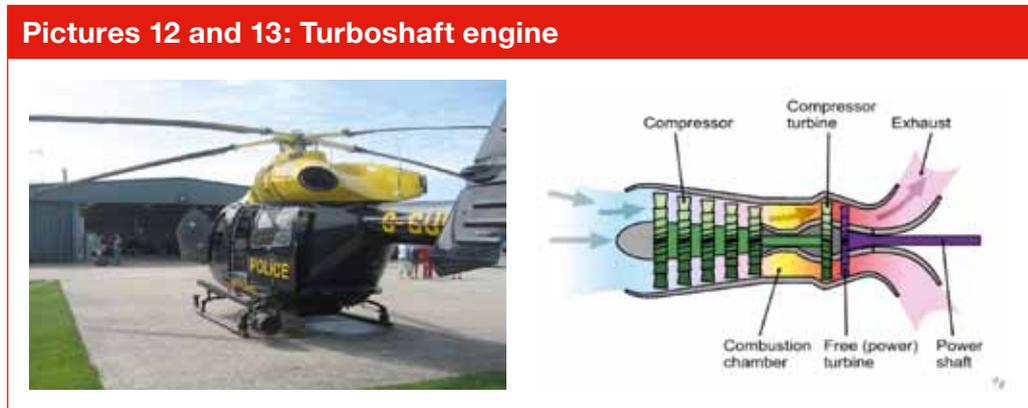
**Pictures 10 and 11: Turboprops on a military transport aircraft**



Source WSFRS

## Turboshaft engine

**8C3.18** Turboshaft engines are most commonly found in helicopters. The principle is essentially the same as the turboprop however the output shaft is not connected to a propeller but instead to the power turbines. It is connected either directly or through a gearbox, to a shaft that drives the helicopter's main and tail rotors.



Source BAA AFS

## Jet engine hazards

**8C3.19** The majority of fires that are associated with aircraft engines will usually be associated with the accessory section of an engine. This accessory section contains the following components:

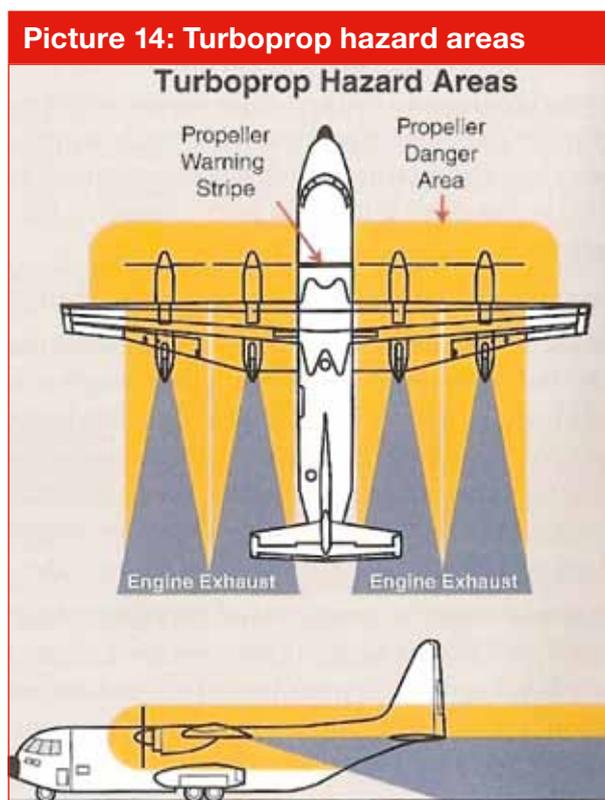
- fuel pumps
- fuel lines
- hydraulic pumps
- hydraulic lines
- oil pumps
- oil lines
- gearbox (if turboprop or turboshaft)
- electrical generators
- propellers.

**8C3.20** If any of the fuel pumps or fuel lines leak, the fuel or lubricants may be released in mist form which will be easily ignitable. A number of these systems will have fluids under high pressure e.g. hydraulic lines.

## Engine hazards

**8C3.21** All aircraft engines are noisy and hearing protection is required. Noise generated is significantly different due to the nature of each engine type. Gas turbine engines are often much larger than piston engines, and can produce higher noise levels.

- 8C3.22** Any aircraft with propellers presents a significant hazard to Fire and Rescue Service personnel responding to an aircraft incident. Propeller strikes will cause fatal injuries and therefore whether propellers are turning or stationary they should be cordoned off and all responding emergency services kept clear.
- 8C3.23** The turning of a propeller (even a very small movement) can, as previously mentioned, generate fuel to be pumped through the fuel supply lines and ignition sparks can cause the engine to start or turnover.
- 8C3.24** Propellers are to be left alone and not touched, cordoned off and treated as a hazard throughout the incident.
- 8C3.25** In general, the exhaust gas hazard area is dependent on the size of the aircraft.
- 8C3.26** Jet engine exhaust gases are superheated and can reach velocities of over 800mph. Gas turbine engine exhausts produce high temperatures and high velocity airflows. The exhaust from some turbine engines is capable of moving large objects or overturning vehicles where these are too close to exhaust systems.
- 8C3.27** The intake of air and resulting suction generated by running jet engines is sufficient to draw personnel into the engine. The picture below shows the force of this suction.



Source IFSTA USA

**Picture 15: Cargo container drawn into engine demonstrating the power of engine suction**

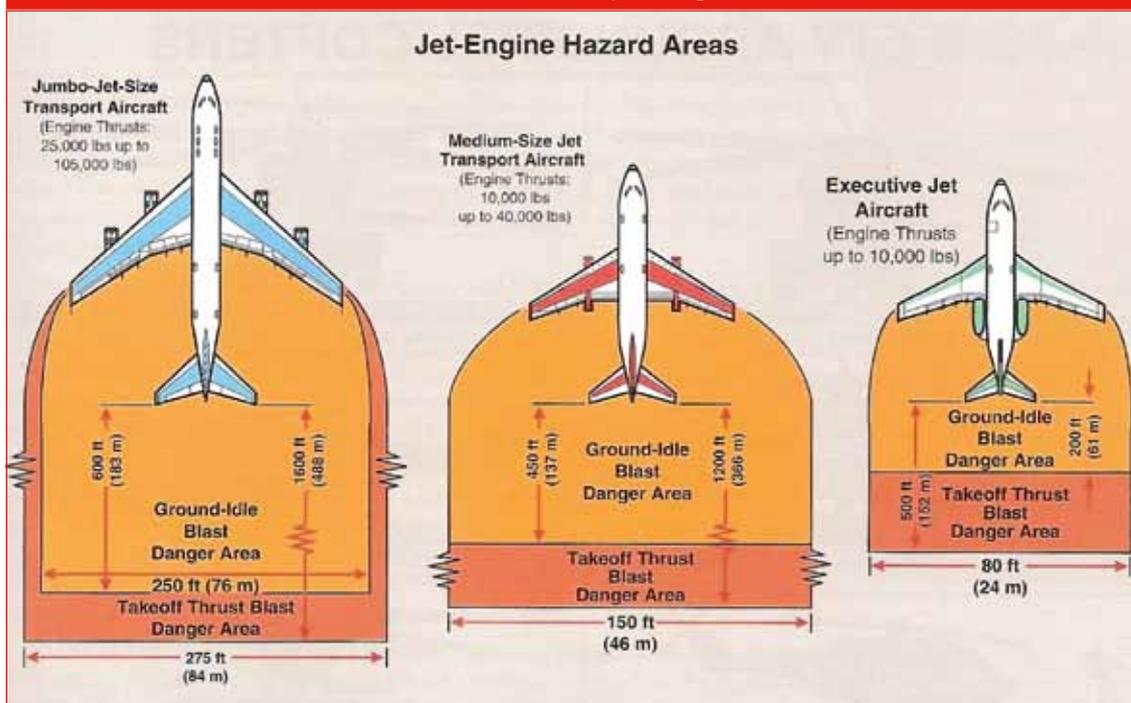


Source Bournemouth AFS

**8C3.28** To minimise the risk of personnel from being drawn into the engines or being injured as a result of a propeller strike, personnel must not approach the front of any engine that is running or could possibly be running. With modern aircraft the recommended safety distance will be a minimum of 10m away from the front and sides of any engine. In addition the exhaust gas hazard area will vary depending upon the size of aircraft.

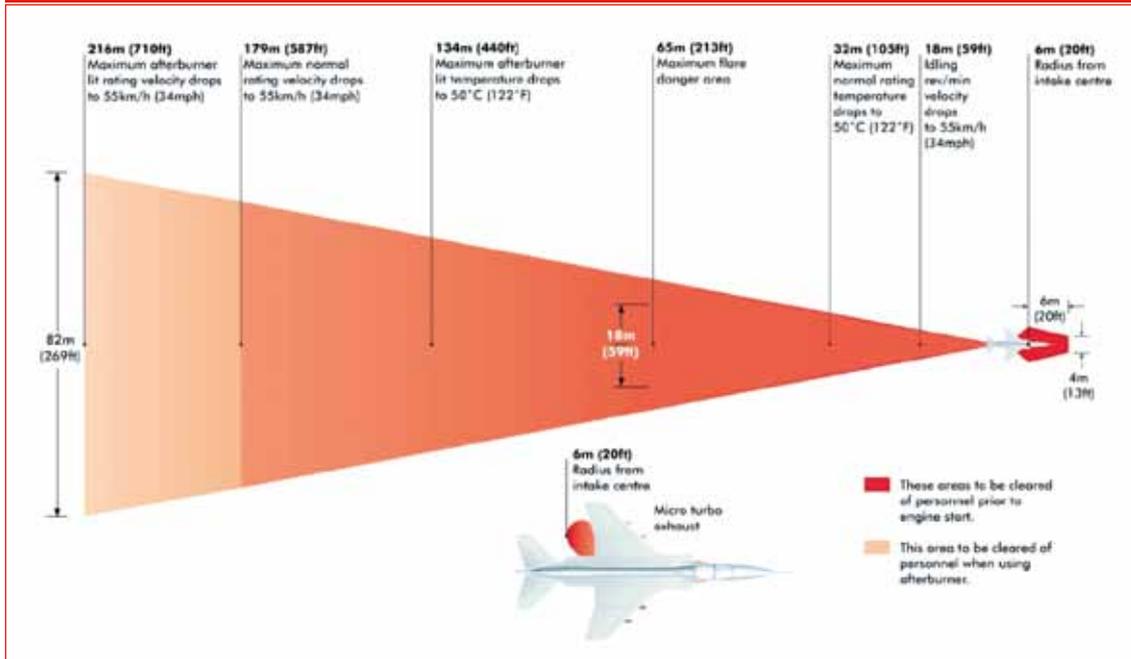
**8C3.29** The diagram below denotes the hazard areas and distances to be observed.

**Picture 16: Hazard areas associated with jet engines**



Source IFSTA USA

**Picture 17: Engine danger areas associated with military aircraft**



Source MOD Crown Copyright

### Caution

After an accident a jet engine may continue to run.

Even after shutdown engines retain sufficient heat to ignite flammable materials for up to 20 minutes after shutdown.

**8C3.30** When possible cordon off areas around engines and establish a safety zone.

## Auxiliary power unit

**8C3.31** An auxiliary power unit is a turbine engine on an aircraft, which is to provide energy for functions other than propulsion.

**8C3.32** The primary purpose of an aircraft auxiliary power unit is to provide the aircraft with power when the main engines are not operating, for example:

- to operate the aircraft electrical system
- to operate the aircraft pneumatic power
- to operate heating systems
- to operate ventilation/air-conditioning systems.

**8C3.33** The location of the auxiliary power unit is primarily in the tail of the aircraft with a rear exhaust and an access panel underneath, however location of the auxiliary power unit can vary.

**Pictures 18 and 19: Auxiliary power unit exhaust port and auxiliary power unit viewed through an open inspection panel**



Source Ron Puttock GFS

## PART C-4

# Aircraft fuel, fuel tanks and aircraft systems

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## Introduction

- 8C4.1** This chapter will discuss aircraft fuel and fuel tanks. Like any type of transportation incident fuel will play a significant part in the hazard management of the incident. The factors that make aircraft incidents slightly more complicated than other transportation incidents, is the volume of fuel that could be involved (e.g. the Airbus A380 has a fuel loading of 324,000 litres) and the different properties of that fuel.
- 8C4.2** An analogy of passenger aircrafts has been to describe them as:
- 'A cinema sandwiched between two petrol stations'*
- 8C4.3** It is very important that incident commanders and responding personnel have an understanding of the different aircraft fuels that they may encounter dependant on type of aircraft, and to understand the hazards that these fuels may present.
- 8C4.4** All aviation fuels are flammable, corrosive, irritant, toxic and will contaminate other materials, however their properties do differ.

## Aviation fuel

- 8C4.5** There are two generic types of fuel used in aviation generally defined as gasoline (petrol) and kerosene.

## Avgas

- 8C4.6** Piston engine aircraft normally use Avgas (Aviation gasoline) but can also use Avtur. Avgas is classified as:
- 100LL is the main grade sold in the UK
  - other grades of Avgas are available
  - the figure 100 relates to the octane rating of the fuel and the LL denotes low lead.
- 8C4.7** As a result of its high vapour pressure (40kPa) and low flash point, Avgas vapour can be readily ignited with a spark or flame at ambient temperatures. However, liquid Avgas must reach a moderately high temperature before it can auto ignite (450°C).

## Avtur (Jet A1)

- 8C4.8** Jet A1 or Avtur is the most widely and commonly used kerosene fuel. Liquid Avtur will not ignite under normal temperature. As a result of its low vapour pressure (1kPa) and moderate flash point, Jet A1 vapour cannot be readily ignited by spark or flame at ambient temperature. Jet A1 liquid will auto ignite at a fairly high temperature (245°C).
- 8C4.9** The military designation for turbine fuel is AvTur (AViation TURbine Fuel). North Atlantic Treaty Organization (NATO) codes F-34 or F-35 are also used. In the UK this is supplied as Jet A1 with anti-icing additive or Jet A1.

## Avtag (Jet B)

- 8C4.10** Some naval and foreign civil aircraft use Avtag (AViation Turbine Gasoline, NATO F-40, and sometimes called Jet-B) which is naphtha rich kerosene.
- 8C4.11** Avtag is a wide cut fuel of approximately 60 per cent Gasoline and 40 per cent Kerosene. Avtag has some of the characteristics of each of these fuels. It has a moderate vapour pressure (17kPa) and low flash point (<0°C) which means vapours can be readily ignited by a spark or flame at ambient temperatures. Avtag has an auto ignition temperature similar to Jet A1 (250°C).

Physical properties of fuel			Limits of flammability	Rate of flame spread m/min
Fuel	Flash point	Auto ignition temp		
Avgas	-40°C	450°C	1.4 % to 7.6%	215-245m
Avtur (JET A1)	38°C	245°C	0.7% to 5.8%	30m
Avtag (JET B)	-23°C	250°C	0.8% to 5.0%	215-245m

## Avcat

- 8C4.12** Avcat is a military-unique fuel because it has a flash point substantially higher than commercial aviation turbine fuels. It is stored in large quantities on aircraft carriers and other vessels. The high flash point of this fuel is designed for increased safety in these military-unique applications/locations. It is only found on Royal Navy aircraft.

## Mogas

- 8C4.13** Some aircraft manufacturers recommend the use of Mogas (motor gasoline, petrol) in certain light aircraft. Regular unleaded gasoline is approved for use if it complies with standard fuel specification limits and requirements.
- 8C4.14** A mixture of Mogas and Avgas may be used in the same fuel tank. If a mixture contains 25 per cent or greater by quantity of Mogas then the aircraft is considered to be using Mogas.
- 8C4.15** General principles:
- fuels are lighter than water
  - fuels are less viscous than water
  - fuels are not miscible with water
  - fuel vapours are more than twice as heavy as air.

## Military fuels

- 8C4.16** Military aircraft will generally use conventional fuel (Jet A1) or in the case of Royal Navy, Avcat. Military fuels may be given certain additives to give them better performance for high altitude flight but fundamentally, a hazard to firefighters at a crash site is the same hazard that will be presented at a civil aviation incident.
- 8C4.17** Previous guidance mentioned hydrazine (H-70) which is a specialist fuel found only in the F-16 fighter aircraft used by NATO allies. The amount of hydrazine that is carried on the F-16 is small (approximately 20L) and is used to fuel the emergency power unit (EPU), which is a gas turbine used to power the emergency electrical generator and emergency hydraulic pump.
- 8C4.18** The probability of coming into contact with hydrazine is very small however specialist advice will need to be sought in dealing with this chemical should an F-16 crash in the United Kingdom.

## Avpin

- 8C4.19** Avpin (isopropyl nitrate) is a military fuel that is no longer generally used or produced in the UK due to its unstable properties. However foreign visiting forces may still be utilising this fuel type and therefore it is worth mentioning in this chapter.
- 8C4.20** Avpin is a mono fuel which means it will continue to burn without an air supply due to its molecules containing oxygen. It is used in liquid engine starter systems. The average quantities carried do not normally exceed 14 litres.

**8C4.21** The physical properties of Avpin are:

- flash point 10°C
- highly volatile
- vapour is 3.5 times heavier than air
- it is not miscible with water
- it has a wide range of flammability 2 to 53 per cent by volume with air
- the escape of a small quantity of vapour can create a flammable mixture.

## Comparative fire hazards of aviation fuels

### Avgas

**8C4.22** As a result of its low flash point Avgas can be readily ignited with a spark or flame at normal temperatures. However, it must reach a high temperature before it can auto ignite.

### Jet A1

**8C4.23** As a result of its high flash point Jet A1 cannot be readily ignited by spark or flame at normal temperature, it will however, auto ignite at comparatively low temperatures.

### Jet B

**8C4.24** Jet B is a mixture of kerosene and gasoline and therefore has some of the characteristics of each of these fuels. It has a low flash point which means it can be readily ignited by a spark or flame at normal temperatures, and its low auto ignition temperature means it can be readily ignited when in contact with hot metals etc.



Source WSFRS

**8C4.25** All aviation fuels are corrosive, irritant, toxic and will contaminate other materials.

## General features of burning aviation fuels

**8C4.26** When the vapour given off from aviation fuels is mixed with air and then ignited, a flame zone develops above the surface of the fuel.

**8C4.27** As the temperature rises the rate of vaporisation increases.

**8C4.28** The development of a flame zone and the rate of vaporisation accelerate each other. Therefore, an aviation fuel fire reaches peak intensity very rapidly.

**8C4.29** Aviation fuel fires develop intense heat when burning, due to the high calorific value which is more than twice that of common combustible materials such as timber and textiles.

## The magnitude of aviation fuel fires

**8C4.30** The surface area of fuel exposed to the atmosphere will determine the size of an aviation fuel fire.

**8C4.31** Factors which govern the surface area of the fuel available for burning are:

- escaping fuel which is not being retained within the airframe
- fuel escaping into open air where it can spread freely
- escaping fuel which is being spread by movement of the aircraft
- fuel escaping after the aircraft has come to rest.

**8C4.32** The condition and contour of the ground may also have a bearing on the surface area if the fuel has:

- soaked into the ground
- formed into pools which may vary in size and depth
- formed into streams which may be running in a particular direction.

## Fuel tanks

**8C4.33** Fuel is carried in a number of structurally separate but interconnected tanks and can be found in the wings, fuselage and the tailplane of an aircraft. Low pressure pipe work, usually light alloy pipes ranging from 25mm to 100mm, run throughout the airframe for the following purposes:

- delivery of fuel to the aircraft engines
- transfer of fuel between tanks
- fuelling and de fuelling the tanks

- venting the tanks
- jettisoning fuel from the tanks.

**8C4.34** The fuel pipe work in an aircraft is concentrated in the wings and centre section. However fuel pipe work may extend to the rear of the aircraft to supply the auxiliary power unit and to service optional fuel tanks that may be located in the tail. The routing of fuel lines are a key consideration whilst undertaking rescue operations within the fuselage.

**8C4.35** Generally speaking there are no fuel pipelines forward of the centre section of a commercial aircraft. However in general aviation aircraft and some military aircraft fuel lines may run forward depending on the location of the aircraft engine, and/or in flight re-fuelling capabilities (military).

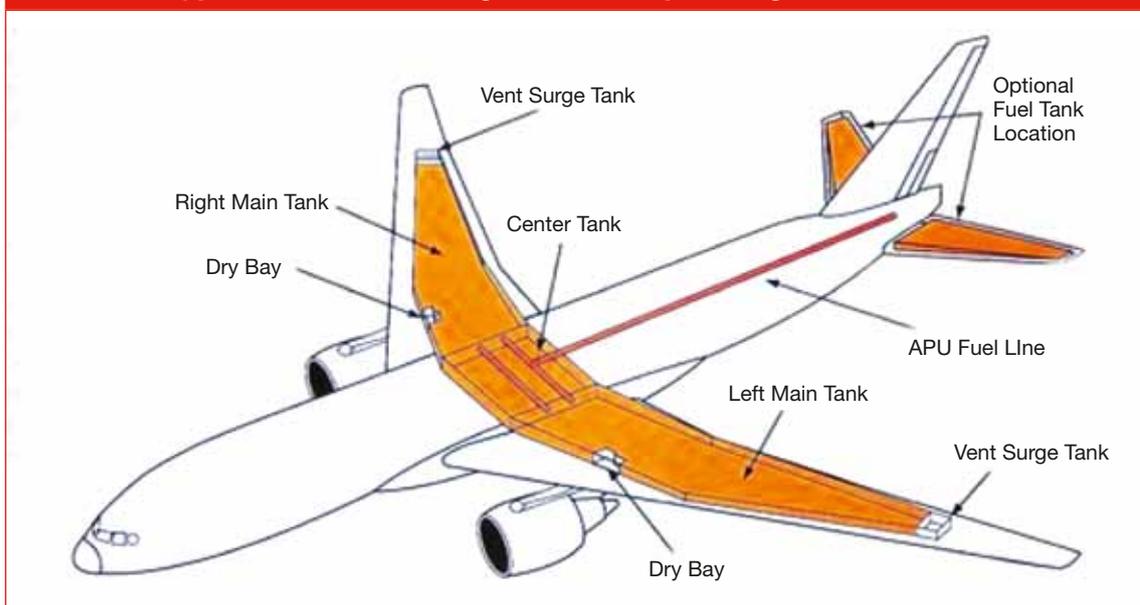
## Principal types of fuel tanks

### Rigid tanks

**8C4.36** These are usually constructed from sheet aluminium with internal baffles. The baffles reduce surge and help to strengthen the tank. They are often covered with fabric, and have a vent pipe, an overflow, a base sump and a fuelling orifice.

**8C4.37** These tanks are usually set in cradles within the wings or fuselage and are strapped in and bonded to the aircraft to prevent the formation of static electricity.

**Picture 2: Typical fuel tank configuration in a passenger aircraft**



Source IFSTA USA

## Integral tanks

- 8C4.38** Integral tanks use the aircraft airframe compartments for storing fuel. These are invariably found in the wings but may additionally be located in the fuselage and tailplane area. The use of the aircraft's airframe produces the lightest of fuel tanks and the most commonly used in the larger contemporary passenger carrying aircraft.
- 8C4.39** Any aircraft accident can readily distort or damage such tanks, or split joints with a consequential release of fuel.

## Flexible tanks

- 8C4.40** These tanks are flexible bags made of plastic, nylon or neoprene rubber or other man made material, which are fitted into the wings or the fuselage and secured by press-studs.
- 8C4.41** These tanks have the advantage of being very resistant to shock and may not suffer damage in an accident unless they are cut on jagged metal surfaces.
- 8C4.42** However, because of their construction materials, they are flammable and give off toxic vapour when burning.

## Auxiliary tanks

- 8C4.43** Many aircraft can be fitted with extra fuel tanks and generally these will be found in/under the fuselage, under wing or at the wingtips.
- 8C4.44** Military aircraft wingtip fuel tanks are usually made of fibreglass or similar composite lightweight fabrication and in some cases asbestos. Larger tanks are likely to be made of aluminium using the stressed skin construction similar to the fuselage and are capable of supersonic flight.
- 8C4.45** The normal procedure when flying is to use the fuel in these tanks first so that should any emergency arise these tanks (empty) can be jettisoned as an emergency procedure.

## Aircraft systems – lubricating oils

- 8C4.46** Lubricating oils used in aircraft are:
- lighter than water
  - more viscous than water
  - less volatile than fuels
  - have high flash points (210°C – 250°C)
  - have low auto ignition temperatures (250°C – 350°C).

**8C4.47** There is normally little risk of ignition while the oils are cool. It should be noted that these oils are often under high pressure and high temperature when in use and either of these conditions increases the risk of ignition.

## Hydraulic fluids

**8C4.48** Modern hydraulic fluids are generally fire resistant and will not present a fire hazard under normal circumstances. However when these fluids are escaping from a pressurised container and atomised, the fine mist spray can be easily ignited. Care should be taken to avoid hydraulic fluids escaping under pressure, as they can be injected into exposed skin.

## Liquid oxygen

**8C4.49** The main oxygen supply for occupants of an aircraft may either be supplied by:

- Compressed Oxygen System
- Liquid Oxygen System (LOX).

**8C4.50** Compressed Oxygen System: This is supplied from a number of cylinders containing gaseous oxygen. The capacities of the cylinders differ from military to civil aircraft and can be located in a number of different positions within the fuselage.

**8C4.51** Liquid Oxygen System: A LOX system is supplied from one or more LOX converters. These are spherical or cylindrical insulated containers with evaporating coils and valves to regulate the rate of evaporation of the liquid according to demand. The converters are designed to deliver gaseous oxygen through a pressure controlled valve.

## Alcohols

**8C4.52** The principal use of alcohols in aircraft is as follows:

- methyl alcohol is mixed with water to form water methanol, which is injected into engines to improve their performance in normal mixture of 40 per cent of melting alcohol and 60 per cent water; the total quantity of the mixture in an aircraft is usually between 270Ltrs and 680Ltrs
- aircraft de-icing fluid is used for de-icing the airframe and control surfaces, or used as antifreeze for water cooled engines similar to those of car engines.

**8C4.53** With the exception of water methanol and engine antifreeze (used in engine coolant), the quantities of alcohol carried for the above purposes will be no more than a few litres.

## PART C-5

# Incidents involving aircraft undercarriages

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## Introduction

- 8C5.1** Undercarriage incidents are not uncommon and Fire and Rescue Service personnel are likely to face these types of incidents when attending aircraft incidents on airport, with or without the attendance of the Rescue and Fire Fighting Service.
- 8C5.2** Many hazards exist when dealing with undercarriage assemblies and it is therefore imperative that Fire and Rescue Service personnel are familiar with the required tactics and techniques which are needed to manage this type of incident safely.
- 8C5.3** The more familiar personnel are with the underside of an aircraft the less formidable it will look and feel on the day an incident occurs. Therefore, joint training and familiarisation visits with the Rescue and Fire Fighting Service are key to achieving greater awareness and understanding of these types of incidents.

## Undercarriage problems

- 8C5.4** Undercarriage problems can occur for many different reasons and result in a number of different problems for responding Fire and Rescue Service personnel. Below is a list of possible problems and causes however this is not an exhaustive list:
- 8C5.5** Undercarriages can collapse as a result of:
- heavy landing
  - aborted take off
  - spot cooling/thermal shock due to incorrect application of firefighting media
  - structural failure
  - mechanical defect e.g. undercarriage not locking in position
  - effects of internal/external fires, affecting the structural strength of airframe.

**Picture 1: Aircraft landing with one undercarriage collapsed/failed**



Source BAA AFS

**8C5.6** Tyres can burst as a result of:

- heavy landing
- aborted take off
- foreign object damage
- heat transfer from brake assemblies
- tyre failure
- heavy braking.

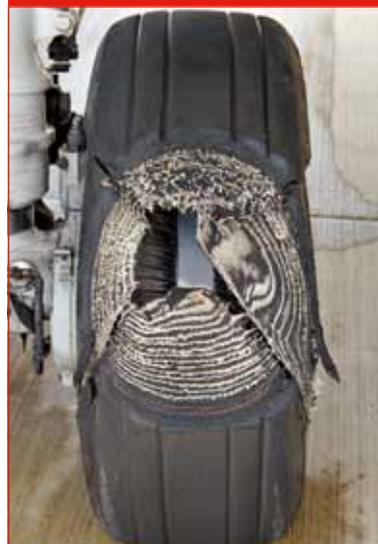
**8C5.7** Hot brake assemblies can result from:

- heavy braking
- defective brake components.

**8C5.8** Full or partial wheels up landing due to:

- loss of undercarriage controls
- failure of undercarriage assembly.

**Picture 2: Burst tyre as a result of heavy braking**



Source BAA AFS

## Hazards

### Positioning personnel and appliances

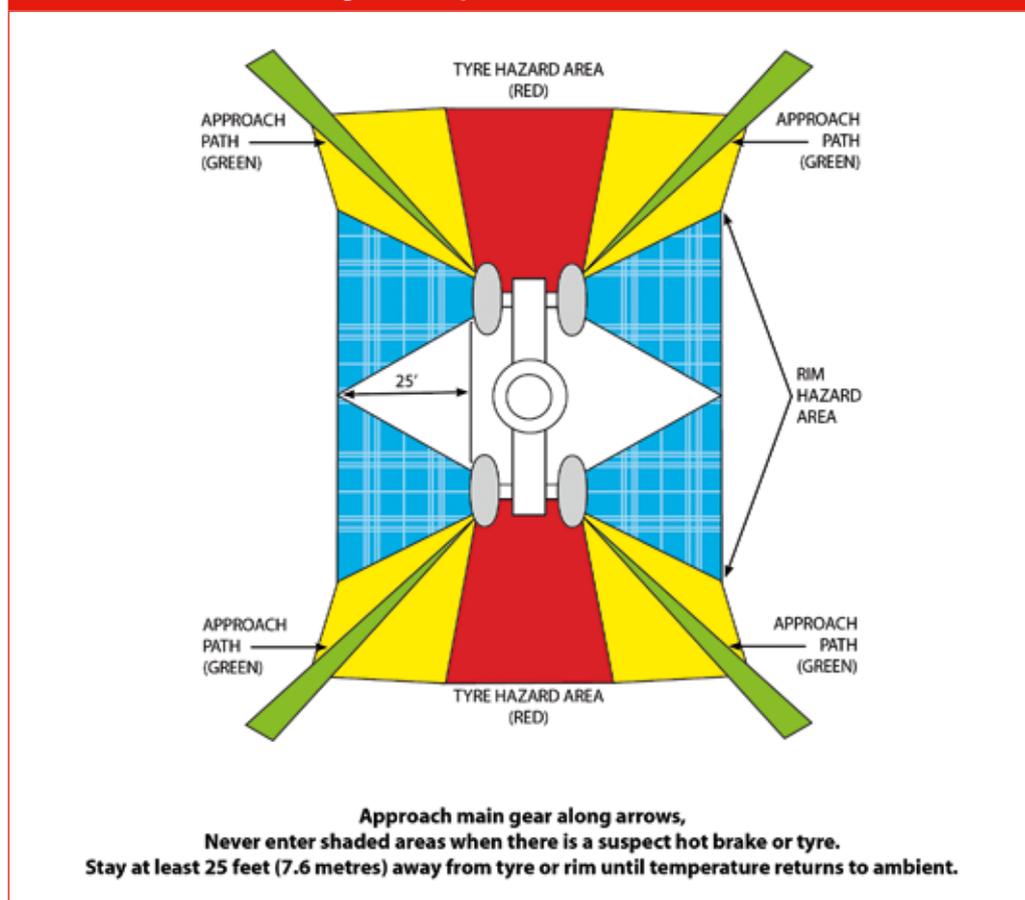
**8C5.9** Due to the serious danger of structural collapse care must be taken when positioning appliances and no Fire and Rescue Service personnel should walk under the fuselage or wings unless they have been directed to undertake a specific task by the Incident Commander.

## Danger zones

**8C5.10** Fire and Rescue Service personnel should be conscious of the particular danger areas at this type of incident where it is necessary for personnel to be deployed underneath the aircraft itself. The main danger areas to be considered are:

- Engines – engine propellers, jet engine air intake and exhaust efflux zones
- Ram air turbine deployment
- Under the fuselage, mainplane or tail – should the undercarriage assembly collapse the aircraft will tend to list downwards on the side of the collapse and may also cause the aircraft to swing in one direction, the nature and amount of movement will vary according to:
  - point of collapse
  - aircraft type
  - weight of aircraft
- Rim disintegration zone – extends outwards at an angle of approximately 45 degrees from the centre of each wheel (see diagram ‘Undercarriage and Tyre Hazard Zones (Boeing)’. It is into this area that the majority of debris caused by wheel/tyre failure will be projected. Debris may also be projected into areas

**Picture 3: Undercarriage and Tyre Hazard Zones**



Source Boeing

fore and aft of the undercarriage. In view of the inherent dangers to personnel the rim disintegration area should be avoided and personnel operating fore and aft of the assembly should do so with extreme caution

- Boeing's latest guidance on the hazard areas associated with rim and tyres are indicated in the diagram below.

## Evacuating passengers and crew

**8C5.11** If not evacuated away from the aircraft, passengers and crew could be vulnerable to injury should the incident develop. The Rescue and Fire Fighting Service will be fully engaged in tackling this type of incident and therefore the responding Fire and Rescue Service can play a key role in assisting with the evacuation of passengers and crew to a designated safe location, up wind and uphill from the aircraft. Many airports have developed passenger evacuation management systems to assist with evacuation (see chapter On Airport incidents for more detail).

## Release of hazardous materials

**8C5.12** Aviation fuel may be released as a consequence of ruptured fuel tanks due to the upward propulsion of tyre fragments, hydraulic oils may be released due to failing undercarriage components. An aspirated foam blanket should initially be laid over any aviation fuel releases, whilst the evacuation, firefighting and rescue operations continue. However the need to maintain the foam blanket after this phase should



Source BAA AFS

be risk assessed. As the foam blanket can create additional hazards and problems in the later phases of the incident (see Air Accidents Investigation Branch guidance for emergency responders at aircraft incidents).

- 8C5.13** The brake dust may also become dispersed in the immediate area of the assembly and therefore respiratory protective equipment should be worn.

## Pressurised systems

- 8C5.14** Fractured hydraulic lines and the sudden release of fusible plugs are a potentially serious hazard to crews employed in close proximity to undercarriage assemblies, which are either involved in fire or which have received accident related damage.
- 8C5.15** Hydraulic systems may release fluids at pressures of up to 200bar and the need for crews to be wearing full protective clothing including visors down is of paramount importance. Releasing fluids at these pressures will result in the liquids atomising into a fine spray, which will easily ignite if given a suitable ignition source.
- 8C5.16** A fusible plug is located on all aircraft wheel assemblies; it is designed to release excessive tyre pressures brought about by over-heated tyres or fire situations. These fusible plugs will rupture at approximately 200°C. Such heat may be generated in either heavy landing/braking or an abandoned take off. The release plugs may blow at any time without prior warning.
- 8C5.17** Some modern aircraft have a capability within the flight deck to monitor pressures and temperature of each individual wheel assembly and therefore liaison with the flight deck crew is highly recommended.
- 8C5.18** This can be achieved by liaison with the Airport Incident Commander who may have the capability to contact the flight deck via VHF radio channel 121.6 if available. If not, contact with the aircraft can be facilitated through air traffic control in order to determine wheel assembly temperatures and to clarify Fire and Rescue Service activity with the flight deck.

**Pictures 5 and 6: Burst tyres**



Source BAA AFS

**Picture 7: Fusible plug**



Source Kieran Merriman BAE Systems

## PART C-6

# Escape slides and access points

## Gaining access

- 8C6.1** Generally aircraft are designed to be evacuated within ninety seconds or less in the event of an emergency. The main cabin door is provided for normal everyday access while service doors are provided for catering and cleaning operations.
- 8C6.2** The cabin doors are the primary means of egress with secondary means consisting of over/under wing hatches, tail-cone jettison systems, rear air-stairs or stairs that lower at the rear of the aircraft, roof hatches and escape windows (flight deck).
- 8C6.3** The aviation industry refers to cabin doors on aircraft by reference to a number and a left or right designator. Left and right being designated as viewed from the pilot seat facing forward. For example, a door may be referred to as R1 or 1 Right, this being the nearest door to the flight deck on the right hand side of the fuselage.
- 8C6.4** **NOTE: the use of port and starboard should no longer be used.**

## Aircraft doors

- 8C6.5** The normal means of entrance into the aircraft will be through a door. The number and position of doors differ greatly between aircraft and operators. Doors may be located on either side or just on one side of the fuselage and are usually simple to operate. All doors have an exterior latch release that disconnects the locking device and permits the door to swing open, pivot open, swing down, or fall free from the aircraft.

**Picture 1: Diagram of door numbering**



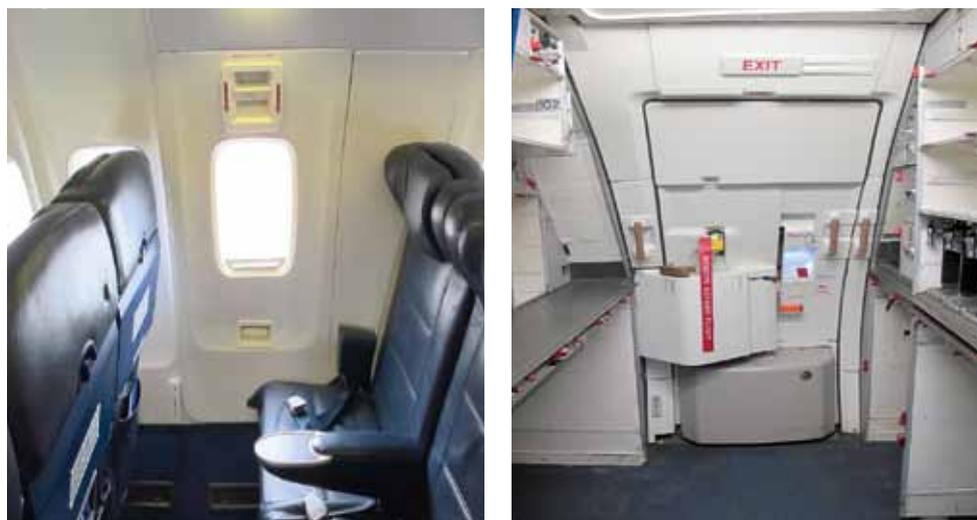
Source WSFRS

**Picture 2: Door opening mechanisms on passenger aircraft**



Source Ron Puttock GFS

**Pictures 3 and 4: Internal view of internal access door and over wing**



Source Ron Puttock GFS

- 8C6.6** Passenger aircraft (and most other aircraft including military) will have operating instructions on/or adjacent to each of the door or hatch mechanisms, see examples below.
- 8C6.7** Depending on the aircraft size and type, the door configurations will vary tremendously and the methodology of opening will also vary. Therefore Fire and Rescue Service personnel should take the opportunity to visit their local airports and take time to review the type of doors they are likely to encounter.

**8C6.8** Personnel should not just concentrate on the operation from outside but should also be familiar with operating systems from the interior of the aircraft, as this may be required should quick egress become necessary during internal firefighting rescue operations.

## Door hinges

**8C6.9** The majority of all doors on commercial aircraft will open outwards and hinge forward. Therefore ladders should be pitched to the side of the door away from the hinges and the doors will need to be opened with great care.

**8C6.10** Smaller general aviation aircraft may have exit doors on both side of the fuselage and others will have them on one side only. Unlike most large aircraft, smaller passenger aircraft have exit doors that are hinged on the bottom, open downwards and have steps built into them. Compressed air pistons or heavy spring tension mechanisms assist the opening of these doors. Firefighters should stay clear of the path of these doors to avoid injury, as they could be opened from the inside with little warning.

**Picture 5: Door hinge on a commercial aircraft**



Source Ron Puttock GFS

**Picture 6: Small passenger aircraft Gatwick**



Source Ron Puttock GFS

## Aircraft slides

**8C6.11** In aircraft that have door sills 2m or more above the ground, it is reasonable to expect that the door will be fitted with an emergency escape slide.

**8C6.12** Two types of slides may be encountered:

- self supporting and inflated by an inert gas such as nitrogen or carbon dioxide
- non inflatable design made of synthetic materials which require support.

**8C6.13** Self supporting slides must be automatically deployable and inflate in approximately six seconds. They must also be self supporting on the ground regardless of landing gear collapse and be usable in winds up to 25kt, with the assistance of only one person.

**8C6.14** The evacuation of an aircraft should be possible in approximately ninety seconds with slides being able to move seventy persons per lane, per minute. In larger aircraft escape slides may have multiple lanes, therefore resulting in large numbers of passengers evacuating simultaneously. It is good practice to task Fire and Rescue Service personnel to the bottom of each slide in use, to assist passengers and prevent congestion which may result in injury to passengers.

**Picture 7: Girt bar at the bottom of a slide assembly**



Source WSFRS

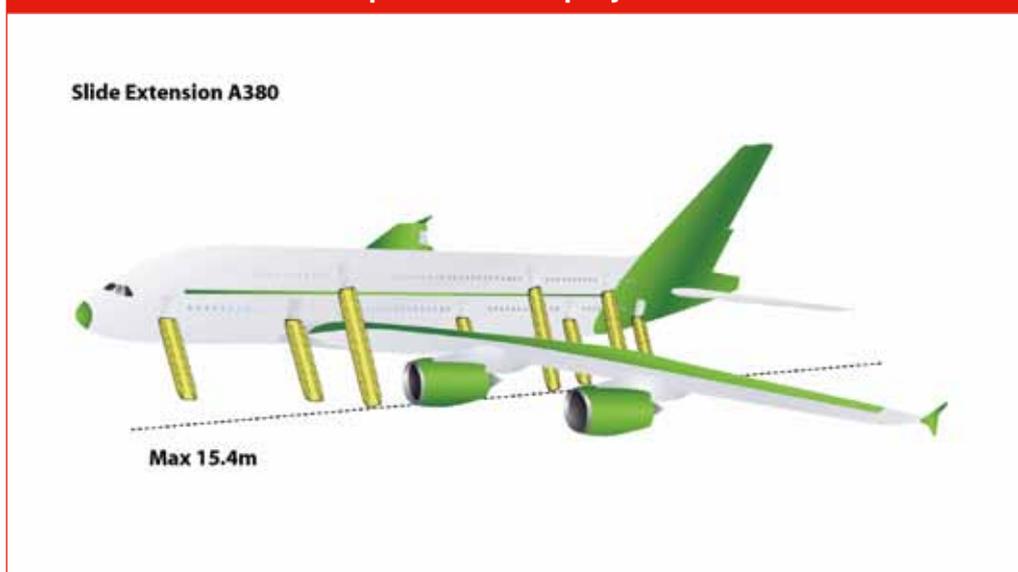
**Picture 8: Girt bar securing clips located on the floor inside the aircraft door**



Source WSFRS

- 8C6.15** Fire and Rescue Service personnel tasked to assist with evacuation slides should keep their visors down (if fitted) as there is a risk of sustaining injury from flailing limbs of evacuating passengers.
- 8C6.16** When the aircraft door is opened from the outside the mechanism should disarm the escape slide actuation system. However Fire and Rescue Service personnel opening doors from the outside should pay particular attention to the risk of the escape slide deploying due to the malfunction of the safety systems or damage to the door received in the aircraft accident.
- 8C6.17** Ladders should be pitched beside the door on the side opposite to the hinges (aft of the door on almost all passenger aircraft with hinged doors).
- 8C6.18** At the bottom of the slide assembly, on the interior of the door is a metal bar referred to as the girt bar when the door is armed this bar is locked into place by two metal fixings on the inside of the door sill.
- 8C6.19** When opening the door from the outside, the door should be cracked open and a visual check carried out to ensure that the girt bar is free from the securing clips inside the door frame.
- 8C6.20** If the girt bar is located within the securing clips the door is still armed and if the door is opened the evacuation slide will deploy.
- 8C6.21** Slides deploy a considerable distance away from the fuselage and therefore great care must be taken when parking appliances or moving on foot around the aircraft.
- 8C6.22** If the slide inflates as a consequence of the door being opened from the outside by responding firefighters; due to the design of the slide it will inflate either side of the door frame and therefore there is a high likelihood of the Fire and Rescue Service ladder being destabilised.

**Picture 9: Distance escape slides can project from an aircraft**



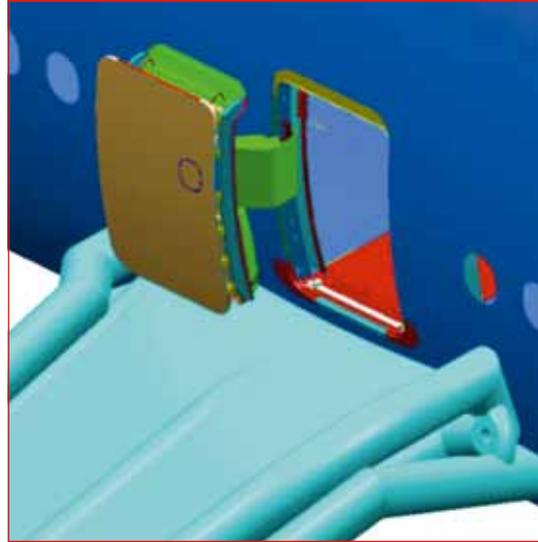
Source Airbus

**8C6.23** Slides can be disconnected from the aircraft and used as rafts in the event of the aircraft ditching in water. The top of the slide has a lanyard which detaches the slide from the aircraft. This facility should be utilised when removing the slide to facilitate firefighting and rescue operations.

**8C6.24** Slides can also be cut or deflated by Fire and Rescue Service personnel to assist access to the aircraft if necessary.

**8C6.25** Familiarisation of this system is best obtained by visiting local airports where slides are tested by engineers on a regular basis (large airports with maintenance facilities).

**Picture 10 Showing that slide inflation could easily destabilise a Fire and Rescue Service ladder**



Source BAA AFS

## Over wing exits

**8C6.26** Over wing exits in most aircraft are of plug type design, meaning that the exit hatches must be pushed inwards from the outside or pulled inwards from the inside. In some older aircraft they may be spring loaded and will open outward and upward.

**8C6.27** On commercial passenger carrying aircraft these hatches are normally located above or below the wing depending on the height of the wing on the fuselage.

**Picture 11: Example of over wing exit hatches on a narrow bodied aircraft**



Source WSFRS

- 8C6.28** Depending on the size and age of the aircraft these hatches may or may not have slides attached.
- 8C6.29** It is not uncommon for these exits to be opened incorrectly by passengers in the event of an emergency, due to a lack of attention to the safety briefs.

#### **Incident**

Ryanair engine fire at Stansted Airport in 2002.

Passengers evacuated themselves onto a burning wing, despite the Rescue and Fire Fighting Service shouting at them to return inside the aircraft and evacuate via a usable exit.

## **Windows**

- 8C6.30** Most large passenger aircraft have a flight deck designed with windows for the pilots to escape in the event of an emergency. These escape windows are on either side of the flight deck and on some aircraft are designed to be opened from both the inside and outside of the aircraft via a small knock-in panel.
- 8C6.31** The windshield of an aircraft is glass which is sandwiched between Plexiglass and may be extremely difficult to break with hand tools.
- 8C6.32** Cabin windows are triple pane in construction, with two of the window panels being held together in a rubber sealing strip and held in place within the window frame by clips. The third pane is part of the interior finishing of the cabin.
- 8C6.33** Cabin windows can be knocked in with an axe/sledgehammer to assist ventilation. However this would be a last resort, as conventional openings will be more effective ventilation points.

**Picture 12: Flight deck pilot escape window with escape rope located in compartment above**



Source WSFRS

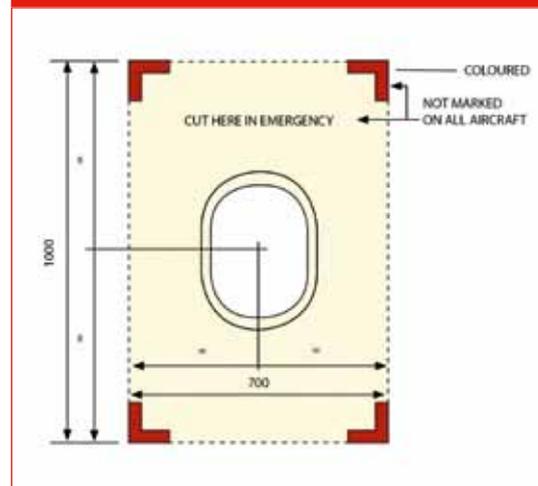
## Flight deck security doors

- 8C6.34** On passenger carrying aircraft access to the flight deck may prove exceedingly difficult due to the reinforced security doors now fitted between the flight deck and the passenger compartment. As stated previously rescue teams should not waste time forcing these doors if there are still casualties in need of assistance, within the aircraft.
- 8C6.35** Rescue and Fire Fighting Service personnel at your local airport may have more information as to the type of securing system utilised for different types of aircraft and some potential methods to overcome these security systems. However due to the security implications of this information, no further guidance on these doors is available within this operational guidance manual.

## Emergency break in points

- 8C6.36** These are areas marked on the fuselage of some aircraft but more commonly these areas are not indicated.
- 8C6.37** They are located where there are no internal obstructions such as electrical wiring or pipe work. They are not weak points in the airframe structure but merely areas between frames, therefore only the skin and stringers should require cutting.
- 8C6.38** However, the majority of these break in points are located high on the fuselage and well above the aircraft cabin floor. This can cause problems with access and will require suitable working platforms, should forced entry be attempted.
- 8C6.39** The only method of cutting through these areas will be with powered tools and the reality of achieving rescues by utilising this method is very small indeed.
- 8C6.40** All other options in gaining entry into the aircraft should be attempted before resorting to cutting in points.

**Picture 13: Emergency break in point**



Source Boeing

**Picture 14: Break in point**



Source WSFRS

## PART C-7

# Cargo aircraft

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## Introduction

**8C7.1** A cargo aircraft can be defined as any aircraft capable of storing and carrying freight. The majority of all aircraft have the capability to carry cargo as well as passengers and any aircraft accident can be complicated by the additional hazards of cargo over and above those hazards represented by aircraft construction, fuel systems, passengers etc. Some military aircraft combine the internal fuselage space to carry passengers as well as cargo.



Source MOD Crown Copyright

**8C7.2** Aircraft can be converted from a passenger carrying aircraft to carry cargo or can be a purpose-built/ designed aircraft. The construction of cargo aircraft is generally the same as for other aircraft. However they may have various alterations as follows:

- larger fuel tanks
- multi floored or compartmentalised cargo areas
- stronger and more robust undercarriage configurations.

**Picture 2: Military transport aircraft undercarriage assembly**



Source WSFRS

## Cargo doors

**8C7.3** The majority of cargo doors on aircraft are hinged at the top of the opening and swing out and up. They are capable of being opened from the outside by means of electronic or hydraulic controls which can on many occasions be manually overridden.

**8C7.4** Many different door opening procedures can be encountered and therefore it would be impossible to address them in this manual. However a visit to your local airport and discussions with Rescue and Fire Fighting Service will assist Fire and Rescue Service personnel knowledge on the types of cargo doors that may be encountered.

**Pictures 3 and 4: Example of typical cargo bay door (top hinged)**



Source Ron Puttock GFS

## Internal floor layouts

- 8C7.5** Depending upon the type of cargo carried on an aircraft, the design of floor areas for cargo holds can present significant hazards to Fire and Rescue Service personnel and great care should be taken when tasked to enter these areas. Floors can be open or solid, with trip hazards such as raised tracks or rollers designed to allow cargo containers to be rolled into position. In a post crash scenario there may be a risk of unstable cargo loads, damaged and opened cargo containers which will pose additional hazards to responding Fire and Rescue Service personnel.
- 8C7.6** Narrow bodied aircraft will ordinarily have a solid floor where cargo is bulk loaded as opposed to wide bodied aircraft where cargo is palletised or preloaded in containers. In addition wide bodied aircraft may have tracking systems and/or floor rollers. See pictures below.

**Pictures 5 and 6: Internal floor layouts/hazards of aircraft holds**



Source Ron Puttock GFS

## Types of cargo carried

- 8C7.7** The transportation of dangerous goods by air is strictly regulated and based upon the *Technical Instructions for the Safe Transportation of Dangerous Goods by Air regulations* published by International Civil Aviation Organisation (ICAO).
- 8C7.8** However not all cargos are hazardous in their own right, however following an aircraft accident they may represent a significant hazard to responding Fire and Rescue Service personnel, as they can be strewn across the crash site e.g. one of the biggest problems following the Lockerbie air disaster was the presence of sewing machine needles, which were being carried as cargo and these needles were spread across the crash site. This resulted in responding emergency services and post crash investigation teams receiving puncture wounds, which very much slowed the progress of body recovery and site clear up.

## Marking and labelling

- 8C7.9** Packaged goods are marked and labelled in accordance with United Nations (UN) recommendations. Both primary and secondary hazard symbols are displayed if appropriate.
- 8C7.10** Where goods are designated as being excluded from passenger aircraft, an aircraft specific cargo aircraft only orange label must be displayed.

## Radioactive substances

- 8C7.11** The safe transportation of radioactive material by civil aircraft is stringently governed by International Atomic Energy Agency and International Civil Aviation Organisation regulations. These regulations ensure that appropriate measures have been taken, in relation to the nature and quantity of material, when designing the packaging for radioactive materials.
- 8C7.12** It is fully recognised that radioactive material could be involved in a severe aircraft incident therefore packaging is designed so that the material should not constitute a hazard, even in extreme circumstances. In the case of packages containing materials with a high level of radioactivity, it is a requirement that the packaging will undergo tests to demonstrate its resistance against a severe impact and thermal environments. In addition the package will have a fireproof trefoil symbol indicating the presence of radioactive material.
- 8C7.13** Each year a substantial number of packages containing radioactive material are transported by air within UK airspace however only a very small proportion contain appreciable levels of radioactive material with most being radioactive isotopes for medical and research purposes.
- 8C7.14** Despite stringent safeguards, the possibility of an escape of radioactive material in an aircraft incident cannot be entirely ruled out. The properties of radioactive materials and the procedures necessary when dealing with incidents involving them are detailed in the operational guidance hazardous materials.
- 8C7.15** All airports that are licensed to transport radioactive materials should have on site procedure to deal with an emergency. However an aircraft accident and subsequent radioactive materials leaking/escaping may be outside their scope.
- 8C7.16** If there is any possibility that radioactive materials have escaped, the IC should ensure that the police have invoked NAIR (National Arrangements for dealing with Incidents involving Radioactivity).

**Picture 7: Identification label for cargo that cannot be loaded on passenger aircraft**



Source BAA AFS

**8C7.17** NAIR cannot be instigated for incidents involving military aircraft. (The military have their own procedures and teams that will take command of the incident and attend the scene, see military chapter).

## Shipper's declaration

**8C7.18** All dangerous goods must be accompanied by a shipper's declaration. The shipper's declaration for dangerous goods can be distinguished from other flight documents by the red and white hatching on each side of the document. The declaration should contain the following information:

- proper shipping name
- UN Number
- UN class, division and subsidiary risk(s)
- packing group (if applicable)
- packing instructions and type of packaging
- net quantity and number of packages.

**8C7.19** For radioactive materials, additionally:

- name or symbol of radionuclide
- activity
- package category and transport index.

**8C7.20** The shipper's declaration is produced by the shipper. There should be one copy at the originating point with one other travelling with the dangerous goods.

**Picture 8: Shipper's declaration**

**DANGEROUS GOODS IN EXCEPTED QUANTITIES**  
This package contains dangerous goods in excepted small quantities and is in all respects in compliance with the applicable international and national government regulations and the IATA Dangerous Goods Regulations.

\_\_\_\_\_  
Signature of Shipper

\_\_\_\_\_  
Title

\_\_\_\_\_  
Date

\_\_\_\_\_  
Name and address of Shipper

This package contains substances in Class(es)  
(check applicable copies)

Class    2    3    4    5    6    7    8    9  
          

and the applicable UN Numbers are \_\_\_\_\_

Source BAA AFS

## Notification To The Commander (NOTOC)

**8C7.21** A 'special load form' must be given to the commander (pilot) of the aircraft, identifying what dangerous goods have been placed on board in the cargo and where they have been loaded. This form is known as a NOTOC and must be on the aircraft in the possession of the commander (pilot). There should also be a copy of the NOTOC at the airport of loading and airport of destination although, unlike the commander's (pilot's) copy, this is not a legal requirement.



Source BAA AFS

## Pictures 10 and 11: Wide bodied aircraft cargo container with integrated fire suppression system (pre and post actuation)



Source CAA

- 8C7.22** Hazardous cargo will be identified by conventional UN packaging labels identifying the type of hazard they present, it will also indicate whether the cargo is permitted to be carried on a passenger carrying aircraft or a dedicated cargo aircraft.
- 8C7.23** Aircraft cargo is usually placed in containers or placed on pallets which are secured with netting. On some aircraft the containers can include an integrated fire suppression system, see pictures below.

## Cargo identification

- 8C7.24** At any aircraft incident the early identification of the cargo carried is paramount in managing the incident safely. However this identification may be challenging because of the wide variety of circumstances in which goods may be encountered and the condition in which they present themselves at the crash site.
- 8C7.25** If the cargo is properly marked and intact, then the identification will be simpler. However the Incident Commander will need to be aware that on occasion cargo may be incorrectly marked and incorrectly transported to avoid high cargo fees and therefore any cargo needs to be treated with suspicion.
- 8C7.26** Some methods of identification and verification of cargo are as follows:
- markings on packages
  - labels
  - cargo manifests
  - UN numbers and hazard identification labels
  - container types (barrel, boxes, cylinders etc)

- shipping papers (bill of lading documentation, available from the carrier and from the flight deck)
- the pilot.

**8C7.27** It is the responsibility of the company shipping the cargo to ensure that all packages are properly labelled, packed with the appropriate markings and that they have completed the Shippers Declaration of Dangerous Goods.

**8C7.28** International Fire Service Training Association (IFSTA) recommend that when identifying cargo carried at an aircraft incident that three independent sources should be used to identify and verify the cargo, for example:

1. cargo manifest
2. the type of container consistent with that described on the cargo manifest
3. the correct UN packaging label consistent with the container and manifest

**8C7.29** For further information on managing hazardous material incidents see operational guidance manual 'Hazardous Materials'.

## Livestock

**8C7.30** All sorts of live animals can be carried as cargo ranging from frogs through to horses. The larger the animal carried the more difficult and hazardous access into the cargo area will be.

# Helicopters

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## Introduction

- 8C8.1** The construction of the airframe of the helicopter is similar to the fuselage of fixed wing aircraft, but generally lighter. The larger the helicopter, the stronger the structure and the more protection it provides for occupants. The smaller the helicopter, the lighter the construction and the less protection it affords. Construction materials are primarily light weight aluminium alloys and composite materials.
- 8C8.2** There are several reasons for this: it is not stressed to carry a mainplane, the cabin is not pressurised for high altitude flight and the undercarriage assemblies are comparatively smaller.
- 8C8.3** Helicopters are produced in a wide range of designs, and as with fixed wing aircraft, they are grouped in weight categories for convenience. There are three categories:
- >5700kg
  - between 2250kg and 5700kg
  - and <2250kg.

## Main cabin

- 8C8.4** The cabin space in a helicopter is usually a high proportion of the total volume of the fuselage. There will be a firewall bulkhead between the cabin and the engine/transmission decking.
- 8C8.5** Cabin furnishings are often similar to those used in fixed wing aircraft, including many synthetic materials.
- 8C8.6** Seating arrangements are similar to fixed wing aircraft with single or double seats being used. They can be forward facing, aft facing, side on, or a combination of each and there may also be provision for stretchers for example in Helicopter Emergency Medical Service (HEMS) helicopters.
- 8C8.7** Some of the doors and windows are designed to be jettisoned in an emergency and there may also be life rafts located under seats, in the cabin roof, or in sponsons.

**Picture 1: Internal seating configuration in a AS332 helicopter**



Source HAI Airport Fire Service

## Rear fuselage

**8C8.8** The rear end of the main cabin often has access doors into a cargo/luggage compartment but primarily it supports the transmission shaft, tail rotor and gear boxes.

## Lower fuselage

**8C8.9** This normally houses the fuel tanks and fuel system components along with many avionic components. It's unusual to find many luggage bays in the lower fuselage. On some helicopters, the lower fuselage houses the retractable undercarriage. On others it forms the fixed undercarriage attachment points, and may also house floatation equipment.

## Landing gear

**8C8.10** Landing gear can be fixed, utilising skids or wheeled systems. It can also be retractable, folding into fuselage or sponsons.

**8C8.11** Wheeled undercarriages may incorporate pressurised fluid systems for retraction and braking. These, along with pressurised tyres and magnesium wheel components, present additional hazards for Fire and Rescue Service personnel.

**8C8.12** Helicopter undercarriages are designed to absorb relatively high vertical loads to protect the crew and/or passengers along with impact absorbing seat cushions. If the aircraft lands heavily on one skid or leg, then it may collapse causing the helicopter to roll over due to the relatively high centre of gravity.

## Water actuated devices

### Floatation gear

**8C8.13** Water actuated devices known as buoyancy floatation gear are fitted to helicopters which operate over water. These units can be found in wheel hubs, carried in sponsons and can be manually operated by the crew. However they are primarily operated by saline switches, and it is unlikely that firefighting media will operate them. **Note** this is not a legal requirement for general aviation helicopters.

**8C8.14** Floatation gear is designed to give stability to the helicopter on the water in the event of the helicopter having to ditch on water. The accidental actuation of one of these devices at a crash site could destabilise the helicopter in a rash scenario.



Source AAIB



Source Aberdeen RFFS

### Automatic deployable emergency locator transmitter (ADELT)

**8C8.15** Helicopters operating in the offshore industry use ADELT. This unit when released from the helicopter transmits a continuous signal on frequencies 121.5 and 243.0 MHz simultaneously, thereby allowing responding craft to locate and possibly home in to the signal.

**8C8.16** The ADELT unit is attached to the fuselage on the opposite side of the tail cone from the tail rotor with the direction of deployment to the rear, downwards and slightly outwards. The unit may be deployed manually or automatically. Either operation will activate a squib that will unlock the retaining mechanism, releasing the ADELT under spring pressure.

**8C8.17** On some types of unit a whip aerial (approximately 1m in length) is stowed folded over and whips straight as the unit is deployed away from the helicopter. This adds an additional hazard to responding Fire and Rescue Service personnel.



Source Aberdeen RFFS

Ejection speed: 5 Metres/Second

Range of travel: Approx 10 Metres

## Engines

- 8C8.18** Larger helicopters have turbo-shaft engines; many smaller helicopters have piston engines. Both utilise a system of gearboxes to drive main and tail rotors. There are also helicopters in operation that utilise a ducted fan instead of a tail rotor or fenestron.
- 8C8.19** Position of engines varies depending upon the design of the helicopter. Smaller helicopters will often have the engine mounted in the structure behind the cabin. Larger helicopters tend to have engine/engines mounted on top of the main fuselage/cabin structures. Military helicopters often have engines mounted in pods either side of transmission systems.

**Picture 5: Turbo shaft engine on Sussex Police helicopter**



Source WSFRS

**Picture 6: Chinook helicopter at RAF Odiham**



Source WSFRS

**Picture 7: Mesh covered fire access point on a Chinook helicopter**



Source WSFRS

**Picture 8: Flap fire access panel on a Lynx helicopter**



Source WSFRS

**8C8.20** Where two engines are mounted side by side there will be protective firewalls positioned between engines and between engines and cabin structures.

**8C8.21** If engines are located inside nacelles they may be fitted with fire access panels, through which extinguishing media may be introduced.

## Main rotors

**8C8.22** The helicopter main rotor is positioned above the cabin/main fuselage, and will normally consist of between two and five blades. Some helicopters, such as the Chinook have two sets of main rotors.

**8C8.23** Main rotor blades are most often constructed from metal leading edges and root ends with the main body of the blade being of composite construction. Some smaller helicopters utilise rotor blades consisting almost entirely of metal construction.

**8C8.24** When damaged as a result of an aircraft accident, rotor blades may shatter, spreading shards of composite material over wide areas. Rotor components may also be thrown some distance from the impact site.

## Tail rotors

**8C8.25** Conventional tail rotors consist of between two and five blades constructed from metal and composite materials. These will generally be painted in colours that make them easier to distinguish. Some helicopters utilise a 'fenestron' which is in effect a tail rotor consisting of many smaller tail rotor blades housed in a duct (see picture of Dauphin).

**Picture 9: Internal configured tail rotor**



Source WSFRS

**8C8.26** Some newer helicopters do not use a tail rotor, but rely on an anti-torque system, commonly referred to as NOTAR (NO Tail Rotor). The system uses a fan inside the tailboom to build a high volume of low pressure air, which exits through two slots located along the tailboom. This changes the direction of airflow around the tailboom, creating thrust opposite to the motion imparted to the fuselage by the torque effect of the main rotor.

**Picture 10: Traditional tail rotor**



Source aerospaceweb.org

**8C8.27** As with all helicopters Fire and Rescue Service personnel should treat the rear of any helicopter, whether it has a traditional tail rotor or a NOTAR system, as a hazard area and only enter this area if instructed to do so by the pilot or Incident Commander.

**Picture 11: NOTAR on Sussex Police helicopter**



Source WSFRS

## Electrical systems

**8C8.28** Voltages vary between different manufacturers, but normally start from 24V DC battery or external supply. Once the engine has started the helicopter generators can produce between 28-240V AC for powering all other electrical circuits and equipment.

**8C8.29** If a crash situation has occurred isolation of the battery must be considered before entering the helicopter. Any spark may cause ignition of flammable vapours. Batteries are normally situated in the nose of the helicopter and can be reached from the ground and are identified by external markings. Batteries can also be positioned in system bays elsewhere on the helicopter, for example at the rear of the cabin, making it more difficult to locate and isolate.

**8C8.30** It is recommended that as the primary source of power, the batteries should be isolated as soon as possible when a helicopter becomes involved in an incident.

**8C8.31** Fire and Rescue Service personnel should endeavour to record any such actions as clearly as possible in order to assist the investigating officers or representative from the Air Accidents Investigation Branch.

## Fuel and fuel tanks

**8C8.32** Larger helicopters with turbo-shaft engines will operate on Jet A1 whilst the smaller helicopters with piston engines will operate on Avgas.

**8C8.33** Some small helicopters, such as the Robinson 22 and Hughes 300 have fuel tanks of metal or composite design, mounted externally behind the cabin. Larger helicopters will utilise fuel tanks mounted in the floor or rear of the cabin structure. These may be a separate tank fastened within the structure, or more commonly, will be flexible bag tanks installed within tank bays.

**8C8.34** Helicopter fuel tanks may be either:

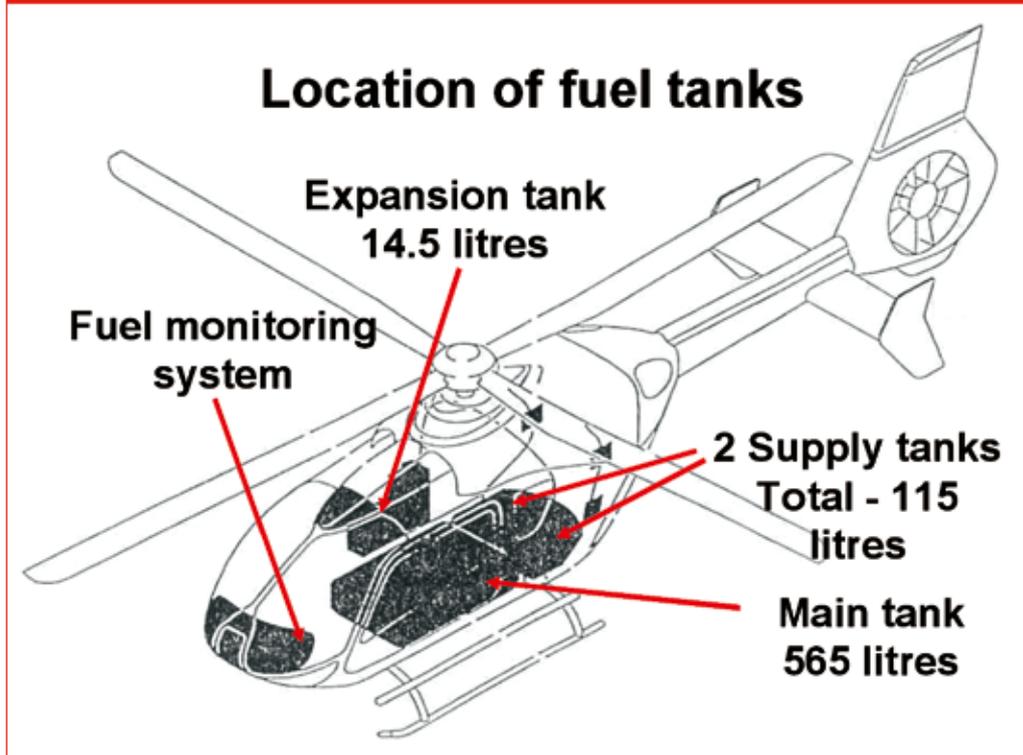
- integral i.e. compartments formed by the airframe (treated internally with rubber solution)
- bag type tanks i.e. flexible rubberised bags that withstand shock.

**Picture 12: Standard battery in a Lynx helicopter**



Source WSFRS

**Picture 13: Fuel tank location on a 135 Eurocopter**



Source Highlands and Islands Airport Fire Service

**8C8.35** The fuel tanks will be situated close to the passengers, either under the floor or to the rear of the passenger compartment. The number of tanks varies according to the type of helicopter. As well as main tanks, some helicopters may carry auxiliary fuel tanks. These can be carried externally, on wing sponsons, in baggage holds or in the form of internal transit/ferry tanks.

## Fuel distribution pipes

**8C8.36** Fuel pipe work (light alloy) runs through the airframe for the following purposes:

- fuel from tanks to high pressure pumps
- transfer from tank to tank
- fuelling and de-fuelling tanks
- jettisoning of tanks
- venting of tanks.

**8C8.37** As with all aircraft these will be a key consideration for Fire and Rescue Service personnel undertaking rescue operations.

## Engine related fires

- 8C8.38** Helicopter engines are designed to power the main and tail rotors through a gearbox, to generate the services required, i.e. electrical power, cooling and heating.
- 8C8.39** Very high temperatures are reached when the engines are running but these are insulated from the main fuselage. Because of these high temperatures and fuel having to pass around the engine, it follows that fuel and oil leaks may occur within the engine compartment with a resultant fire. Large helicopters may have fire detection sensors and fire extinguishing systems.
- 8C8.40** Fires within a helicopter engine are very rare because engines are built with high resolution steel or titanium to withstand internal temperatures exceeding 2000°C. If an internal engine fire does occur, shutting off the fuel cocks with the engine running will normally deal with the situation. This will blow any residual fire into the exhaust where it can be dealt with by first aid extinguishers.

## Fire detection systems

### Fire wires

- 8C8.41** This is a system of wires passing around the engine or engine bay with a low voltage passing through conductors. If unusual heating takes place, the capacitance in the conductors will change; this change is measured and relayed to the cockpit as an alarm signal.

## Fire extinguishing systems

- 8C8.42** Once a fire in the engine bay has been detected, the pilot can operate the helicopter's fixed fire extinguishing system if fitted. The system consists of a sphere containing Halon (or equivalent firefighting media) pressurised with nitrogen, tubing to deliver the agent, nozzles and electrical or mechanical devices for firing and controlling agent discharge. Each engine has its own system but they are normally grouped together and inter-connected so that both units can be discharged into one engine.

## Helicopter crash rescue

### Particular features of helicopter crashes

- 8C8.43** The most significant difference between helicopters and other fixed wing aircraft is that the helicopter wings rotate (rotors). This means that in the event of a crash a helicopter is less likely to remain upright than a fixed wing aircraft.

- 8C8.44** It could be assumed that because a helicopter can take off and land without forward speed, there may be less disruptive damage to the helicopter and the survivability of the occupants may be higher than that of a fixed wing aircraft. However smaller helicopters are often badly disrupted, even at zero speed incident which can become catastrophic when a rotor blade touches the ground. Larger helicopters incorporate stronger structures that improve survivability.
- 8C8.45** Heavy impact landings cause undercarriages to collapse and may cause the helicopter to roll.

## Rescue tactics

- 8C8.46** Approach to an accident/fire should be as for that of a fixed wing aircraft, but personnel must be aware of the hazards associated with main and tail rotors. Where these are still turning great care should be taken when moving towards the fuselage.
- 8C8.47** Under crash conditions it is advisable to approach the helicopter in a crouching position if the main rotor is still turning. The rotor blades will continue to turn and sag lower and lower even if the engine has stopped. It must be assumed that these will sag below head level.
- 8C8.48** **Note:** keep clear of air intakes and exhausts.
- 8C8.49** The doors and hatches on helicopters are normally of simple construction and they are likely to be jammed, as a consequence of the post crash damage. If they do become jammed it should be possible to lever them off or open.

**Picture 14: Helicopter roll**



1. Heavy landing causing the undercarriage to collapse.



2. Full structural failing of undercarriage assembly, rotor blades shatter as they make contact with the ground.

Source RAF Odiham – MOD Crown Copyright

**8C8.50** If forcible entry is necessary the lighter gauge metals and composites used in helicopter construction make this task easier than with a larger commercial fixed wing aircraft.

**8C8.51** However a helicopter on its side will present Fire and Rescue Service personnel with access problems, as one side of the helicopter will be against the ground and the only access doors will be facing upwards (see picture 15). Access will require the use of short extension ladders and sliding doors open or forcibly removing doors will be difficult.

**Picture 15: Helideck accident**



3. Final position of helicopter.

Source Aberdeen RFFS

**8C8.52** Once access has been made, personnel will need to enter the aircraft and due to the many different seating configurations, this task alone will be challenging.

**8C8.53** When in the aircraft, the confined space and the practicalities of physically lifting the casualties out through the opening above your head, is one that will challenge the most expert teams, but something that can be simulated and practiced, with the use of road vehicles (scrap vans or minibuses).

**8C8.54** Cutting through the helicopter floor or the roof of the fuselage to gain access, will most probably not be an option due to the position of fuel tanks and engines.

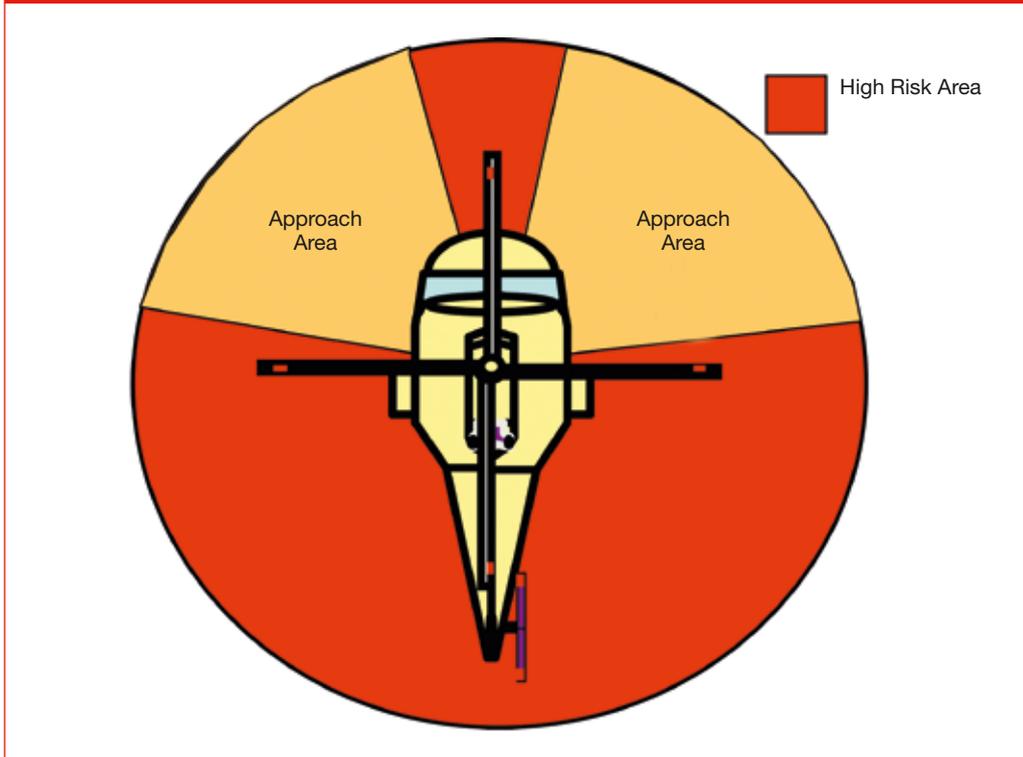
**8C8.55** Where water actuated devices are fitted into the wheel hubs care must be taken not to stand directly at the side of the wheels in case the disc which covers the device inadvertently activates. This may cause serious injury to personnel in close proximity.

**8C8.56** Where water activated devices such as ADELTA are fitted care must be taken when working in the vicinity of the unit which will be located on the opposite side to the tail rotor. If this device inadvertently actuates it may cause serious injury to personnel in close proximity.

**8C8.57** In situations where the pilot is conscious and able to give instructions, approach in full view of the pilot and follow his directions. Avoid blind areas of the helicopter where the pilot cannot see you.

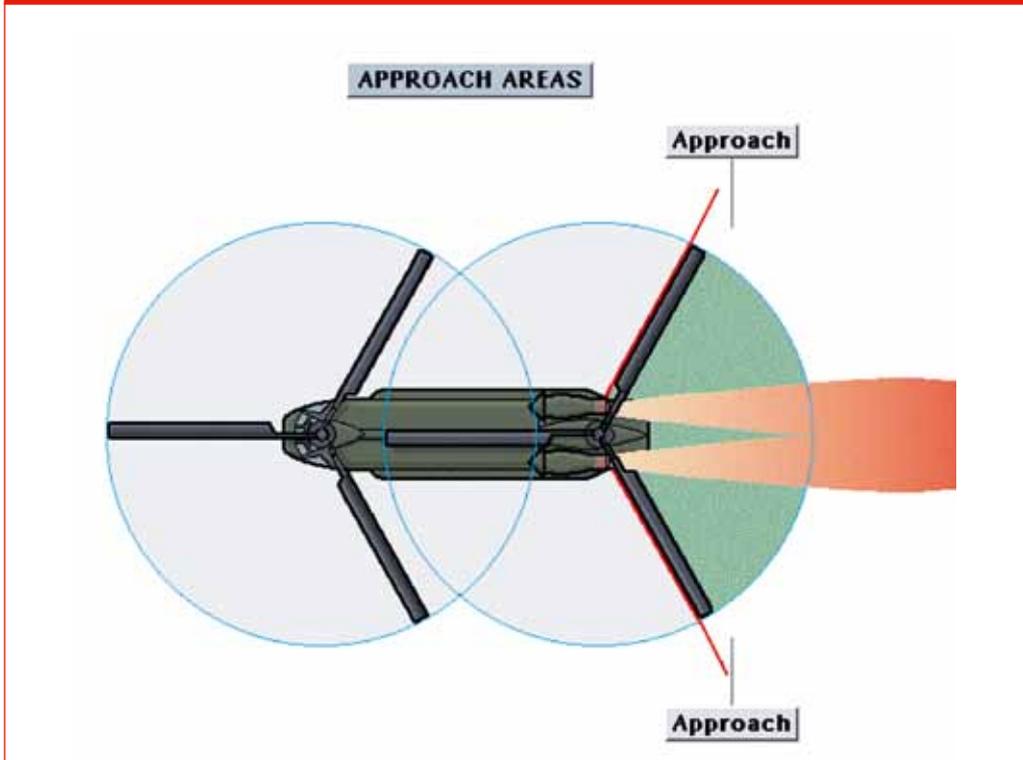
**8C8.58** There is one exception to the general advice of approaching the helicopter from the front and that is when dealing with a Chinook helicopter. Due to the pitch of the blades the safest area of approach will be from the rear of the aircraft, as shown in the diagram overleaf.

Picture 16: Helicopter Hazard Areas



Source Gatwick Airport RFFS Training Notes

Picture 17: Approach areas for Chinook



Source MOD Crown copyright

**8C8.59** The photograph opposite shows the front rotor blades of the Chinook can easily droop to below 5 feet from the ground.

**Picture 18: Demonstrates rotor blade height from the ground for a Chinook helicopter**



Source MOD Crown Copyright

## Flight deck rescues

- 8C8.60** Is it worth mentioning that, while in (larger) fixed wing aircraft the captain/pilot-in-charge sits on the left-hand side, in helicopters the pilot will sit on the right hand side.
- 8C8.61** The flight deck on most helicopters is surrounded by large perspex panels (often referred to as the 'bubble') which may have to be broken or cut to gain access.

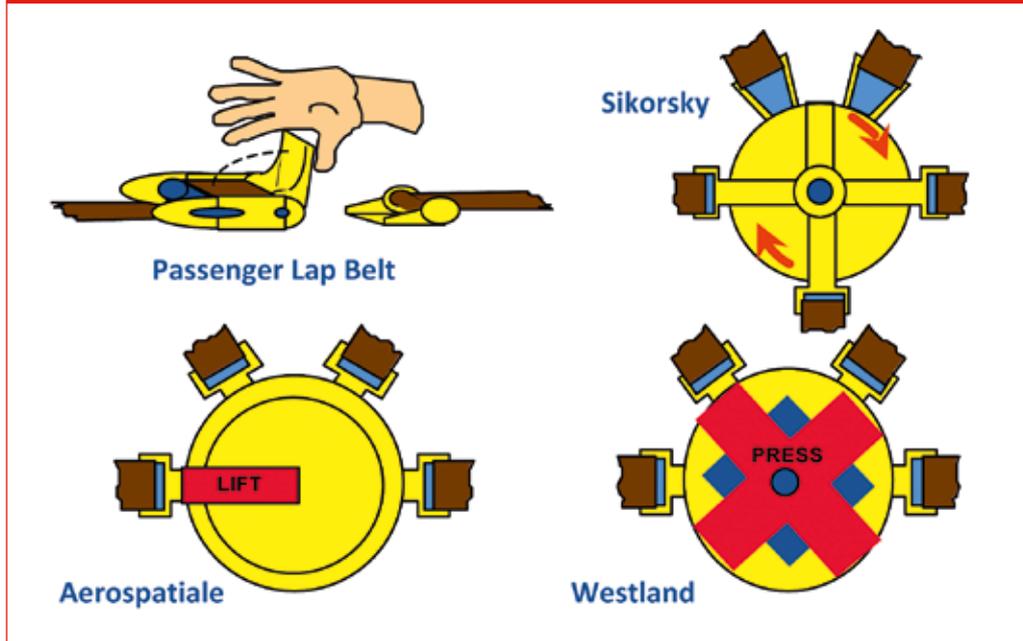
**Picture 19: Helicopter bubble**



Source MOD Crown Copyright

- 8C8.62** If the pilot has to be released from the seat harness, which is a 4/5 point inertia reel type, it will be necessary to operate a quick release lever which is situated on the left side of the seat; this is done by pushing the lever forward. The quick release lever slackens off the inertia reel and the harness is then undone by operating the normal release mechanism.
- 8C8.63** The cabin floor level is low and since it is likely that a crashed helicopter would be lying on its side, it is an advantage to have a short ladder available.

Picture 20: Types of harness used



Source Gatwick Airport RFFS Training Notes

## Firefighting tactics

### Approach

**8C8.64** The approach to any incident involving helicopters can be extremely hazardous depending on the nature and seriousness of the particular incident. It is impossible to set down precise instructions and the following is therefore intended to provide guidance in order to assist the decision making process on arrival.

**8C8.65** The Incident Commander should take steps to identify the role of the helicopter through their information gathering process.

**8C8.66** Factors to be considered may be:

- size of helicopter
- possible number of occupants
- position of helicopter
- damage sustained by helicopter
- type of helicopter e.g. military or civil
- any passengers visible on arrival
- fire situation on arrival
- are engines running
- are rotors turning.

- 8C8.67** Fire and Rescue Service personnel should on arrival at the scene of an incident involving a helicopter take particular care when deciding on the initial positioning of appliances. Rotor blades invariably extend a considerable distance from and around the main body of the helicopter.
- 8C8.68** When attending incidents involving military helicopters, Fire and Rescue Service personnel should consider the required tactics for dealing with military aircrafts in general. Never approach military helicopters directly from the front or rear as these are the main danger areas in relation to any weapons on board but approach at a 45o angle from the front or rear. Military weapon systems may be omni-directional e.g. Apache helicopter cannon (see Apache picture below). Other military helicopters have the potential to fit rapid firing guns covering both sides of the fuselage and to the rear e.g. Chinook & Merlin.
- 8C8.69** The apache helicopter is fitted with a canopy jettison system, as the cockpit can only be accessed from the right side of the aircraft. This system is similar to the miniature detonating cord (MDC) found on military fixed wing aircraft.
- 8C8.70** The control lever for this system is located on the nose of the aircraft and operating instruction are stencilled onto the airframe. The actuation of this system is not as explosive as that in a fixed wing aircraft, as the canopies are less strong however all Fire and Rescue Service personnel should be briefed before actuation and kept clear of the airframe whilst the canopies are jettisoned.

**Picture 21: Apache helicopter weapon platform**



Cannon

Rockets

Hellfire  
Missile  
Gantry

Source WSFRS

**Pictures 22, 23 and 24: Show the location of the canopy jettison lever, one of the side canopies that will drop out following its actuation**



Source MOD Crown Copyright

## Helicopter incidents at which helicopter engines and rotors have been shut down prior to arrival

- 8C8.71** If on arrival at the scene it is apparent that the helicopter engines and rotors have been shut down, action, in the case of civilian helicopters, can in general follow the tactics and techniques used for fixed wing aircraft. However Fire and Rescue Service personnel should bear in mind devices peculiar to helicopters such as floatation devices and ADELTS systems as referred to above.
- 8C8.72** Fire and Rescue Service personnel should bear in mind that owing to the particular design features of a helicopter any fire occurring may quickly enter the cabin if not speedily dealt with.
- 8C8.73** Fuel spillages which occur may be covered with aspirated foam and this blanket will need to be maintained until all ignition sources are under control and be subject to continual risk assessment.

- 8C8.74** An entry into the helicopter cabin and cockpit areas to carry out rescue is the priority which must be considered simultaneously to controlling the fire. Any evacuating crew and/or passengers should be removed to a place of safety upwind of the incident.
- 8C8.75** Charged branches (aspirated foam) must be maintained throughout the duration of the incident.
- 8C8.76** Many helicopters have fire access panels, which will be marked on or around the aircraft engine or engines. These should be used if safe to do so.
- 8C8.77** At incidents where pressurised flammable liquids or running fuel fires are involved the use of a dual application of foam/dry powder, should be considered.
- 8C8.78** Hand held extinguishers, dry powder, CO<sub>2</sub>, can be very effective if used correctly and directed into the correct fire access panel.
- 8C8.79** Owing to the potential for a fire to subsequently ignite or re-ignite whilst rescue operations are in progress, charged lines should be taken into enclosed cabin areas by rescue crews and covering charged lines maintained outside.
- 8C8.80** Firefighting and rescue operations involving large passenger carrying or laden cargo helicopters may be protracted, particularly if casualties are trapped inside the wreckage.

## Helicopter incidents at which engines are running and rotors turning

- 8C8.81** If on arrival at the scene helicopter engines and the rotors are still turning, urgent consideration must be given as to the need to approach close to the helicopter.
- 8C8.82** In such situations urgent contact with the helicopter crew should be established and only action required to save life or prevent fire from affecting the fuselage should be taken. In this case great care must be exercised in approaching the helicopter paying particular regard to both main and tail rotors.
- 8C8.83** Personnel should approach in a crouching position bearing in mind when rotors slow they will continue to sag and in many cases droop below average head height level. The helicopter rotor blades can descend to approximately five feet off the ground if the pilot moves direction control to forward position.
- 8C8.84** Extreme care must be taken when fire fighting and working rescue equipment under such conditions, with equipment at the scene being carried below waist level.
- 8C8.85** In situations where the pilot is conscious and able to give instructions, approach in full view and follow their directions. Avoid blind areas of the helicopter where the pilot cannot see you.

- 8C8.86 Under crash conditions where the pilot is incapacitated it **may** be advisable to approach from the rear of the helicopter. Keep to the opposite side of the tail from that of the stabilising rotor and remain close to the fuselage. Entry into the main fuselage can be made with the minimum of danger to the firefighter as the main rotor is designed to rise above the tail. **This applies to crash conditions only.** Normally approach in full view of the pilot and obey their instructions.
- 8C8.87 Approach the helicopter from the downhill side if possible. Never approach or leave from the uphill side. Make sure all personal protective equipment is secure and chinstraps are used on helmets.
- 8C8.88 Personnel must avoid engine air intake and exhaust efflux areas.

## Aide memoire – Working around helicopters

Picture 25: Safety around helicopters

<h3 style="margin: 0;">SAFETY AROUND HELICOPTERS</h3>	
	
1. Approach or leave machine in a crouching manner (for extra clearance from main rotor).	7. If leaving helicopter while hovering, get out and off in one smooth, unhurried motion.
	
2. Approach or leave on the downslope side (to avoid main rotor).	8. Do not touch bubble or any of the moving parts (tail rotor linkage, etc.).
	
3. Approach or leave in pilot's field of vision.	9. Keep helipad clear of loose articles — water bags, groundsheets, empty cans, etc.
	
4. Carry tools horizontally, below waist level (never upright or over shoulder).	10. When directing machine for landing, stand with back to wind with arms outstretched toward landing pad.
	
5. Hold onto hard hat when approaching or leaving machine, unless chin straps are used.	11. When directing pilot by radio, give no landing instructions that require acknowledgement as pilot will have both hands busy.
	

Source IFSA, USA

## Areas of training required for personnel attending standby duties at helicopter landing sites

**8C8.89** Where possible, Fire and Rescue Service personnel should receive familiarisation training on the type of aircrafts that are likely to use the landing site. Training with the aircrew and aircraft engineers will be invaluable.

**8C8.90** General areas of training should include:

- details on passenger and crew capacity, seating configurations, type number, location of exits and method of operation
- location and operation of fuel stops, master switches and switches provided for emergency access
- location of battery position and isolation switches
- engine type, location and inbuilt firefighting systems
- training on special firefighting hazards and other special features associated with the aircraft
- safe route of approach and methods of communicating with the pilot, (pilot sits on the right hand side of the aircraft)
- training on hazards associated with rotor blades and associated hazard areas, these will differ from aircraft to aircraft
- external power supplies – ground power units
- any specific hazards with landing gear such as ADELTA systems and floatation gear
- internal hazards such as liquid oxygen, Entonox cylinder locations and other pressurised systems
- stretcher locations and methods of releasing unit
- emergency access panels and methodology of gaining access from outside in
- method of opening clamshell doors if rear access compartment is provided.

## Standby protocols

**8C8.91** Areas for consideration:

- landing and taking off – suitable safety distances taking in to consideration:
- blade disintegration area can be up to 300m
- rotor downwash, safety distances will differ depending on size of aircraft
- methods of dealing with an engine fire “rotors running”
- methods of dealing with an engine fire “rotors stopped”

- methods of dealing with a running fuel fire
- the correct extinguishing media that should be used under different scenarios
- what firefighting media needs to be immediately available
- what personal protective equipment must be worn, high visibility, helmets fastened, visors down, hearing protection etc
- if staff are working with helicopters on a regular basis there are recognised emergency hand signals which are available from the Civil Aviation Authority – CAP 637 Visual Aids Handbook chapter 6 Table E. ( [www.caa.co.uk/docs/33/CAP637.PDF](http://www.caa.co.uk/docs/33/CAP637.PDF) )
- the hazards of foreign object damage (FOD) to aircraft need to be understood and inspection of the landing site should be made where possible, for example litter bins should have lids secured, temporary signs should be removed outside of the downwash areas
- no flashbulbs or camera lights should be used during takeoff or landing and no handheld torches or vehicle headlights should be directed at the pilot or any other crew members, due to the possibility of night vision goggles being worn.

# Military aircraft

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## Introduction

**8C9.1** Military aircraft of varying types and roles, operate from military airfields/bases around the country and may also operate from civil airports for a variety of reasons:

- diversion
- troop movement
- air displays
- refuelling
- training exercises
- military operations
- civil aid e.g. flooding.

**8C9.2** The type of aircraft can vary enormously from small two seat trainers through to large passenger/cargo aircraft.

**8C9.3** Large transport aircraft may be similar in appearance to civil airliners but with unconventional interior configurations. The majority of military aircraft are capable of carrying weapons and fast jets will use differing Aircraft Assisted Escape Systems.

## Aircraft types

**8C9.4** The mainstay of the large transport/tanker role is formed from the Tristar, Boeing C17 and variants of the Hercules C130. Aircraft such as the Boeing 767 and Airbus A300/330 are being developed for the air tanker role.

**8C9.5** Offensive and defensive roles, include fast jets such as the Typhoon, Tornado and Harrier.

**8C9.6** The reconnaissance and maritime patrol aircraft roles are carried out by the Sentry AWACS and Nimrod, as well as the Falcon.

**8C9.7** The training role employs aircraft such as the Slingsby T67 Firefly, Grob Tutor, Tucano, Hawk and the Jetstream 31.

**8C9.8** Rotary aircraft such as the Apache, Merlin, Chinook, Lynx and Squirrel are also used.

## Remotely piloted air system

**8C9.9** Remotely piloted air systems (RPAS) are increasing in their use and being developed to carry out specialist roles for the military. They range in size from small model sized to full size aircraft. These aircraft are remotely piloted from a ground location and the aircraft themselves may contain all the hazards associated with military aircraft.

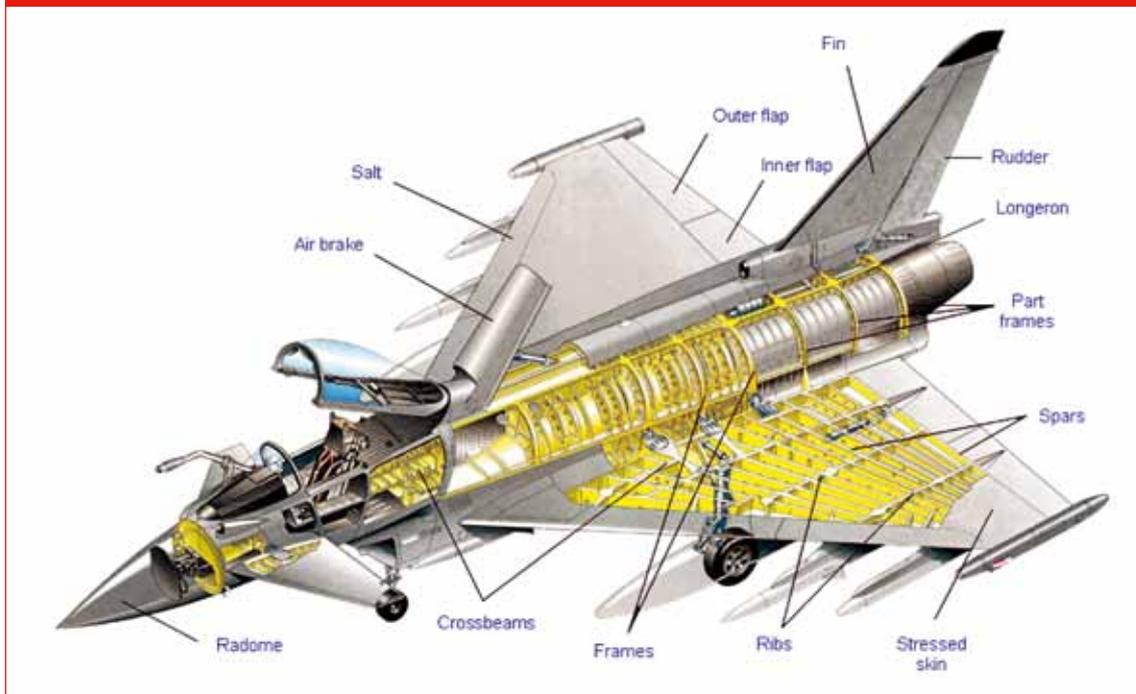
**Picture 1: Example RPAS**



Source MOD Crown Copyright

## Construction

**Picture 2: Typhoon airframe cut away diagram**



Source MOD Crown Copyright

**8C9.10** It is impossible to describe the complexity of a fast jet airframe construction. However the above cut away illustration demonstrates the complexity and differences of construction from conventional civil aviation aircraft.

**8C9.11** The metals used in airframe construction are:

- aluminium alloy – this is a metal that is most used in construction. However the composition of alloys varies with the different types of aircraft and use of application
- duralumin – an alloy of aluminium, copper 4 per cent and 1 per cent of magnesium, manganese and silicon
- alclad – is duralumin with the surface finish of pure aluminium
- magnalium – is a lighter alloy of aluminium with about 2 per cent copper with 2/10 per cent of magnesium added
- lithium alloy – light weight material.

**8C9.12** These alloys are used in sheet metal form or as a machine casting or forging. Such components are intrinsically stronger than an assembly of parts. Machined components are used in areas of high stress within the aircraft.

### **Stainless steel and titanium alloys**

**8C9.13** Although light alloys are adequate for the majority of airframe construction, it is necessary for materials having other properties where greater strength or resistance to heat is required, for example:

- stainless steel may be used in areas of high stress such as wing attachment points or engine bearers
- titanium and/or stainless steel may be used in areas that are subjected to excessive heat, the melting point of titanium and stainless steel alloys is approximately 2,000°C.

### **Polymer composite materials**

**8C9.14** These materials are used extensively in fixed wing and rotary wing aircraft such as the Harrier, Typhoon and the Lynx and Merlin helicopters.

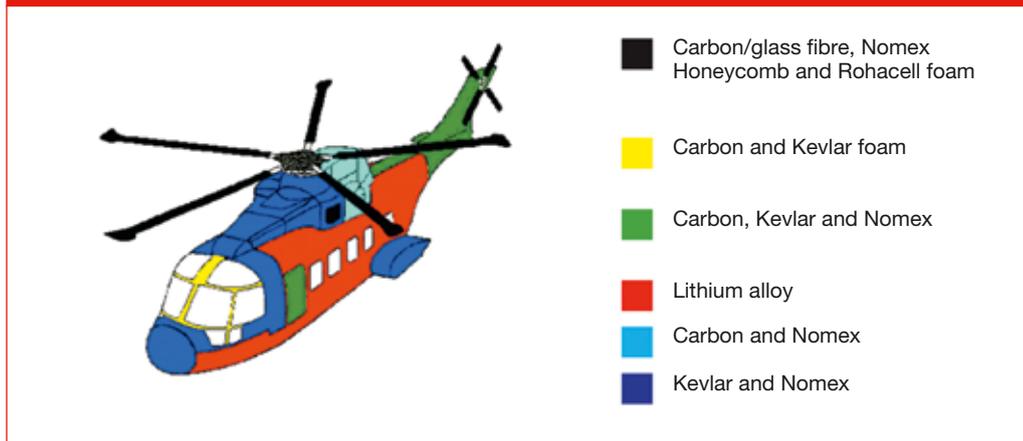
Please see appendix C polymer composites.

## **Unusual and specialised materials**

**8C9.15** As well as traditional materials used in aircraft construction, military aircraft and some weapons systems will utilise specialist materials such as:

- Depleted Uranium – used in weapons systems and as inert ballast on some aircraft. Depleted uranium poses a concern for crash site clear up teams (who will have to declare an area clear of all materials prior to handling the

**Picture 3: Composite materials used in Merlin helicopter**



Source MOD Crown Copyright

crash site back to the owner) but does not present any significant hazard to responding Fire and Rescue Service personnel carrying out firefighting and rescue operations

- Beryllium – not easily distinguished from other common metals and only occasionally used in aircraft construction but more widely used in electrical and electronic equipment installed on aircraft. The probability of coming into contact with this material is small and Fire and Rescue Service personnel undertaking firefighting rescue operations should be protected by their personal protective equipment and respiratory protective equipment.
- Radioactive substances used in targeting systems – glass lens systems located on some strike aircraft, if fractured, can leak radioactive material. Fire and Rescue Service personnel undertaking firefighting and rescue operations should be adequately protected by their personal protective equipment and respiratory protective equipment.

**8C9.16** With all of the above materials the general principle applies. Fire and Rescue Service personnel should carry out life saving rescue operations and firefighting operations in appropriate personal protective equipment and respiratory protective equipment.

**8C9.17** Any substances found on the crash site should be left alone and not touched and Fire and Rescue Service personnel should be withdrawn at the earliest opportunity and the crash site handed over to the responding military authority.

**8C9.18** Early clarification with the Aeronautical Rescue Coordination Centre will confirm the nature and hazards of the materials involved with the type of aircraft Fire and Rescue Service personnel are dealing with, which will assist the incident commander in assessing the level of personal protective equipment and respiratory protective equipment needed to undertake tasks that are required.

## Military identifying symbols

**8C9.19** Below are symbols that are used on military aircraft for the identification of system pipelines and components. The pipework systems are marked for identification purposes at each side of every union, cock or other connection. The markings are intended to give warning for ground crews and engineers but will be good pointers of potential hazards should an aircraft accident occur. Picture 4 below detail symbols for Petrol, Oils and Lubricants (POL); Pressurised Gases and Electrical systems.

**Picture 4: Standard markings**

SYSTEMS FILLED WITH POL OR PRESSURISED GASES		
 FUEL	 HYDRAULIC FLUID	 OXYGEN
 ROCKET FUEL	 DE-ICING	 POWER BOOSTING
 ROCKET OXIDISERS	 COOLANT	 AIR-CONDITIONING
 LUBRICATING OIL	 PNEUMATIC	 INERT GAS
		 FIRE EXTINGUISHANT
ELECTRICAL SYSTEMS		
 EXTERNAL ELECTRICAL CONNECTION	 GROUND OR EARTHING RECEPTACLE	 BATTERY

Source MOD Crown Copyright

## Cockpit canopies

**8C9.20** Canopies come in three principal designs:

- rear hinge canopy
- side hinge canopy
- sliding canopy

**Picture 5: Rear hinge canopy**



Source WSFRS

**Picture 6: Side hinge canopy**



Source MOD Crown Copyright

**Picture 7: Sliding canopy**

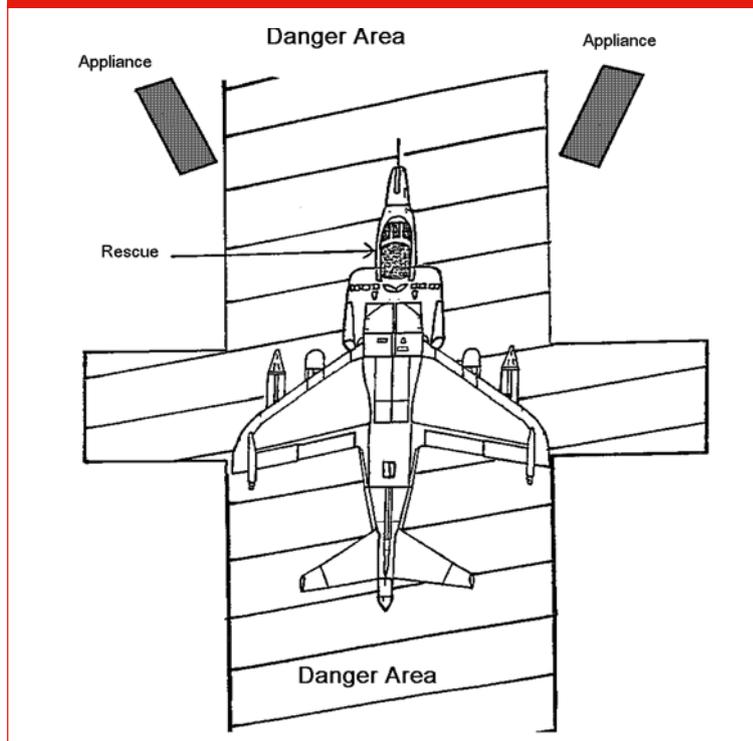


Source MOD Crown Copyright

## Approach and positioning of appliances

- 8C9.21** Large military aircraft should be approached in the same way as a large civil aircraft. Positioning of the appliances should be broadly similar to create survivable conditions inside the fuselage.
- 8C9.22** Fast jet aircraft should be approached with caution, remembering that the life risk is in a small area at the front of the aircraft. In this case the best approach is approximately 45° from the front of the aircraft; avoid positioning appliances or walking directly in front of any weapons being carried.

**Picture 8: Danger areas when approaching military aircraft**



Source MOD Crown Copyright

**Picture 9: Typhoon under fuselage engine intakes**



Source MOD Crown Copyright

**8C9.23** Firefighters working around aircraft with engines running must be aware of the potential for injury. Some fast jet aircraft (Typhoon) have under fuselage engine intakes which are large and close to the ground. At idle power, there is a serious risk of engine ingestion.

## Internal layout

**8C9.24** The interior layout of military aircraft may not be as expected. For example the occupants may be facing forward, backward or sideways, and may be located in office style seating configurations.



Source MOD Crown Copyright

## Hazards

**8C9.25** As well as the known hazards encountered with civil aircraft and their construction materials, further additional hazards may be present at an incident involving a military aircraft. These hazards may be in the form of:

- weapons
- pyrotechnics
- defence suites
- radar radiation hazard
- infra-red and laser emissions
- Aircraft Assisted Escape Systems.

# Weapons

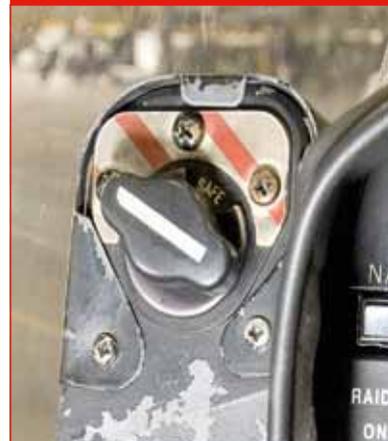
## Aircraft armament safety features

**8C9.26** Military aircraft are generally equipped with an array of integral or other safety features to prevent inadvertent release/operation of explosive stores on the ground. These features vary between aircraft types and further information should be obtained from the on site military adviser or Aeronautical Rescue Coordinating Centre (ARCC). The safety features fall into two categories:

- master armament safety switch (MASS)
- weight on wheels switch (WoW).

**8C9.27** The master armament safety switch is a mechanical device that isolates the electrical supply to the explosive stores fitted to the aircraft. Normally situated on the left side of the cockpit/fuselage the master armament safety switch condition may be ascertained from the colour of the visible light or flag which is located on the left hand side of the cockpit window, green indicates 'safe' and red indicates 'live'.

**Picture 11: MASS on a Harrier**



Source MOD Crown Copyright

**Picture 12: Harrier cockpit indicator for MASS showing green to indicate safe mode**



Source MOD Crown Copyright

**Picture 13: Apache helicopter fully armed**



Source MOD Crown Copyright

**8C9.28** The weight on wheels switch is a device fitted to the main undercarriage of fixed wing aircraft which isolates the weapon firing and release circuits whilst the undercarriage is down and locked.

**8C9.29** There are many different weapon systems utilised on military aircraft and they will differ depending on the role. Some of the reconnaissance and maritime aircraft that are not normally associated with weapons are capable of carrying missiles for self defence.

**8C9.30** Weapons can be generally grouped as:

- missiles
- bombs (torpedoes and depth charges)
- rockets
- guns.

## Missiles and rockets

**8C9.31** The essential difference between a missile and a rocket is that the former is guided to the target and the latter is not. Missiles are carried on aircraft on special pylons or launch rails whilst rockets are inevitably carried in pods attached to the aircraft pylons.

**Picture 14: Hellfire missiles rack USAF**



Source WSFRS

### Pictures 15 and 16: High explosive bomb and stingray torpedo



Source MOD Crown Copyright

### Picture 17: Maverick rocket



Source MOD Crown Copyright

- 8C9.32** Missiles have a motor which is fuelled by using an explosive propellant or by an air breathing gas turbine using conventional aviation fuel. During its independent flight, the missile is armed and guided by a control system, and uses movable wings to steer the missile to the target, where the missile warhead is detonated.
- 8C9.33** When a rocket is launched it is driven by a solid propellant motor that can rapidly accelerate to speeds in excess of Mach 2, both rockets and missiles contain high explosive material.

## Bombs

- 8C9.34** Bombs carried by military aircraft may contain high explosive, the majority are likely to be training bombs, which are less powerful, although they can still be very dangerous.
- 8C9.35** High explosives and training bombs do not normally explode on impact of a crashed aircraft since the fuses are not likely to have been set. Nevertheless the behaviour is unpredictable and there is always some risk attached to them.
- 8C9.36** For the purposes of this operational guidance if it looks like a bomb, it is a bomb until you are told otherwise by a military specialist.
- 8C9.37** If during rescue operations, any bombs are seen in such a position that they may become heated, they should be cooled with water spray. Foam is not recommended as a cooling media because although the water drains from the foam which will assist cooling to a small degree, it is not considered efficient.
- 8C9.38** It is vital that apart from cooling the bombs no attempts should be made by Fire and Rescue Service personnel to move or in any way interfere with the bomb, whether the bomb has been subjected to heat or not.

## Gun ammunition

**8C9.39** There are a number of different gun types that may be fitted to aircraft. These range from signal pistols, which discharge pyrotechnics, through to machine guns and aircraft cannons, which fire projectiles that may be inert or in the case of cannon, may be inert or high explosive filled.

**Picture 18: Machine gun on a Chinook helicopter**



Source MOD Crown Copyright

**8C9.40** Fixed wing aircraft guns are normally installed within the aircraft structure or in pods attached to the aircraft and inevitably fire forwards. Guns fitted to rotary aircraft may point in any direction or be omni-directional. Normally ammunition is stored in tanks within fixed wing aircraft or special boxes within the crew cabin in the case of rotary aircraft.

## General guidance

**8C9.41** Weapons will be carried both internally and externally and will differ in size, type and design, and all may represent a hazard when involved in fire.

**8C9.42** The latest American strike aircraft, the F22A Raptor has a large weapon loading but all weapons are fully enclosed in the aircraft construction and no weapons are held on pylons. Therefore it is likely that this type of construction will be followed in future aircraft design within the UK.

**Picture 19: USAF F 22A raptor strike aircraft showing no external weapons**



Source Rob Shenk Great Falls USA

**8C9.43** During impact and possible subsequent fire where aircraft are armed with external directional weapons such as rockets and missiles, the associated danger zones should be taken into account:

- Items of aircraft armaments may have been torn from pylons or elsewhere and lay to the rear of the aircraft (but not necessarily in line)
- Items not torn off the aircraft may well function as designed after a few minutes of exposure to the heat of a major fire
- Guns/cannons are vulnerable to impact damage and may be distorted and jammed by the heat of a major fire. The bulk of ammunition is not in the gun itself, but in magazines/ammunition tanks elsewhere in

the aircraft. The ammunition may burst when exposed to fire, but the effects of this would tend to be localised. However, any round actually loaded in the gun/cannon may function as designed, thus the area in front of the barrels should be avoided. Most aircraft fly with a live or dummy round in the breach of the gun.

**8C9.44** All weapons and missiles contain an element of high explosive material which can be exposed as the casing breaks down, and whilst unlikely to detonate en-masse, it will represent a significant hazard when unstable. Missiles themselves carry highly volatile fuels and oxidisers, which may react to rapid heating long before any explosive device.

**8C9.45** As with all weapons, if found, whether attached to or separated from the aircraft they should not be disturbed for any reason. They should be marked, cordoned off and specialist assistance sought for disposal.

**8C9.46** In an aircraft accident involving weapons containing high explosive, the military recommend a minimum cordon distance of 400m from the aircraft fuselage. Aircraft not carrying high explosive weapons, 100m from the main body of the wreckage or 30m beyond an area that encompasses all items of wreckage except Aircraft Assisted Escape Systems, whichever is greater.

**8C9.47** Fire and Rescue Services should refer to their standard operating procedures (SOP) for dealing with explosives as cordon distances may differ from those recommended from the military. This cordoned distance may need to be increased substantially following advice from military advisers or the Aeronautical Rescue Coordination Centre (for information on the Aeronautical Rescue Coordination Centre please see appendix D).

**Picture 20: Raptor strike aircraft**



Source WSFRS

## High explosives

- 8C9.48** High explosives compounds used in weapons usually melt between 50°C and 100°C and they may drip or flow out of the weapon. These explosives are then only safe if they have been completely burned. High explosive which is not burned remains very sensitive to friction, heat or shock and must be treated as very unstable and dangerous.
- 8C9.49** HE compounds are produced in several colours; they may be white, buff, yellow, orange, rust, red, or blue. They burn with a flame which is usually distinct from the flames of any other materials with which they may be mingled; their flames may be white or greenish white or an abnormally bright red; their smoke is white or distinctively light in colour.
- 8C9.50** In an incident involving high explosive there is a possibility of detonation. It is the opinion of military advisers that, if no attempt is made to subdue a fire involving high explosive components, or to cool the component, the chance of detonation is about one in ten. Obviously the likelihood of detonation is even less if the fire is controlled at an early stage, or if the high explosive component is kept cool by continuous water spray.
- 8C9.51** Key points:
- Ignition or detonation of the high explosive is very unlikely if its temperature can be kept below 150°C
  - In military tests, the temperature of a weapon involved in a fire has been kept below 100°C by bringing two spray nozzles into use in the very early stages of fire and positioning one at each side to fully envelop the weapon by water spray
  - At an incident where high explosive is seen to be torching or jetting, detonation may follow quickly. If detonation occurs, it might be a small explosion, one of considerable magnitude, or a series of small explosions.

## Nuclear weapons

- 8C9.52** Nuclear weapons and their associated equipment are designed to limit the likelihood and consequences of an accident. Additionally, storage and movement of nuclear weapons are governed by stringent regulations.
- 8C9.53** The inherent safety features that form part of the design of nuclear weapons, ensure that there is no risk of a nuclear explosion should a weapon be involved in an accident. Nuclear weapons will not normally be carried on combat aircraft in peacetime. They are, however, occasionally moved in special protective containers, secured within the holds of military transport aircraft.
- 8C9.54** The appearance of a nuclear weapon is similar to that of a conventional high explosive bomb. All nuclear weapons contain high explosive when they are fully assembled and therefore a conventional explosion may occur when a nuclear

weapon is involved in an accident. Although the nuclear weapon will not produce a full nuclear yield explosion there is a risk of radioactive material being spread over a limited area as a result of a conventional explosion.

- 8C9.55** If a military aircraft accident involves nuclear weapons or materials, the Nuclear Accident Response Organisation will assume command of the incident.
- 8C9.56** The RAF will send a Special Safety Team to the scene as soon as possible. The Team will be trained and equipped to deal with the incident involving nuclear weapons and assemblies.
- 8C9.57** The Fire and Rescue Service Incident Commander will however have to deal with all matters relating to the incident initially and therefore early communications with Aeronautical Rescue Coordination Centre will prove to be invaluable in carrying out a risk assessment and initiating a tactical plan.
- 8C9.58** As with all military aircraft incidents Fire and Rescue Service personnel should be kept clear of all aircraft components and debris unless it is necessary for them to carry out life saving tasks. The military advice about the minimum safe distance for weapons (400m) is equally applicable to nuclear weapons.
- 8C9.59** If an approach to an aircraft is necessary the appropriate standard operating procedure for radiation incidents should be adopted by the Incident Commander. Further information on generic standard operating procedures for this type of incident can be found in operational guidance on hazardous materials.

## Pyrotechnics

- 8C9.60** Pyrotechnics can be found on military fixed wing aircraft and helicopters. Some may contain a small explosive device. They can be in the form of:
- chaff and infra-red flares
  - signal cartridges
  - distress flares
  - large smoke markers.
- 8C9.61** These devices are stored and used in specialist applications and present a significant hazard. Some may be magnesium based and burn intensely with a risk of serious injury to personnel.
- 8C9.62** Pyrotechnic squibs are small metal tubes closed at one end and plugged by a crimped rubber plug at the other end. They have a number of uses:
- flash squibs are vented explosive units designed to emit a small flame which is used to ignite rocket motors

- closed squibs incorporate a low explosive charge designed to jettison under wing weapons and external fuel tanks, they are also located in fire extinguishing systems around the aircraft.

**8C9.63** Marine markers and floats can be deployed away from the aircraft similar to aircraft flares and chaff. Marine markers and floats can weigh a considerable amount and if deployed could result in serious injury to responding Fire and Rescue Service personnel.

## Defence suites

**8C9.64** These are designed to provide counter measures for self defence. They can be broadly grouped into:

- chaff
- flares.

**8C9.65** Chaff is a defence against missiles and consists of a large quantity of radar reflective material (foil strips), discharged from anywhere around the aircraft, including helicopters. These strips are explosively ejected in a large cloud and discharged by a small explosive device. Helicopter chaff is directed up into the rotor blades to assist with its distribution. Some chaff may be infra-red sensitive which will ignite on release to atmosphere, presenting an additional ignition hazard.

**8C9.66** Flares are a defence against infra-red (heat seeking) missiles and are designed to create a heat signature greater than the engine exhaust. These units are generally magnesium based and burn at a very high temperature. They can be discharged to a distance of 50m at high velocity and a danger area of 200m and when ignited, may prove difficult to extinguish, or present an intense source of ignition (flares burn at 12,000°C).



Source MOD Crown Copyright

**Picture 22: Infra-red chaff dispenser**



Source MOD Crown Copyright

**8C9.67** Chaff and flare associated hazards:

- can provide an ignition source for fuel spillages
- are released at an explosive speed
- will burn so brightly they can damage the eyes of responding Fire and Rescue Service personnel
- will burn at such a temperature that contact with skin will create serious burns.

**8C9.68** These systems are very sensitive and can self activate at any time, therefore they should always be treated as a hazard, until made safe by a specialist military technician.

**Picture 23: Flare dispensers located on the underside of a strike aircraft**



Source MOD Crown Copyright

## Radar radiation hazard

**8C9.69** The use of radar on civilian aircraft is normally restricted to weather indication and is relatively small in size and power output. The use of radar on military aircraft is primarily for detection and surveillance. These radar units operate on differing wavelengths and at much greater power output when switched on.

**8C9.70** The EC3 Sentry AWACS uses an externally mounted (dish) scanner for airborne early warning and control with a range over several hundred miles. In normal operating mode the dish rotates and is visible from a large white strip across the

surface of the dish, however, it should not be assumed that it is switched off if the dish is not rotating. The Nimrod uses fully enclosed (nose cone) search water radar of extremely high power and there is no external indication of its operational status.

**8C9.71** Fast jet aircraft use targeting radar, usually located in the nose of the aircraft, but may be pod mounted, with no external indication of its operational status.

**8C9.72** Military radar installations on aircraft, when switched on, represent a significant hazard to Fire and Rescue Service personnel. However in a crash scenario with the engines stopped the likelihood of these radar working is minimal, as the onboard battery systems will not be powerful enough to operate them. In addition a host of inbuilt safety systems will disarm/deactivate these systems in an emergency landing/accident.

## Infra-red and laser emissions

**8C9.73** Military aircraft are increasingly fitted with infra-red guidance systems for weapons targeting. These may be both FLIR (forward looking infra red) and SLIR (sideways looking infra-red).

**8C9.74** These emissions can be damaging to delicate eye tissues and all Fire and Rescue Service personnel should be aware of the dangers of looking directly into glass panels located on the aircraft nose or elsewhere on the aircraft, until it can be confirmed that all systems have been isolated. Military laser guidance systems, unlike medical lasers, operate at a much higher intensity for targeting purposes and have the potential to cause harm, particularly to the eyes and delicate tissues.

**8C9.75** The likelihood of infra-red and laser guidance systems operating post crash is minimal due to the aircraft safety system (crash switches, weight on wheels switch isolating systems). These systems have to be manually selected by the pilot and therefore it is unlikely these will be activated at a crash site.

## Aircraft assisted escape systems

**8C9.76** There are many types of Aircraft Assisted Escape Systems fitted to aircraft in service with the UK military aircraft and visiting forces. Therefore it is impossible and impractical to describe the operational systems in detail, however the principle of operation of all Aircraft Assisted Escape Systems are similar.

**8C9.77** Aircraft Assisted Escape Systems is a collective term that includes the following components:

- the ejection seat, including the ejection gun(s), guide rail, seat pan, instruments and all operating and adjustment controls
- all equipment fitted to, or onto the ejections seat, rocket pack, parachute, personal survival pack, personal equipment connector, emergency oxygen

- all ejection seat/aircraft interfaces and connections
- systems and sub-systems for clearing the ejection path from the aircraft e.g. canopy jettison, miniature detonating cord (MDC)/linear cutting cord (LCC) retro-rockets, canopy penetration, control devices.

**8C9.78** These systems are fitted to all fast jets and some training aircraft such as the Hawk and Tucano. All of the systems combine to form a method of saving aircrew life by working together in a predetermined sequence. They can be broadly divided into two areas:

- the canopy clearance system
- the ejection seat.

**8C9.79** The canopy clearance system is a method of removing enclosed canopies to allow the free and safe movement of the ejection seat during the ejection sequence. This system is an integral part of the ejection process and can be achieved in two general ways.

- Miniature detonating cord/linear cutting cord
- canopy jettison.

## Miniature detonating cord/linear cutting cord

**8C9.80** Miniature detonating cord or a linear cutting cord may also be referred to as a 'mild detonating cord'. This is an explosive cord that is clearly visible both around and through the top of the canopy. When operated, the cord is designed to explode outward, shattering the canopy material to allow the seat to pass through without injury to the pilot.

**8C9.81** This system is part of the ejection sequence but can be operated independently from outside the aircraft. The external operation is normally located on the forward side of the aircraft and marked accordingly.



Source MOD Crown Copyright

- 8C9.82** If used for rescue, extreme caution must be exercised and all firefighters cleared from the area for a distance of at least 20m before operating. External operation of the miniature detonating cord/linear cutting cord will not initiate the ejection sequence, but after operation the seat will still be live.
- 8C9.83** Military advice indicates that the miniature detonating cord/linear cutting cord creates an initial cloud of fine particles and slithers of canopy transparency in line with the cord which are blasted outwards. With miniature detonating cords the remainder of the canopy simultaneously breaks into irregular sized pieces, with a linear cutting cord the canopy splits into two sections which are projected sideways away from the aircraft. These pieces can travel a distance varying between 3m and 20m depending on the canopy shape. However it should be noted that the majority of the canopy fragments are propelled upwards and sideways rendering the area forward of the cockpit area comparatively clear of debris.
- 8C9.84** Military advice indicates that Fire and Rescue Service personnel dressed in full protective clothing with helmet and visor down, outside the 3m area, are adequately protected from canopy debris when the miniature detonating cord is operated.

## Canopy jettison

- 8C9.85** This system is part of the ejection sequence when initiated by the pilot. Where fitted, the external operation initiates the canopy jettison.



Source Martin-Baker

- 8C9.86** A system of explosive release and small rocket propellants remove the canopy and the frame as one unit. These usually fire upwards and backwards simultaneously and present a significant hazard when operated on the ground due to the velocity and weight of the canopy (100kg or more). If operated as part of the external rescue methodology, extreme caution must be exercised before actuation, to ensure all Fire and Rescue Service personnel are clear of the area above and behind the aircraft. Actuation of the external canopy jettison will not initiate the ejection sequence but the seat will still be live.
- 8C9.87** On some older aircraft, the canopy jettison is not rocket assisted, when actuated by the pilot or externally, the canopy bolts will be released. This will result in the canopy being removed in flight by the slipstream and when the aircraft is on the ground resulting in the canopy being released, therefore allowing the canopy to be manually lifted clear of the aircraft.

## Access to cockpit

- 8C9.88** A military aircraft canopy is a transparent covering located above the cockpit. It is usually constructed out of a transparent material and is extremely strong and heavy. Methods of rescuing aircrew from the cockpit will require one of three differing scenarios:
- normal entry
  - emergency entry
  - forced entry.

### Normal entry

- 8C9.89** Gaining access to the cockpit initially should be by normal means, canopies can ordinarily be opened by the pilot by means of a manual, pneumatic, electronic or hydraulic system. These units can weigh in the region of 100kg and therefore once open they will need to be secured in place to prevent them from slamming shut, which could render serious injury to Fire and Rescue Service personnel and/or aircraft crew.
- 8C9.90** Alternatively canopies can be opened by a release mechanism on the outside of the aircraft, the method and design of opening mechanisms changes depending on the type of aircraft.
- 8C9.91** In the event of an aircraft accident and the pilot incapacitated the canopy may need to be opened by responding Fire and Rescue Service personnel.
- 8C9.92** Instructions on how to open the canopy in an emergency situation will be written on the outside of the aircraft.

Source MOD Crown Copyright

**Picture 26: External canopy release on a Harrier**



Source MOD Crown Copyright

**Picture 27, 28 and 29: Emergency instruction and emergency canopy release cable on a Harrier**



Source MOD Crown Copyright

**8C9.93** Emergency entry by Fire and Rescue Service personnel to an aircraft fitted with an miniature detonating cord/linear cutting cord:

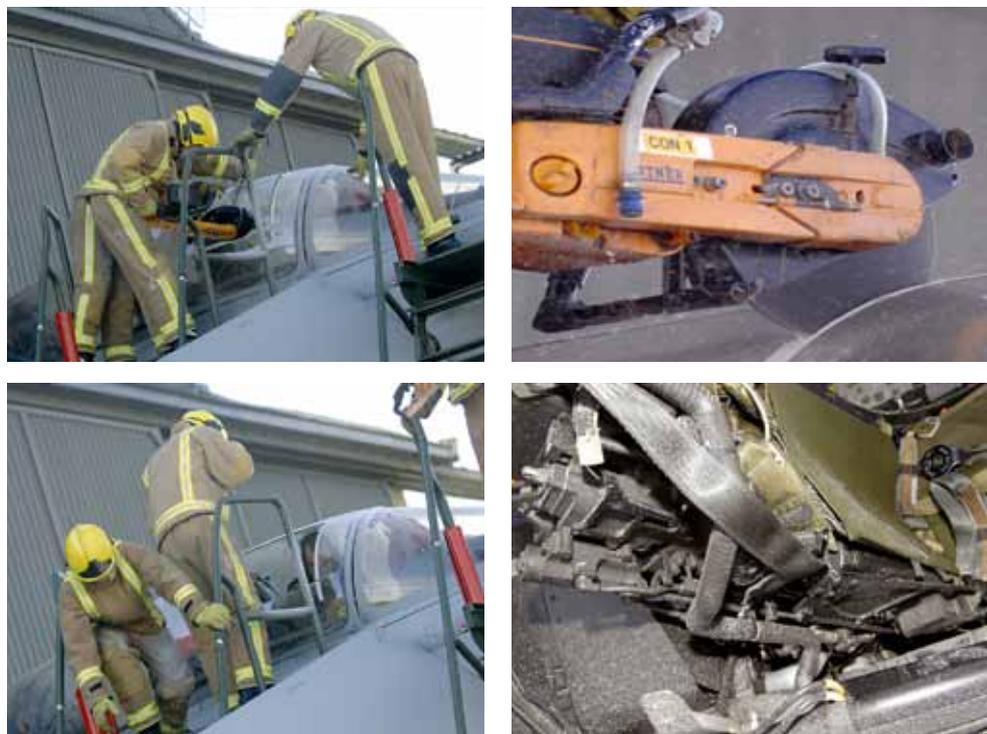
- approach the cockpit in full view of aircrew

- be prepared for the aircrew to operate miniature detonating cord, on such a signal face away from the aircraft at least 3m forward of the cockpit area, if this is not possible crouched down below the line of the cockpit sill
- if Fire and Rescue Service personnel are to operate the cable, brief all staff and maintain the safety cordon
- remove cable from its storage
- move to a position forward of the cockpit taking up the slack
- facing away from the cockpit (full personal protective equipment and visors down) give the cable a sharp pull to detonate explosive cord
- the cable can be extended by the use of a line if the situation warrants it (i.e. the position of the aircraft).

## Forced entry

**8C9.94** The condition of the aircraft may prevent successful operation of the emergency rescue handle. As an example, cables or linkages may become distorted, or cracked tubing may allow cartridge gases to be exhausted ineffectually. In the event, it would be very difficult to gain access and the rescue team would have to be very resourceful.

**Picture 30, 31, 32 and 33: Forced entry being made into a cockpit by DFRMO firefighters, final pictures indicates the amount of dust produced as a result of this activity**



Source MOD Crown Copyright

## Cutting through the canopy

**8C9.95** A power saw/disc cutter may be used to cut through the canopy including the miniature detonating cord/linear cutting cord, this practice must only be used in extreme circumstances, when cutting care must be taken not to pinch the cord against an internal hard surface. There will be a considerable amount of dust created by this activity and therefore suitable respiratory protective equipment must be worn by Fire and Rescue Service personnel. There is a high likelihood that the aircrew will have an O2 mask on. However if forced entry is to be made the airway protection of the aircrew will be difficult to control until the cuts have been made.

## Not to be considered under any circumstances

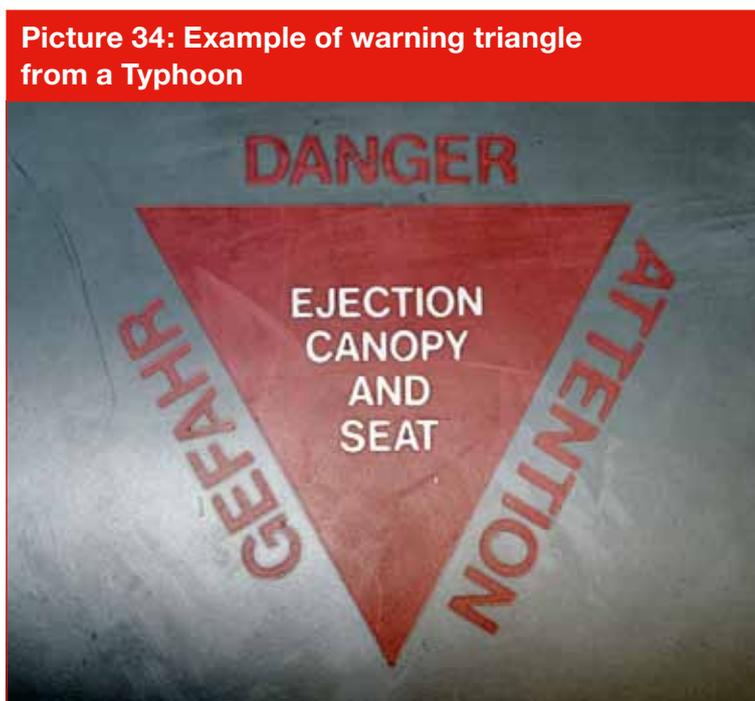
**8C9.96** Forcing off the canopy with hydraulic rescue equipment or crowbars is a highly dangerous activity and not recommended.

**8C9.97** It would be difficult to assess the state of any damage to the aircraft canopy, which could fire off if the canopy frame is interfered with.

## Ejection seat

**8C9.98** An ejection seat is a life-saving device for aircrew whose aircraft is in an unrecoverable situation, however whilst the aircraft is on the ground, it presents a dangerous explosive hazard to persons entering or leaving the cockpit.

**8C9.99** To highlight the dangers of ejection seats all aircraft are marked with a warning triangle at the point of entry to the cockpit.



Source MOD Crown Copyright

## Ejection sequence

- 8C9.100** There are many different types and designs of ejection seats and the sequences will differ according to design, below is an example of a rocket assisted ejection seat sequence.
- 8C9.101** Once the ejection handle is pulled by the pilot, the canopy clearance system will operate. Part of that operation is to initiate the seat firing sequence. Once the canopy has been removed, the seat will begin to rise using a progressive explosive cartridge which will carry the seat 6ft to 8ft up the inbuilt guide rail. The raising of the seat will fire a rocket pack located under the seat pan designed to carry the seat approximately 300ft clear of the aircraft. These rockets discharge downward at an extremely high temperature and velocity.
- 8C9.102** During this phase, the inbuilt barostat and gyroscopes will release a drogue chute which stabilises and ejects the seat. As the seat slows, the main chute will deploy and the seat separates from the pilot deploying the survival pack.

**Picture 35: First stage of ejection sequence**



Source Martin-Baker

**Picture 36: Drogue chute in operation**



Source Martin-Baker

**8C9.103** Whilst it varies from seat to seat, the whole ejection sequence takes approximately 2.8 seconds. Where two seats are fitted, either tandem or side by side, there is an inbuilt time delay to avoid collision but this is measured in tenths of a second and will visually appear to be simultaneous.

## Command ejection

**8C9.104** This facility is fitted to most modern two seat strike aircraft, which allows either pilot to initiate ejection for both seats, should one pilot become incapacitated. With this system active, inadvertent operation will activate both seats sequentially.

## Ejection seat safety

**8C9.105** Aircraft Assisted Escape Systems present a significant hazard to responding Fire and Rescue Service personnel attending a military aircraft incident. In reality if the incident is off airfield then there is a high likelihood that Fire and Rescue Service personnel will be the first on the scene.

**8C9.106** Martin-Baker is one of the principal suppliers of ejection seats to the UK military and produces many variants and designs. Ejection seats will also be found in private ex-military aircraft which are flown and displayed at numerous air shows around the country each year.

**8C9.107** Ejection seats can be made safe but personnel need training and familiarisation and due to the extensive range of seat configurations this training and familiarisation will be difficult to achieve for Fire and Rescue Services.

**8C9.108** To make an ejection system safe requires the controlling of the firing sequence by pinning the ejection handles or the safe seat lever.

**8C9.109** Unless there is overriding reasons to do so, Fire and Rescue Service personnel should not attempt to make safe an ejection seat system. This should be left to trained and competent technicians from the relevant military services.

## Making a seat safe – emergency situations only

**8C9.110** Fire and Rescue Service personnel may be faced with undertaking this task in exceptional circumstances and therefore the following guidance is given to assist in this activity.

**8C9.111** On arrival at the aircraft, look for the seat guide rails projecting out of the canopy area. If they are visible it can be an indication that the seats have fired from the cockpit and the crew may be some distance from the airframe. Never assume the seats have gone, a two seat aircraft may have had only one occupant, or a seat may have failed to operate.

**Picture 37: Crashed Tornado, both pilots ejected and the guide rails from the cockpit are clearly visible**



Source MOD Crown Copyright

**8C9.112** Ejection seats can be made safe at varying levels usually described as:

- safe for rescue.

**8C9.113** The seat firing sequence is inoperable but the seat systems are still active and elements such as the drogue gun can still be fired.

- safe for servicing.

**8C9.114** Seat totally disabled for maintenance purposes by a competent technician.

## Seat design and component parts

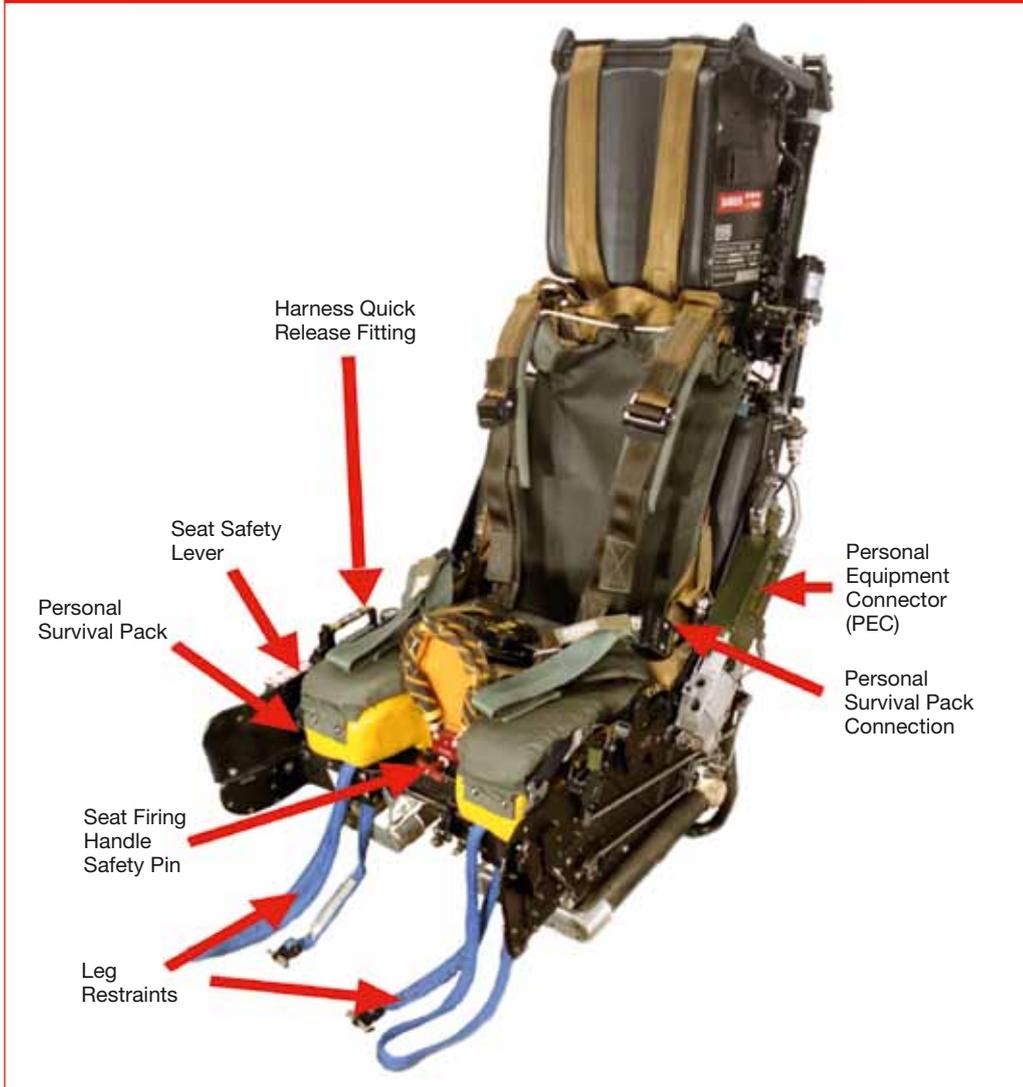
**8C9.115** Whilst the aircraft is parked on the ground, safety devices in the form of distinctive safety pins are fitted to prevent the accidental actuation of the ejection seat.

**8C9.116** Modern ejection seats have changed considerably from their earlier counterparts. In most cases they can be made safe for rescue using just one or two seat pins or by the operation of the seat safe lever (see picture). These seats differ from aircraft to aircraft but they all work in a similar manner. Once initiated, the ejection sequence is fully automatic and can not be stopped.

**8C9.117** All UK aircraft carry a set of seat pins in the cockpit for making the seat safe for rescue; however some visiting forces no longer carry seat pins and rely solely on the seat safe lever.

**8C9.118** To operate the seat safe lever, reach into the cockpit and rotate the lever in an anti clockwise direction, in order to turn from armed to safe egress, as shown in pictures 37 and 38.

**Picture 38: Martin-Baker Mk 12 Harrier ejection seat**



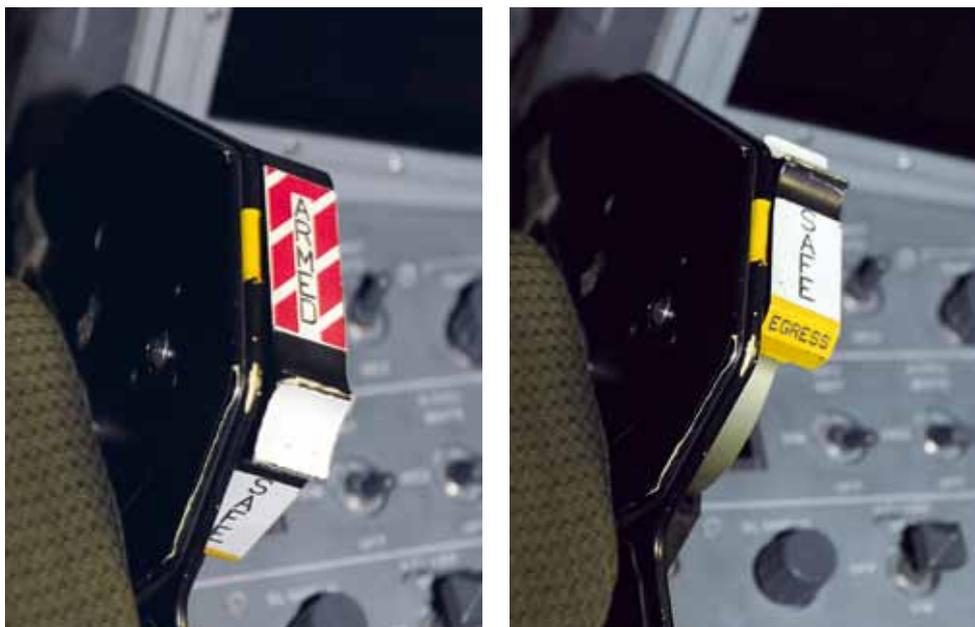
Source Martin-Baker

**Pictures 39 and 40: Mk 10 ejection seat main gun seat safety pin**



Source Crown Copyright

**Pictures 41 and 42: Seat safe lever that can be found on a number of ejection seats**



Source MOD Crown Copyright

## Rescue of aircrew

**8C9.119** The sequence of events:

- operate safe seat lever or locate seat seat pins to make seat safe for rescue
- remove the oxygen mask, do not remove helmet
- disconnect the personal equipment connector, in most cases this will also release arm and leg restraints
- disconnect the personal survival pack
- disconnect leg restraints and arm restraints where fitted, if not already achieved by disconnecting the personal equipment connector
- release the main harness at the central release mechanism
- clear all harnesses and remove aircrew from aircraft.

**Note:**

Be aware of possible spinal injury and if safe to do so, await medical assistance.

**8C9.120** The harness arrangement may differ from aircraft to aircraft but the sequence to be followed is generic to all. Release should generally start at the head and work downwards at the sides of the body to the feet and finish at the main harness release.

## Lift out and removal of casualty

- 8C9.121** Ensure all lines and connectors are released before lifting. Remove the occupant carefully ensuring sufficient personnel to take the weight and all working surfaces are secure. If ladders are used in the lift out they must be properly secured to avoid slippage.
- 8C9.122** You will be operating in very confined spaces and great care must be taken not to operate any switches accidentally.

## Military aviation authority

- 8C9.123** The Military Aviation Authority is the Ministry of Defence (MOD) regulatory body that will regulate, audit and quality assure military aviation. The department was formulated following the recommendations by Mr Haddon-Cave QC, following the Independent Nimrod Review.
- 8C9.124** The Military Aviation Authority remit is to enhance the delivery of operational capability through continuous improvement in military air safety, associated culture and practice, enabled by effective regulation. The Military Aviation Authority will be responsible to the Secretary of State for independently ensuring the highest standards of aviation safety and airworthiness in the military aviation sector.
- 8C9.125** The Military Aviation Authority will cover three principal areas:
1. Operations Group which will regulate and assure flight operations, flight test operations and air traffic management
  2. Technical Group which will issue technical regulations and approvals for organisational technical airworthiness
  3. Military Air Accident Investigation Branch will support all military investigations into military air accidents.

## Military response to an aircraft accident

- 8C9.126** In the event of a military aircraft accident the MOD response will initially be coordinated by the Aircraft Rescue Coordination Centre (ARCC) and the MOD will initiate their standard operating procedures to deal with the incident. This will include a military post crash management incident officer and the Joint Aircraft Recovery and Transportation Squadron.

## Military post crash management incident officer

- 8C9.127** The military definition of post crash management includes those activities carried out at an aircraft crash site:
- preservation of evidence

- health and safety precautions
- corporate communications (public relation duties)
- activities undertaken to restore the accident site to a satisfactory condition.

**8C9.128** The above activities will be overseen by the military post crash management incident officer, their role will be to project manage the crash site on behalf of the MOD, following fire and rescue activities and when given permission to do so by the police. The post crash management incident officer will be assigned to the incident from a suitable military base. The post crash management incident officer will be mobile within three hours of notification to attend the crash site and liaise with the police to establish a suitable time to take over the management of the scene.

**8C9.129** They will remain at the scene to project manage all activities until the relevant accident investigation is being carried out and the aircraft has been recovered. They will also ensure that the site is handed over to the landowner following restoration to a satisfactory condition. This may take days, weeks or months.

## Joint Aircraft Recovery and Transportation Squadron

**8C9.130** The Joint Action Recovery and Transportation Squadron (JARTS) principal responsibilities are:

- to recover crashed MOD aircraft
- for the transportation of military aircraft for the MOD by:
  - land
  - sea
  - air
- the transportation of large uncrated aircraft components
- when requested to support the Air Accidents Investigation Branch at civil aircraft accidents.

**8C9.131** In the event of a military aircraft accident, the Joint Action Recovery and Transportation Squadron will allocate an aircraft recovery officer to attend the scene.

**8C9.132** The aircraft recovery officer will have seen many aircraft crash sites and will be a specialist in this area. The aircraft recovery officer will be deployed from RAF St Athan, within one hour of notification and will endeavour to reach any crash site in the UK, within 12 hours. Their role will be to liaise with the post crash management incident officer and their responsibilities will be to:

- control all inner cordon activities and advice on cordon distances
- ascertain hazards at crash site, and give advise to the post crash management incident officer

- determine appropriate level of personal protective equipment to be worn within the cordon areas
- eliminate hazards and provide health and safety advice to the post crash management incident officer.

**8C9.133** The Joint Aircraft Recovery and Transportation Squadron aircraft recovery officer will be able to provide:

- basic on site accommodation
- air shelters
- cordon facility
- cutting tools
- specialist vehicles
- land survey equipment used to carry out a detailed site survey.

**8C9.134** They will also have access to a wide range of external support agencies to achieve aircraft recovery from remote mountain locations and aircraft recovery at sea.

**8C9.135** For more information on MOD Search and Rescue Facilities and Aeronautical Rescue Coordination centre see appendix D.

## PART C-10

# General aviation

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## Introduction

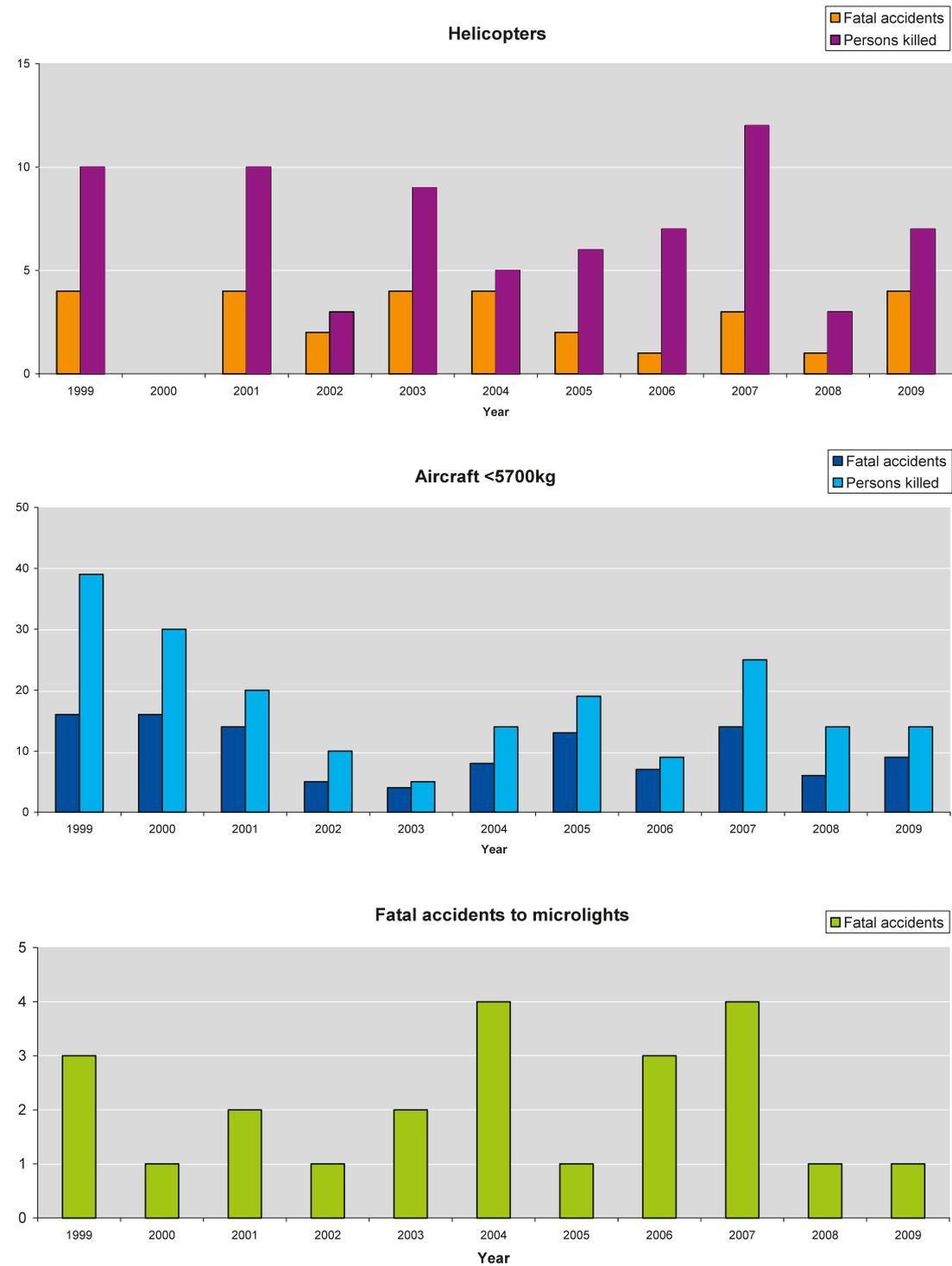
- 8C10.1** General aviation forms the majority of the UK's air traffic, with many airports offering facilities solely for these types of aircraft. General aviation is one of the two categories of civil aviation, the other being scheduled air transport. General aviation refers to all flights, private and commercial that are not military, cargo flights or scheduled airline flights.
- 8C10.2** General aviation covers aircraft from gliders, powered parachutes, hot air balloons and ex-military aircraft up to 5700kg in weight (without fuel loading). This also includes single seat de-regulated (SSDR) aircraft which are aircraft/microlights that weigh less than 115kg (without pilot and fuel).
- 8C10.3** For more information on hot air balloons please see appendix E and for more information on gliders please see appendix F.
- 8C10.4** This chapter will provide an overview of the smaller types of aircraft that Fire and Rescue Service personnel may have to deal with as a consequence of an aircraft incident. Fire and Rescue Service will be more likely to deal with general aviation aircraft incident than a large aircraft or military aircraft incident. Each year there are a number of serious incidents involving general aviation aircraft, as illustrated in the tables overleaf.

**Picture 1: General aviation aircraft crash into tree**



Source Durham Fire and Rescue Service

**Picture 2: CAA statistics for general aviation accidents**



Source CAA

**8C10.5** It is important to note that although the Civil Aviation Authority retains the responsibility for safety regulation, a large proportion of the smaller general aviation aircraft are regulated by the Light Aircraft Association with regard to design, construction and maintenance. Similarly, the majority of microlights are regulated by the British Microlight Aircraft Association. Both of these are specialist bodies acting under the delegated authority of the Civil Aviation Authority.

## Construction

**8C10.6** The type and size of aircraft are as diverse as the materials used to make them and range from single seat microlights to veteran aircraft, such as a Spitfire. General aviation aircraft are constructed from ribs, formers and stringers with a skin of either metal, cloth or composite materials.

## Aircraft engines

**8C10.7** The majority of general aviation aircraft are single engine aircraft, for more information on aircraft engines see *Aircraft Engines* chapter.

## Materials

**8C10.8** Many types of metal alloys are used in construction that will be located throughout the fuselage and will be found at an aircraft accident.

**8C10.9** The most commonly used alloys are:

- aluminium alloy
- magnesium alloy
- titanium alloy.

**8C10.10** Other commonly used materials in aircraft construction are:

- polymer composites
- wood
- plywood skin with a canvas covering
- fibreglass
- steel tubing
- foam (preformed Styrofoam)
- stainless steel cable.

## Wings

- 8C10.11** General aviation aircraft will be either high wing or low wing design. The wings usually contain the main fuel tanks. Like in most types of twin engined aircraft, they also house the engines and engine accessory bays.
- 8C10.12** Additionally, in more complex types of light aircraft the wings may house retractable undercarriages with their associated hydraulics. There may also be wing mounted pods containing avionics such as weather radar.
- 8C10.13** Some light aircraft may be fitted with ice protection systems mounted on the leading edge of the wings. One particular type utilises a chemical anti-freeze called Ethylene Glycol which is pumped from a central tank to outlets or porous surfaces along the wing, to deal with any build up of ice in flight.
- 8C10.14** Ethylene Glycol is flammable with a flash point below 61°C and it will create slippery surfaces if sprayed or spilt on painted aircraft surfaces.

**Picture 3: High wing configuration**



Source WSFRS

**Picture 4: Low wing configuration**



Source WSFRS

## Electrical systems

**8C10.15** The electrical systems of most light aircraft work on 14V or 28V D.C. current and will generally be powered by 12V or 24V batteries. Most batteries will be located in the engine compartment, although they can be located in a number of different locations depending upon the type of aircraft. One indicator of the battery location is the external power socket (if fitted). If the battery is not in the engine compartment it may be close to the external socket.

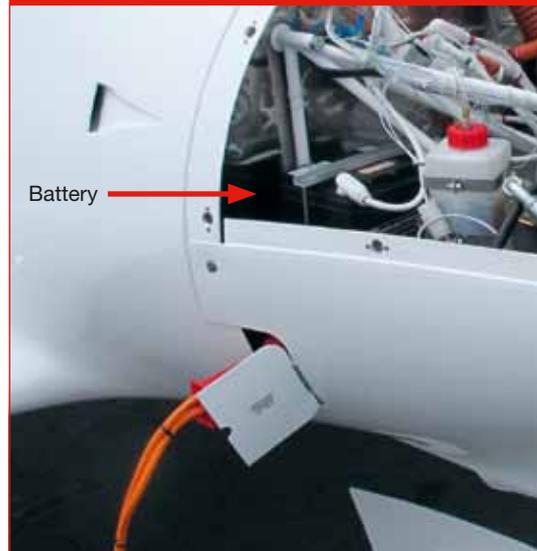
**8C10.16** The batteries will either be traditional lead acid batteries or gel based. These batteries are capable of high amperage and present a significant hazard.

**8C10.17** Batteries can be disconnected at source or isolated from the cockpit by activating the battery master switch. The battery master switch is usually a split 'rocker' type, with one half operating the battery and the other the alternator.

**8C10.18** The diagrams opposite show some common master switch locations. In multi engine aircraft there will be more than one battery master switch. They could be located on an overhead panel.

**8C10.19** If it is decided to remove a battery for safety reasons, ensure that the negative terminal is removed first and the positive terminal last, this will help prevent the possibility of a 'voltage spike' which can cause sparks.

**Picture 5: Ground power socket**



Source WSFRS

**Picture 6: Master switch**



Source WSFRS

**Pictures 7 and 8: Location of battery in general aviation aircraft**



Source WSFRS and Cirrus

## Fuel and fuel system

(For more information see the *Fuel and Fuel Tanks* chapter)

- 8C10.20** The fuel system in general aviation aircraft is designed to supply reciprocating engines which usually run on high octane gasoline Avgas and in some smaller microlights petrol (Mogas), and the use of diesel engines is increasing in general aviation. Turbine engines will use Jet A1 aviation kerosene.
- 8C10.21** Generally the hazards associated with general aviation are that Avgas and Mogas have a much lower flash point than Jet A1. Therefore there is a high risk of post crash fire at a general aviation aircraft incident.
- 8C10.22** It is important to note that the fuel tanks will be located in various places depending upon the aircraft. Fuel will usually be stored within baffled sections of the wings but can also be found in wingtip tanks, tanks within the fuselage, under floors or in the case of some microlights, attached to the open airframe structure.
- 8C10.23** High wing aircraft usually have gravity fed fuel systems. The fuel pressurised by gravity flows down small gauge steel tubes from each tank, which depending on the aircraft type can pass through and down any of the vertical posts around the doors and windscreen. Additionally there may be a fuel pipe running through the roof lining which equalises atmospheric pressure between tanks.
- 8C10.24** Low wing aircraft will have pressure fed fuel systems. The pressure being supplied by a mechanical (engine driven), electrical or both types of fuel pump. Mechanical fuel pumps will cease to operate when the engine stops, electric pumps will continue to pump fuel as long as there is power.
- 8C10.25** The proximity of the fuel tanks to the undercarriage of low wing types is potentially more hazardous in light aircraft than other types. Any fires or severe overheating affecting the undercarriage may quickly impinge on the fuel tanks.

## Making access

- 8C10.26** Making access to the cockpit can be achieved through normal side doors which are secured with locking systems and may be similar to those of road vehicles. Access can also include sliding canopies or hinged canopies and some aircraft will have open cockpits. Fire and Rescue Service with an aircraft risk in their area should arrange for Fire and Rescue Service personnel to be familiar with the different types of locking mechanisms which may be encountered at an accident. Additionally, there are many different types of seatbelt mechanisms in use which rescuers need to be familiar.

**Picture 9, 10, 11 and 12: Some example general aviation aircraft canopies and doors**



Hinged door



Forward hinged canopy



Side hinged gull wing door



Top hinged gull wing door

Source WSFRS

- 8C10.27** Due to the light construction of these aircraft the door assembly units are unlikely to work following an aircraft incident. However access to the cockpit areas should not prove challenging due to the light materials used in the construction of general aviation aircraft.
- 8C10.28** Due to the location of some fuel pipes, ballistic parachute systems no cut zones and the possibility of other aircraft systems being affected, Fire and Rescue Service personnel attempting to force entry into a crashed light aircraft should focus their rescue efforts on the doors and window areas.
- 8C10.29** Fire and Rescue Service personnel attending an incident should be aware that if a low wing aircraft overturns on landing there is a high likelihood that the sliding canopies and hinged openings will be severely compromised as a consequence of the accident. If a high wing aircraft overturns on landing this may not be such an issue.
- 8C10.30** When dealing with inverted aircraft Fire and Rescue Service personnel should always be aware of the possibility of fuel leaks from tank vents, even if the tanks are still intact and the filler cap in place.

**8C10.31** It is very important that Fire and Rescue Service personnel familiarise themselves with general aviation aircraft and airport/airstrips. The light aircraft association have aviation clubs across the country known as 'Struts' and these clubs are a useful source of information on general aviation. Local Struts can be contacted via [www.laa.uk.com](http://www.laa.uk.com).

## Ballistic parachute systems

**8C10.32** A recent development in aircraft design has been to include the installation of ballistic parachute systems into an increasing number of microlight (SSDR), light aircraft and more recently the Diamond Jet. At present these systems are only fitted to single engined aircraft, but manufacturers are looking at the possibility of systems which are capable of being fitted to larger multi engine aircraft. The systems utilise a rocket propelled parachute which is deployed by the pilot if the aircraft or pilot experiences a severe in-flight emergency.

**8C10.33** There are at least three major types of system in aviation use, the Ballistic Recovery System, the Cirrus Airframe Parachute System and the Galaxy Recovery System. The method and sequence of operation is the same with all types. However the component parts, the rocket motor in particular, differ in appearance.

**8C10.34** The systems may be contained within the fuselage construction (cirrus airframe parachute system), internally housed in a rigid launch container in the rear compartment, or externally mounted in a rigid or nylon 'softpack' launch container (Ballistic Recovery System/Galaxy Recovery System).

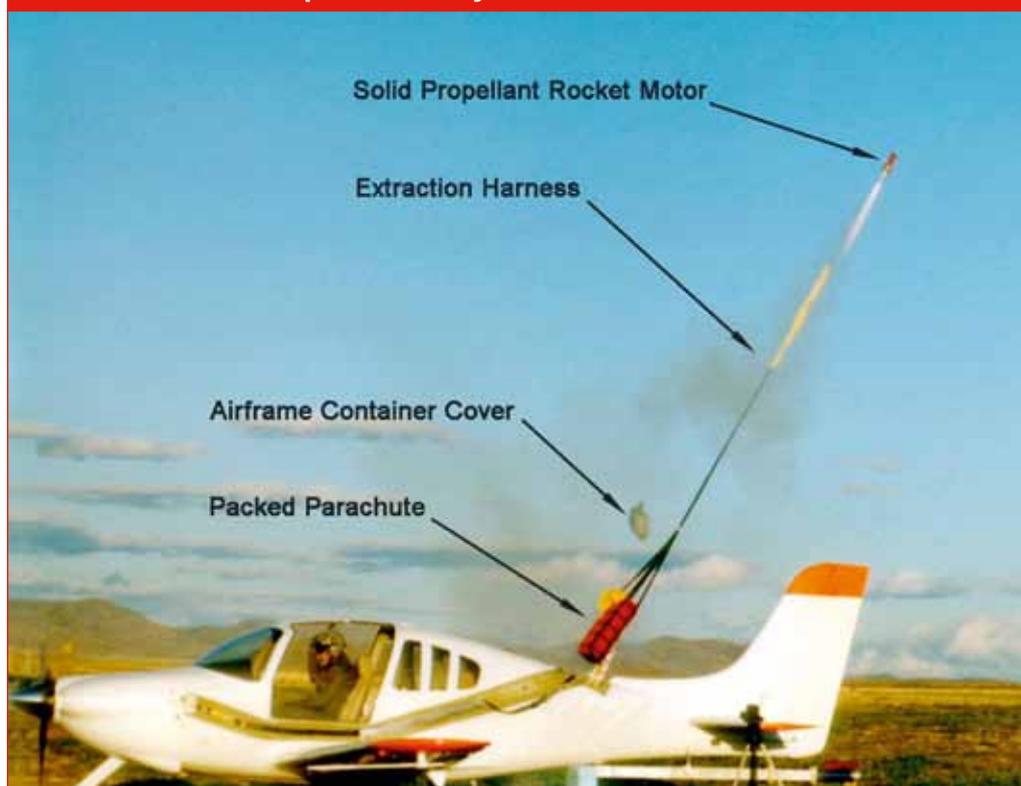
**8C10.35** The usual trajectory taken by a rocket being deployed is to the rear of the aircraft. However in some microlight designs the rocket may deploy straight up, or up and slightly forwards.

**Picture 13: Deployed ballistic parachute system, Oxfordshire**



Source AAIB

**Picture 14: Ballistic parachute system**



Source Cirrus

**Pictures 15, 16 and 17: Examples of ballistic parachute system**



Cirrus CAPS



Ballistic Recovery System



Galaxy Recovery System

Source Cornwall Fire and Rescue Service and Cirrus

- 8C10.36** Under normal conditions, the system is well secured and is not prone to accidental firing. The rocket will only fire if the activation handle in the cockpit is pulled with sufficient force. However, the system can be less predictable if an aircraft has been in an accident.
- 8C10.37** All ballistic parachute systems are self contained and do not rely on external power sources from the aircraft electrical systems. Therefore isolation of batteries and power supplies will not render these systems deactivated.
- 8C10.38** If an aircraft fitted with a ballistic parachute system crashes without the system being deployed it is possible for structural damage to the fuselage to stretch the activation cable to the point where further movement of the wreckage may cause the rocket to fire.

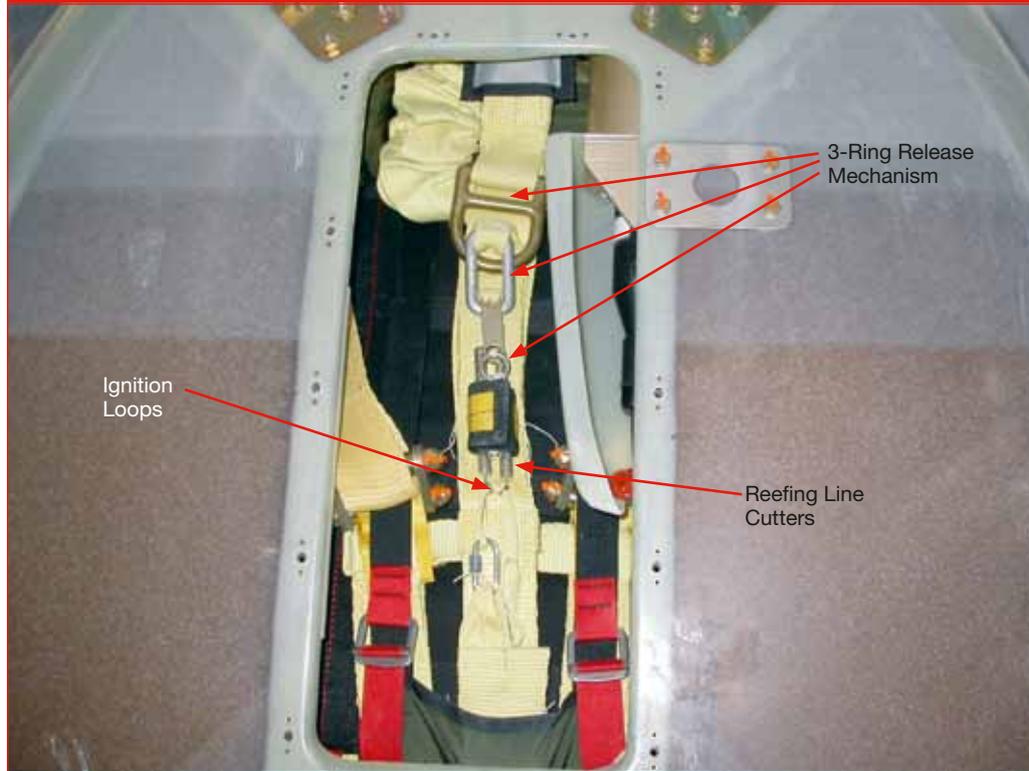
**Picture 18: Ballistic parachute system deployment**



Source Cirrus

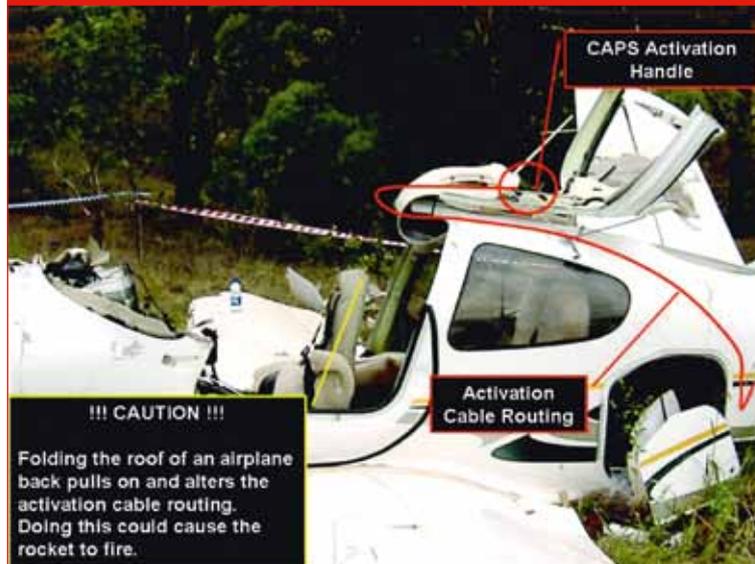
- 8C10.39** Situations have also occurred where ballistic parachute systems have become completely detached from the airframe by the forces generated during a crash which resulted in the still live system lying in the middle of the crash site.
- 8C10.40** If an aircraft fitted with a ballistic parachute system inverts, as a result of an accident and the system deploys accidentally, there will be a high likelihood of a fire occurring, this is due to the rocket firing mechanism being trapped between the aircraft and the ground. Along with the high likelihood of fuel spillage occurring as a result of the aircraft's position, this could result in a very rapidly developing fire situation.
- 8C10.41** A ballistic parachute system unit is comprised of four major elements:
- activation handle
  - activation cable
  - rocket motor assembly
  - parachute container.
- 8C10.42** The ballistic parachute system is initiated by pulling the red activation 'T' handle, which is located in the cockpit. The rocket motor (about 1½/2 inches diameter and 8/10 inches long) then accelerates to over 100mph in the first tenth of a second after ignition. It is the operation of the rocket which presents a significant risk of injury to personnel.
- 8C10.43** An additional hazard presented by some systems is in the way in which the parachute is deployed. A mechanism on the parachute harness straps is held in place until the appropriate time in the parachute deployment sequence.

Picture 19: Cirrus



Source Cornwall Fire and Rescue Service

Picture 20: Demonstrates the potential hazards associated with cutting an airframe fitted with a ballistic parachute system



Source Cirrus

**Note:**

Fire and Rescue Service personnel who move or cut airplane wreckage without determining the existence of a ballistic parachute system or who disregard the positioning of the rocket motor as they work with the wreckage, risk death or serious injury.

**8C10.44** At any incident involving a light aircraft the following action should be taken:

- the fuselage of the aircraft should be examined to check if there is a warning or signs of a ballistic parachute system being fitted, which may include a warning sign approved by the Civil Aviation Authority stating 'Warning! Rocket Parachute' as seen below
- a red operating handle in the roof above the pilot and passenger seat is also an indicator that the aircraft has this system fitted.

**Pictures 21 and 22: Possible warning signs**



Source WSFRS

**Pictures 23 and 24: Ballistic parachute system activation handles before and after deployment**



Source Cirrus

**Facts**

- if the unit activates the rocket will exit the fuselage reaching a speed of 100 mph in the first tenth of a second
- it will reach full extension in 2.5 seconds
- personnel near the aircraft may be injured by the rocket or webbing and debris from the fuselage
- extensive damage to the airframe will occur and spilt fuel could ignite
- if the aircraft is upside down and the unit deploys there is a high likelihood of a fire.

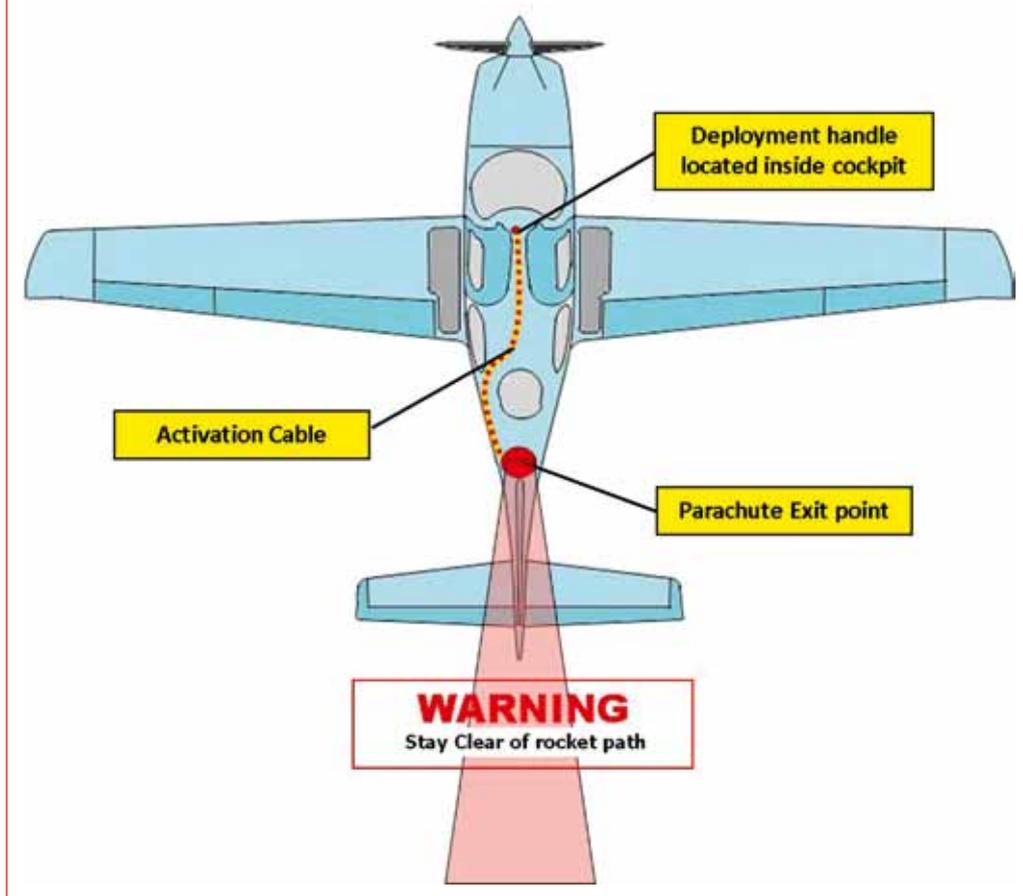
## General aviation aircraft accident – operational considerations

**8C10.45** Where it is identified that the ballistic parachute system is fitted to the aircraft and it has not deployed or the Incident Commander is unable to assess the status of the ballistic parachute system the following should be considered:

- Approach the aircraft from the front or side (beware of propeller hazard)
- If life is not at risk an inner cordon of 100m should be established around the aircraft and access by Fire and Rescue Service personnel and other emergency responders should be restricted until the status of the ballistic parachute system is confirmed
- Where operational crews are required to enter the inner cordon the Incident Commander should assess the potential trajectory of the rocket and parachute if the ballistic parachute system was unintentionally deployed. This should include assessment of risks above the incident such as electricity cables or structures. A 'safe access path' should be designated and controlled to ensure Fire and Rescue Service personnel do not work in the area of trajectory
- Fire and Rescue Service personnel should avoid working in the area above and at the rear of the cockpit and exercise extreme care when using cutting equipment during extrication by being aware of the likely location of the path followed by the activation cable through the fuselage
- Minimise any movement of the aircraft frame to avoid any stresses that may tension the ignition cable
- No attempt should be made to disarm the ballistic parachute system
- In the event of the aircraft being severely damaged by the impact of the accident the rocket assembly can become detached from the aircraft safety frame and therefore presenting a hazard similar to that of unexploded ordnance. The trajectory of the rocket will be difficult to ascertain and the unit

can become unstable (due to post crash heat and fuel contamination) and there have been reports of self detonating, resulting in the rocket assembly flying freely away from the crash site.

**Picture 25: Hazard zones of aircraft fitted with ballistic parachute system**



Source Kent Fire and Rescue Service

- 8C10.46** The Incident Commander should inform other emergency responders attending the incident of the risks of ballistic parachute systems.
- 8C10.47** The police will inform the Air Accidents Investigation Branch of any crash involving aircraft. The Branch will provide additional advice to the Incident Commander on ballistic parachute systems.
- 8C10.48** Further information on the ballistic parachute system can be accessed through the Air Accidents Investigation Branch website at:  
[http://www.aaib.gov.uk/guidance\\_and\\_regulations/guidance\\_for\\_police\\_emergency\\_services\\_and\\_airfield\\_operators\\_2008.cfm](http://www.aaib.gov.uk/guidance_and_regulations/guidance_for_police_emergency_services_and_airfield_operators_2008.cfm)

**Note:**

Only trained technicians should attempt to make safe a ballistic parachute system using specialist cable cutters which are not generally carried by Fire and Rescue Services.

## Pictures 26, 27 and 28: Airbags incorporated into seat harnesses



Source Cornwall Fire and Rescue Service

## Seat belt restraint systems

**8C10.49** Some modern light aircraft and business jets are now incorporating inflatable restraint systems to seat belt systems. One major type is manufactured by Amsafe Aviation and is referred to as the Amsafe Aviation Inflatable Restraint (AAIR) and the following information relates to that product. Other types do exist and firefighters with aviation risks in their areas of operation should attempt to familiarise themselves with different systems.

**8C10.50** In an accident where the system has activated correctly the bags will inflate and deflate within 10 seconds and should not present a hazard to firefighters or the aircraft occupants.

**8C10.51** The pictures below show some examples of different inflatable restraint systems that are currently in use in the UK.

**8C10.52** Usually the operating system is located directly underneath the seat to which it is fitted and consists of an electrical device (Electronic Module Assembly, EMA) which registers the force of the impact. This device is connected to a small helium cylinder which inflates the airbag.

**Picture 29: Electrical module assembly**



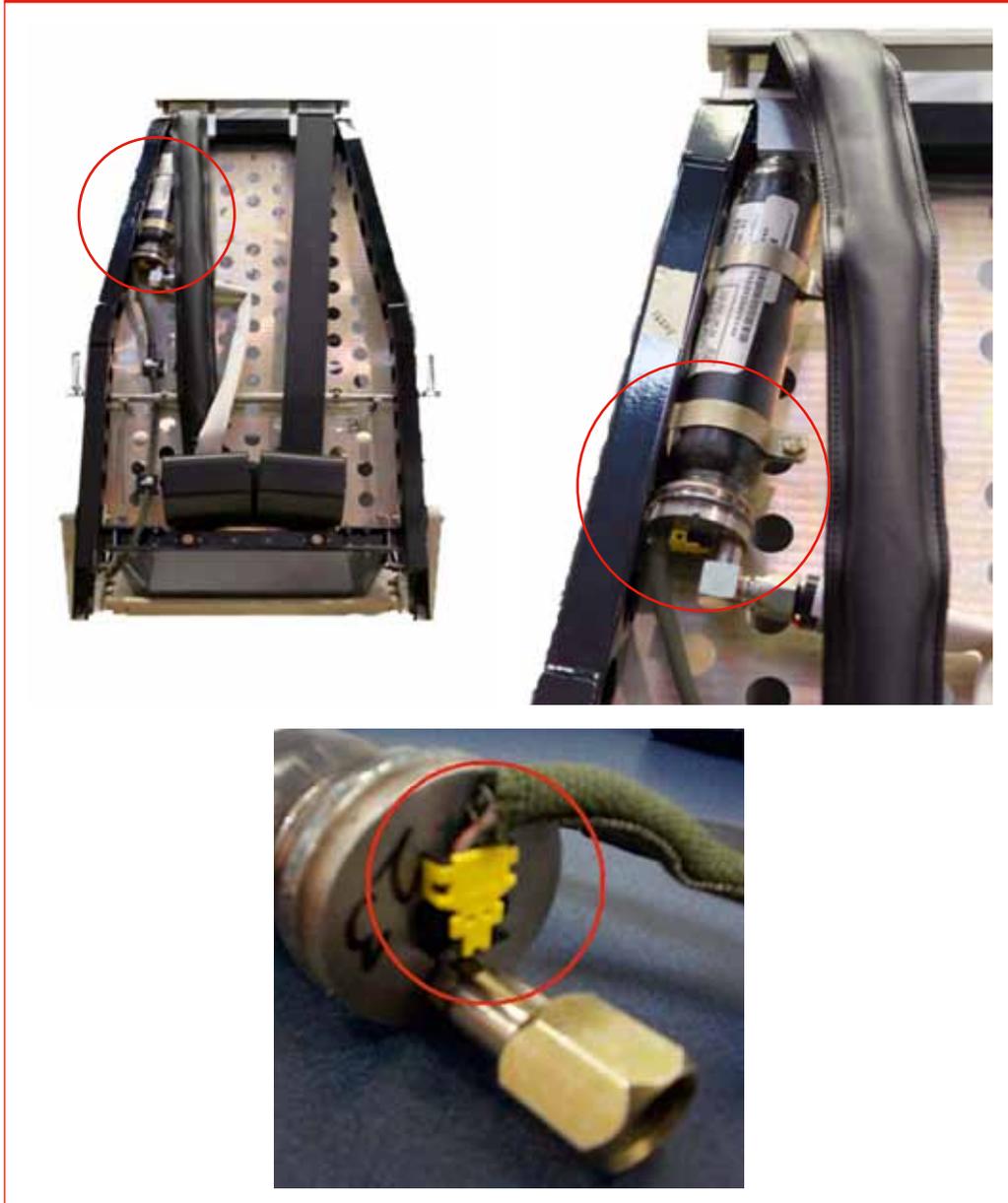
Source Cornwall Fire and Rescue Service

**Picture 30: First method to disconnect cable assembly**



Source Cornwall Fire and Rescue Service

**Picture 31, 32 and 33: Second method to disconnect yellow connector**



Source Cornwall Fire and Rescue Service and Cirrus

- 8C10.53** If an accident occurs and the system has not deployed it may present a hazard to rescuers and occupants. It is possible to deactivate the system by one of three methods.
- 8C10.54** The first method is to disconnect the cable assembly by depressing the locking mechanism which releases the connector valves.
- 8C10.55** The second method is to disconnect the yellow connector from the inflator assembly which is usually located in the immediate vicinity of the electrical module assembly. To disconnect, squeeze both sides of the connector and gently pull away from the inflator.
- 8C10.56** The third method, if access to either of these two connectors is not possible, is cutting the cable connecting the electrical module assembly to the inflator assembly.

**Picture 34: Third method to cut the cable connecting the electrical module assembly to the inflator assembly**



Source Cirrus

- 8C10.57** As the space in the cockpit will be cramped and access to these components is difficult, the reality is that the rescue of the occupants from the cockpit, may well need to be undertaken with the airbags still live.
- 8C10.58** If a fire occurs the inflator assembly will auto-ignite at approximately 230°C and release the stored helium into the aircraft.

## PART C-11

# Aircraft firefighting and rescue considerations

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## Introduction

**8C11.1** This chapter gives general guidance on tackling fire involving aircraft on or off an airport. The areas covered in this chapter are for Fire and Rescue Service personnel and are not directed at Rescue and Fire Fighting Service personnel, who will be working to their own standard operating procedures.

## Cordons

**8C11.2** The use of cordons will be critical in the management of hazards associated with firefighting and rescue operations at an aircraft incident. Dependant on the scale and location of the incident, the size of cordons will vary and to give a definitive distance for cordons is not possible.

**8C11.3** In assessing cordon distances, many factors will need to be taken into account by the Incident Commander. These will need to be constantly reassessed as the incident develops, some key factors to be considered are:

- wind direction/weather conditions
- size of aircraft involved
- engine hazard zones
- slide path (this the contact markings along the ground that the aircraft made as a consequence of the aircraft accident)
- debris (which could be strewn over some considerable distance)
- number and location of casualties
- fuel spillages
- hazardous substances
- post incident investigation requirements by the police/Air Accidents Investigation Branch
- crash site topography
- aircraft armaments/weapon systems
- public/media control.

**8C11.4** Early liaison by the Incident Commander with all agencies and specialist advisers will be critical in achieving realistic and safe cordon distances.

## Compressed air foam systems

**8C11.5** Compressed air foam systems are generally not recommended except at some very low category airports, due to a lack of performance trials involving large aircraft fire scenarios. However this is a developing science and it is envisaged that the use of compressed air foam systems will greatly increase in the coming years, once more detailed analysis is available.

**8C11.6** Therefore Fire and Rescue Services should carry out their own risk assessments if compressed air foam systems are provided on their appliances. Discussions with their local the Rescue and Fire Fighting Service will help clarify the types of incident where the use of compressed air foam systems may be appropriate.

## External fires

**8C11.7** The priority is to create a survivable condition inside the aircraft, for passengers and crew who have not been able to evacuate safely.

**8C11.8** On arrival, appliance positioning is critical, there are no specific instructions regarding this matter, however the following points should be considered:

- so that personnel can clearly see the aircraft and evacuating passengers
- so that appliances do not obstruct escape chutes either in use, or chutes that may be required later
- in a manner which ensures they are unlikely to be unaffected by any sudden movement or collapse of the aircraft (aircraft swing – caused by the collapse of an undercarriage or weather conditions)
- clear of known hazard areas such as rim/tyre disintegration zones, engine intakes and exhausts, propellers, aircraft weapon systems etc
- upwind and uphill
- drivers should be aware of pooling or running fuel.

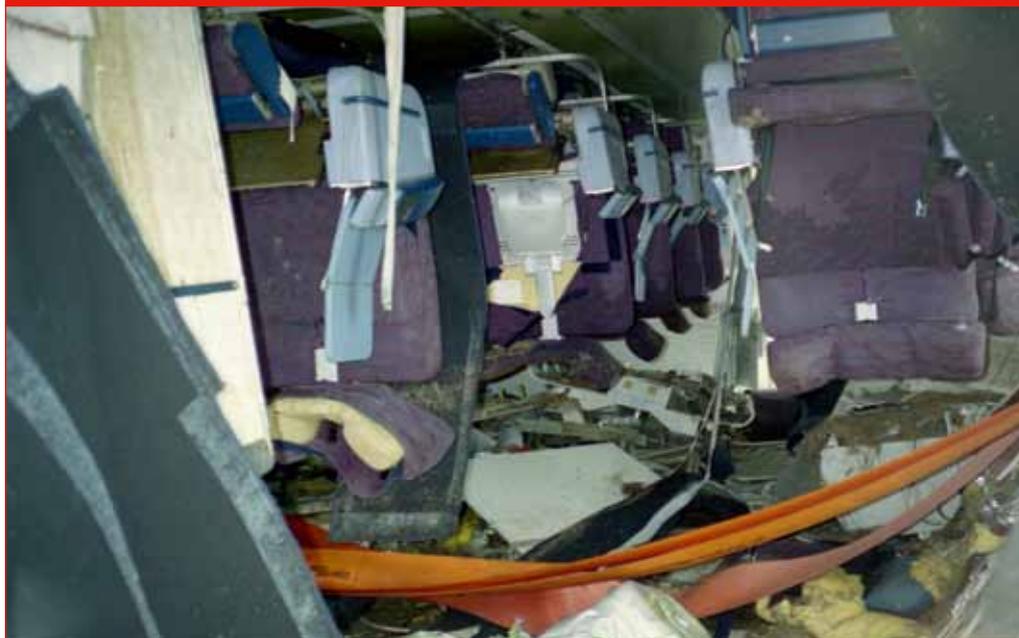
**8C11.9** It is essential that the integrity of the fuselage is maintained; therefore firefighting activities should be directed towards sweeping fire away from fuselage and protecting the escape chutes/routes that are likely to be used. By sweeping fire away from the fuselage the risk of fire penetration is greatly reduced and the fuselage will cool.

- 8C11.10** External fires can penetrate the fuselage within a minute of starting, depending upon the intensity and the location of the fire in relation to the fuselage. Therefore external fires need to be controlled rapidly and entry into the fuselage made as quickly as is reasonably practical.
- 8C11.11** In a fire and/or life risk situation, fuel spillages should be covered by an aspirated foam blanket and maintained until there is no further possibility of accidental ignition. Once all firefighting and rescue operations are complete, a decision will need to be made to stop re-applying foam and maintaining the foam blanket, for the following reasons:
- it covers hazards such as ruts in the ground and sharp debris, creating additional hazards for emergency responders
  - it covers body parts and makes disaster victim identification difficult
  - it creates an additional environmental impact
  - it makes post crash investigation difficult.
- 8C11.12** Escape chutes and exits should be protected throughout the incident by hose lines.
- 8C11.13** As soon as the major fire is under control/out, at least one charged line should be maintained on each side of the aircraft ready for immediate use in case the fire suddenly escalates or reignite.
- 8C11.14** At any time during the incident it is possible that the aircraft or part of the aircraft may collapse. Therefore it is essential that personnel are vigilant throughout the incident and safety officers are designated as per the incident command system.
- 8C11.15** During the incident all personnel within the inner cordon, will wear full personal protective equipment, and the appropriate level of respiratory protective equipment as instructed by the Incident Commander.

## Internal fires

- 8C11.16** Fires involving the interior of modern passenger aircraft are hazardous and complex. Large passenger carrying aircraft will have the capacity to carry more than four hundred passengers (more with the introduction of the A380). Within the cabin area of the aircraft there will be a substantial fire loading. Fires can develop very rapidly if not dealt with, filling the cabin with dense toxic smoke and hampering any escape from the aircraft.
- 8C11.17** The conditions likely to be encountered on the inside of an aircraft with an internal fire include dense toxic smoke, extreme levels of heat and humidity. Personnel are likely to experience difficulty in advancing through the cabin due to debris, casualties and the collapse of the aircraft interior fittings.

**Picture 1: Internal hazards following an inverted aircraft accident**



Source West Sussex Fire and Rescue Service

**8C11.18** Internal fires pose numerous potential hazards for firefighters; the more likely of these are as follows:

### **Aircraft structural collapse**

**8C11.19** In serious internal fire situations there is an ever present risk from the fuselage collapsing. Generally the collapse will occur at the rear of the mainplane, where large portions of the fuselage are unsupported. Personnel working on the exterior of the aircraft must be conscious of where appliances and equipment are positioned. Personnel inside the aircraft must advance with care and ensure their means of egress is maintained.

**8C11.20** The floor of the aircraft fuselage may also be weakened and collapse with no warning, therefore caution must be exercised when moving through the fuselage.

### **Evacuating passengers and crews**

**8C11.21** If not controlled, evacuating passengers and crew may hamper firefighting and rescue operations. Evacuated passengers may attempt to re-enter the aircraft if they discover that their family or friends have not yet escaped. The exercise of firm control over those who have evacuated safely is therefore of paramount importance. The use of passenger management systems as discussed in *On Airport Incidents* is recommended.

## Dense toxic smoke and flammable vapours

- 8C11.22** Fires involving the furnishing of an aircraft will produce large quantities of toxic smoke and flammable vapours. The expedient location and extinguishment of any fire is essential if passengers are to survive. The fuselage must be ventilated without delay. This will allow hot toxic gases and smoke to be replaced by fresh air and therefore greatly improve the chance of survival.
- 8C11.23** The application of foam to the fuselage (internal fires only) is to be avoided as the foam blanket acts as a heat insulator and prevents the internal fire from burning through the fuselage and ventilating the aircraft.

## Pressurised and live electrical systems

- 8C11.24** Fire and Rescue Service personnel working inside may be exposed to pressurised systems and live electrical circuits. Therefore personnel will be required to wear full personal protective equipment and breathing apparatus and correct search procedure must be adhered to at all times.

## Rapid development of fire

- 8C11.25** Because of the rapid build up of heat, large volumes of explosive flammable vapours will be released. This has the potential for a flashover and backdraft, therefore tactics for the reduction of a flashover and backdraft should be adopted.

## Hazardous materials

- 8C11.26** At all incidents involving aircraft there is a danger of aviation fuel, hydraulic fluid, cargo (possibility of numerous hazardous materials) and polymer composite, alloys etc. These all pose a potential hazard and a comprehensive assessment of risk will be required and personnel exposure kept as low as reasonably practicable. Fire and Rescue Service personnel must be provided with the appropriate personal protective equipment and respiratory protective equipment.

## Internal firefighting and search procedures

- 8C11.27** The interior of an aircraft will be unfamiliar to the Fire and Rescue Service personnel. It is therefore vital to personnel working inside the aircraft that firefighting, search and rescue operations are methodical. Fire and Rescue Services should utilise the knowledge and expertise of the Rescue and Fire Fighting Service personnel if in attendance.
- 8C11.28** Fire and Rescue Service personnel entering an aircraft for firefighting operations must, as a minimum, be wearing full personal protective equipment including breathing apparatus. They should also have with them a charged line (45mm) with a hand controlled branch.

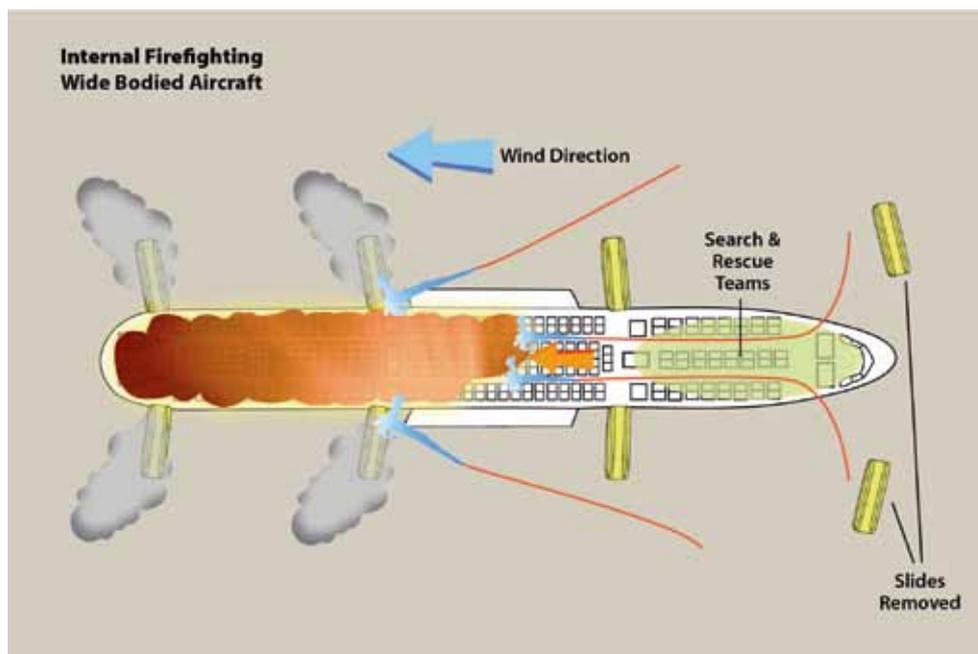
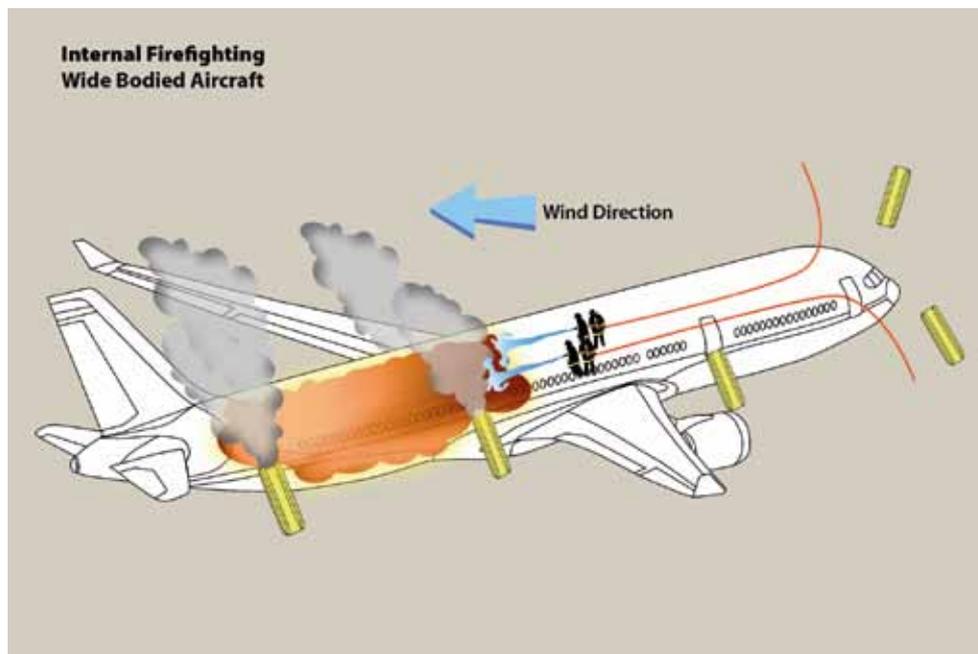
- 8C11.29** Entry into the aircraft may be difficult and escape slides may need to be removed prior to the firefighting teams entering the fuselage. The use of ladders or a stable platform may be necessary.
- 8C11.30** Fire and Rescue Service personnel tasked with firefighting should use a water spray to cool and drive the smoke towards a venting point further along the fuselage (opened by external crews if not already opened by passengers).
- 8C11.31** It is important to vent the fuselage of toxic fumes and smoke as personnel proceed along the fuselage, thus creating a survivable atmosphere. It may not be physically possible to remove all survivors to fresh air, because of the potentially large numbers of passengers involved.
- 8C11.32** Therefore Fire and Rescue Service personnel should not be distracted from their task by passengers that require rescuing, extinguishing the fire and ventilating the fire gases will potentially save more lives. Before venting takes place guard branches should be strategically positioned at the ventilation points.
- 8C11.33** Ventilating an aircraft fuselage can be achieved in a number of ways:
- utilising prevailing wind conditions
  - utilising hose lines and coned spray water jets to forcibly push fire gases towards ventilation points
  - use of positive pressure ventilation fans as per Fire and Rescue Service standard operating procedures, this is not always possible due to the height of the aircraft from the ground
  - internal fires – being allowed to burn through the fuselage, this will self ventilate the aircraft.
- 8C11.34** Hose management will be challenging for teams entering the aircraft due to the confined space, internal layout and post crash debris.
- 8C11.35** Subsequent breathing apparatus teams may be tasked to carry out rescue operations. These teams will need to risk assess the requirements for firefighting media, as hose management and cramped conditions will play a major part of the efficiency of this task.
- 8C11.36** On wide bodied aircraft it will be necessary to use at least one team in each aisle. On some aircraft firefighting/rescue operations may need to be carried out on upper and lower decks. The use of thermal imaging cameras may assist in the location of casualties (thermal imaging cameras do not replace the need for correct search procedures).
- 8C11.37** The searching of the aircraft should be done in a methodical manner and in a way that subsequent teams can assist or re-enter and continue with the search. The use of seat counting and simple laminated charts depicting seat layouts can be useful in identifying casualties and as a reference point for subsequent Fire and Rescue Service rescue teams.

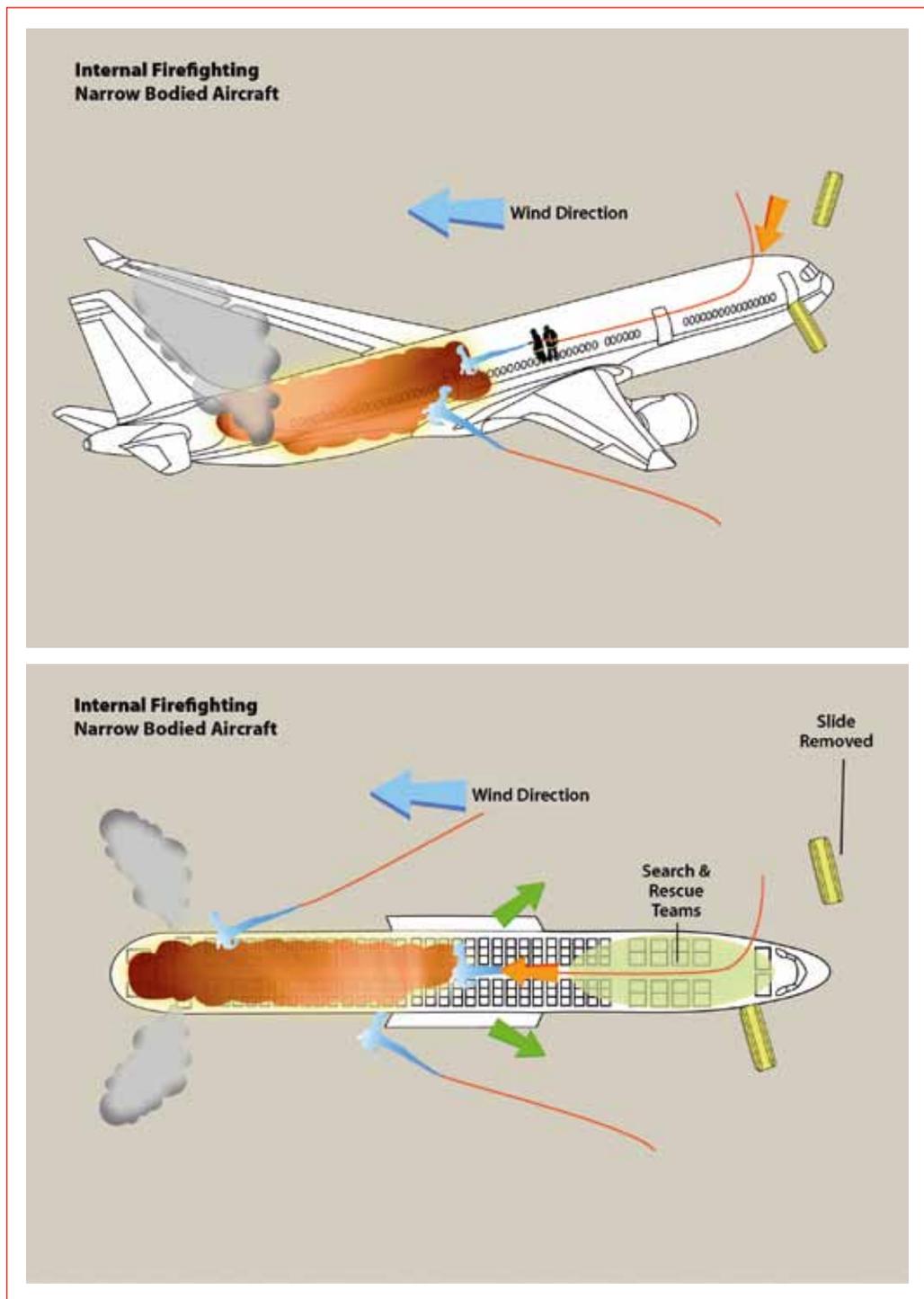
**8C11.38** The water supply to personnel working inside the aircraft must be maintained at all times. Should any team working inside lose their water supply they would be seriously at risk. Therefore during the incident it is vital to monitor the availability of water supplies.

**8C11.39** As in all fire ground operations good communication between personnel is essential.

**8C11.40** Below are some examples of possible internal firefighting scenarios for narrow bodied and wide bodied aircraft.

**Pictures 2, 3, 4 and 5: Indicating possible hose line paths and search and rescue areas**





Source WSFRS

## Fires involving the exterior and interior

- 8C11.41** Aircraft fires which involve both the interior and exterior of the aircraft are extremely difficult to deal with. Entry into the aircraft should not be made until the exterior fire is under control. Secondary fires in the surrounding area would not be a priority.
- 8C11.42** The priority is to bring the external fire under control to effect rescues and maintain the integrity of the fuselage.

- 8C11.43** The exterior fire could prevent the passengers and crew from evacuating the aircraft. In these situations seconds count and the effectiveness and efficiency of the Fire and Rescue Service personnel can literally make the difference between life and death for any persons who survived the initial accident.
- 8C11.44** In the initial stages there is a danger that escape chutes in use could be damaged or cut off by the fire. It is essential that these escape routes are maintained to allow passengers and crew to self evacuate. Efforts should be made to re-establish lost escape routes as soon as possible.
- 8C11.45** Passengers and crew that survive the accident may have a wide range of injuries. These may vary from cuts and minor burns to major trauma. It is essential that survivors are taken to a place of safety (upwind and uphill from the incident), where they will not hinder the firefighting operation. Here the casualties will go through the triage process where the most seriously injured will be treated first.

## Aircraft engines – firefighting tactics and techniques

- 8C11.46** Fires involving aircraft engines bring their own particular operational problems. It is important that Fire and Rescue Service personnel are familiar with the aircraft that regularly use their airports. The following section covers in more detail the firefighting tactics and techniques.
- 8C11.47** Aircraft engines will have in their immediate vicinity a number of pressurised systems, which may rupture without warning and intensify the fire. It is essential that for all operational incidents Fire and Rescue Service personnel wear appropriate personal protective equipment and respiratory protective equipment.

**Picture 6: Fire and Rescue Service personnel tackling a simulated engine fire**



Source Ron Puttock GFS

- 8C11.48** Serious engine fires may cause parts of the aircraft structure to collapse, therefore great vigilance is needed throughout the incident. In order to prevent damage to appliances, equipment and injury to personnel, correct positioning of personnel and appliances is critical.
- 8C11.49** Position appliances and fire personnel so that hose lines fully cover, not only the immediate fire situation, but areas of probable development should the fire progress beyond the location of its origin.
- 8C11.50** Firefighters must be aware that compressors and other rotary parts of an aircraft engine will continue to rotate for a considerable amount of time after the engine has been shut down.
- 8C11.51** Some aircraft engines have fire access panels which can be utilized to deliver firefighting media into engine compartments. These can be found on both fixed wing and rotary wing civil and military aircraft.
- 8C11.52** Tail mounted engines and high level auxiliary power units can be particularly difficult to deal with. A particular hazard that exists, when fighting high level fires is that debris, burning fuel and firefighting agent may fall onto the firefighting teams below.
- 8C11.53** Sudden explosions within the engine compartment have been known to occur resulting in debris being projected at considerable force. Personal protective equipment will offer minimal protection against explosive risks. Strict cordon control and limiting Fire and Rescue Service personnel to unnecessary exposure to hazard zones is a key control measure.
- 8C11.54** Efforts must be made to ensure that any evacuating passengers and crew are kept clear of the engine danger areas; these include engine intake, exhaust areas and propellers. Danger areas will vary with contrasting aircraft, the type, size and location of engines fitted.
- 8C11.55** Notwithstanding water and foam, the most effective agent for dealing with the engine fires is Halon (which is currently carried by Rescue and Fire Fighting Service but will be phased out by 2016) however carbon dioxide may also prove effective. In serious fire situations the use of dry powder may also be considered.
- 8C11.56** Dual application firefighting methods can result in a more efficient and effective method of dealing with this type of incident (entraining dry powder into firefighting water/foam jets).
- 8C11.57** Over recent years the Rescue and Fire Fighting Service have developed a technique referred to as dual application; this has been determined through tests as the most effective way to deal with running fuel and engine fires.
- 8C11.58** The technique requires that a spray of foam solution or water is applied to the fire area in an effort to encapsulate the fire, into this spray a quantity of either dry powder or carbon dioxide can be entrained which carries the complementary firefighting agent into the heart of the fire, resulting in a rapid knock down of the fire.

**Picture 7: Leeds Bradford RFFS demonstrating dual application with bulk dry powder at SERCO Training Centre Teesside**



Source WSFRS

**8C11.59** Once the fire has been extinguished, a charged hose line should be maintained in the vicinity of the affected engine both internally and externally. A constant inspection of this area should be maintained throughout the incident.

## Fluoroelastomers

**8C11.60** Fluoroelastomers are located in some engine seals and hydraulic systems and when exposed to the temperatures that are involved in an engine/aircraft fire, can result in the seals decomposing and resulting in the formation of hydrofluoric acid.

**8C11.61** Therefore full personal protective equipment must be maintained throughout the incident and once firefighting and rescue operations have been completed, Fire and Rescue Service personnel should be withdrawn from the inner cordon, unless required for a specific task by the incident commander.

## Undercarriage incidents – firefighting tactics and techniques

**8C11.62** Owing to the potential of a minor incident involving an undercarriage to rapidly escalate into a major fire involving both the interior and the exterior of the aircraft all Fire and Rescue Service personnel should consider:

- wind direction
- possible spread of fire and heat to fuel tanks and fuselage

- evacuating passengers and crew
- danger zones
- sudden movement or collapse of the aircraft.

- 8C11.63** Fire and Rescue Service personnel should be dressed in full protective clothing with visors down and those working in the vicinity of an undercarriage should wear respiratory protective equipment.
- 8C11.64** Rapid and effective intervention is essential if the incident is to be confined to the undercarriage assembly itself.
- 8C11.65** The aircraft may have stopped off the tarmac runway and could be on softer ground resulting in the aircraft sinking into the ground and/or becoming unstable.
- 8C11.66** Personnel should at all times be aware of their surroundings and assess the risks as circumstances change. Always keep away from the disintegration zones.
- 8C11.67** Deployment of hose lines should follow the recommended approach paths as recommended in diagram 'Undercarriage and Tyre Hazard Zones (Boeing)' (Undercarriage incidents chapter picture 3). Initial approach should be upwind, as crews downwind will be subject to smoke which could limit vision and hamper communications with the upwind crews.
- 8C11.68** Should aircraft occupants need to be evacuated this should be done to a safe area upwind bearing in mind the danger zones.
- 8C11.69** Chocks should be positioned fore and aft of the aircraft wheels as soon as practicable, and the aircraft's brakes released to allow heat to dissipate naturally and evenly. Fire and Rescue Service commanders should liaise with the Airport Incident Commander or aircraft ground engineers (if available) to arrange the insertion of undercarriage locking pins. These pins are designed to prevent the undercarriage collapsing due to hydraulic failure and physically lock the undercarriage in the down position.
- 8C11.70** To avoid 'spot cooling' and subsequent stress failure or disintegration, cooling should be carried out using a water fog/spray applied fore and aft and where possible under the supervision of the Rescue and Fire Fighting Service or aircraft engineer if available.
- 8C11.71** Overheated undercarriage assemblies should be allowed to cool naturally where possible and the use of positive pressure ventilation fans can assist with this operation. In darkness it is important to distinguish between glowing and flaming because part of the assembly may become white-hot but, even so, discharge of extinguishing media should be withheld unless or until flame appears. Consider using a thermal imaging camera to assess the temperature of wheel assemblies.
- 8C11.72** Dry powder should be considered especially where hydraulic oils are on fire. Advantages of dry chemical powders:

- envelopes and covers the whole heated surface simultaneously and uniformly
- little cooling effect, therefore avoiding thermal shock
- powder forms a coating where there is oil contamination
- effective extinguishing agent on hydraulic fluids and lubricants.

**8C11.73** Dual application firefighting techniques should be used where possible and where training has been undertaken.

**8C11.74** An inspection of the aircraft interior should be carried out at the earliest opportunity to either ensure that the fire has not penetrated the cabin or to organise internal firefighting should this be necessary.

## Aircraft rescue operations

**8C11.75** Most conventional tools and equipment commonly used in structural rescue and firefighting can be adapted to aircraft rescue and firefighting situations.

**8C11.76** For example, once entry has been made into the aircraft firefighters may have to cut seatbelts or harnesses in order to free occupants. Salvage sheets and sharp protection can be utilised to protect jagged edges at access and egress points in the fuselage.

**8C11.77** Fire and Rescue Service personnel engaged in rescue operations should plan ahead, so they have the appropriate tools and equipment available to perform forcible entry and rescue operations in a timely and effective manner. Equipment dumps should be established to pool available rescue equipment, as you would at other types of incident.

## Safety

**8C11.78** Operating rescue tools and equipment during aircraft rescue operations can be very hazardous. The number of Fire and Rescue Service personnel in the operational area should be limited to the minimum number necessary to complete the task. All Fire and Rescue Service personnel should be dressed in personal protective equipment appropriate for the tasks that they are required to carry out. All rescue operations should be risk assessed and form part of the operational tactical plan.

**8C11.79** Extrication operations should be constantly reviewed and overseen by safety officers, as activities at one end of an aircraft can adversely affect conditions in another area.

## Stability of the aircraft

- 8C11.80** Fire and Rescue Service personnel should consider the stability of the aircraft before making entry. If the aircraft is not stabilised it may move, shift or roll, resulting in trapping and possibly injuring occupants and Fire and Rescue Service personnel.
- 8C11.81** Many tools, equipment and materials can be used to stabilise an aircraft, for example cribbing, airbags, heavy timber, shoring props and jacks. The utilisation of equipment carried by the urban search and rescue teams could prove invaluable in the early stabilisation of an aircraft.

## Lighting

- 8C11.82** The internal conditions within an aircraft will require additional lighting, as the likelihood of the internal lighting working at a post crash scenario is highly unlikely.

## Flammable atmospheres

- 8C11.83** When choosing tools and equipment to use at an aircraft accident, the Incident Commander should consider the possibility that a flammable atmosphere might exist at the incident site. The forces involved in an aircraft crash will often compromise fuel systems, creating a flammable atmosphere. Fuel leaks should be identified and stopped or controlled and spillages should be covered with aspirated foam throughout the rescue operation.
- 8C11.84** The use of hydrocarbon monitoring equipment should be used if available.

## Materials

- 8C11.85** As discussed in previous chapters, there are numerous materials used in aircraft construction. Therefore a rapid assessment of the type of aircraft involved in the incident will need to be carried out by the Incident Commander, for use when formulating a tactical plan for rescue operations.
- 8C11.86** The utilisation of on scene experts such as Rescue and Fire Fighting Service or military teams will be invaluable in this assessment; however this may not always be the case due to the location of incident.
- 8C11.87** Boeing has undertaken some testing of its latest composite materials which recommend the following tools for cutting through their composite fuselage:
- rotary cutting saw
    - carbide tip
    - diamond tip
  - chainsaws
  - air chisel.

**Pictures 8, 9 and 10: Cutting operations on a Boeing 787 fuselage**



Source Boeing USA

- 8C11.88** When cutting aircraft materials, Fire and Rescue Service personnel should be provided with suitable and sufficient personal protective equipment and casualties in the vicinity of operations will also need protection.
- 8C11.89** Although the above photographs demonstrate that the fuselage can be cut, the reality will be that most access for rescue will be via openings caused as a consequence of the incident or conventional access and egress points (doors).
- 8C11.90** It will be likely that cutting operations will be required around openings that have occurred due to the accident damage as they may need to be opened further to facilitate the removal of casualties. Internal rescue operation will require the cutting and removing of internal components such as seats/seat anchorage points and therefore a variety of cutting equipment carried by Fire and Rescue Service will be required, such as:
- hydraulic rescue equipment
  - electric power saws
  - pneumatic cutting equipment
  - airbags
  - hand tools
    - socket sets
    - screwdrivers

- axes
- sledgehammers
- bolt cutters
- crowbars, wrecking bars, halligan bar etc
- hydraulic jacks
- Urban search and rescue equipment.

**8C11.91** The above equipment will complement that carried by the Rescue and Fire Fighting Service and is given as examples of tools that may be of use.

### **Hot cutting equipment**

**8C11.92** Hot cutting equipment is often overlooked at aircraft accidents due to the ignition hazard. However they are efficient and effective in limited applications at an aircraft incident, but should be deemed as a last resort tool when other systems have failed.

**8C11.93** When used, a continuous assessment of flammable atmospheres will need to be carried out and precautionary firefighting media should be standing by to extinguish any resulting fires.

### **Thermal imaging cameras**

**8C11.94** Thermal imaging cameras have been found to be very useful at aircraft rescue operations in the detection of hidden fires and the location of trapped aircraft occupants.

## **Aide memoire**

### **Dealing with engine fires**

1. establish appropriate rendezvous points and marshalling areas
2. ensure safe and appropriate positioning of appliances and crews
3. appropriate personal protective equipment and respiratory protective equipment must be worn at all times
4. ascertain hazard zones in front and to the rear of engines, set up and maintain strict cordon control
5. ascertain which area/part of the engine is involved
6. control and contain fire and heat to prevent spread to wing and fuselage
7. control/extinguish running fuel fires to prevent formation of spillage fires that could threaten the integrity of the fuselage
8. in most instances, emergency evacuation of aircraft should take place on unaffected side

9. where there has been obvious heat transmission, the wing and fuselage should be sprayed with large amounts of water, check for transmission of heat inside aircraft
10. in high mounted engines and auxiliary power units, be aware of collapse and residual fuel leaks
11. beware of residual fuel leaks when opening cowlings to gain access
12. beware of rotating propellers (however slowly) and the intake and exhaust of jet engines
13. unless there is an immediate danger of escalation, extinguish fires by applying media which causes the minimum of additional damage e.g. CO<sub>2</sub>, water
14. unless there is an immediate danger of escalation, use only the minimum amount of appropriate media to extinguish the fire
15. Fire and Rescue Service personnel should be withdrawn from the inner cordon when firefighting and rescue operations have ceased.

## Aide memoire

### Dealing with undercarriage incidents

1. establish appropriate rendezvous points and marshalling areas
2. ensure safe and appropriate positioning of appliances and crews
3. appropriate personal protective equipment and respiratory protective equipment must be worn at all times
4. rapid intervention is essential to confine the incident to the undercarriage
5. consider the possibility of the aircraft becoming unstable or of aircraft undercarriage collapse
6. hose lines should be deployed both fore and aft of the affected undercarriage
7. personnel must keep clear of disintegration zones
8. aircraft passengers should be evacuated upwind to a place of safety and away from danger zones
9. to avoid 'spot cooling' use water fog/spray applied fore and aft
10. dry power should be considered, especially where hydraulic oils are involved, dual application methods may be appropriate
11. overheated brake assemblies should be allowed to cool naturally, no cooling agent applied
12. interior inspection of fuselage should be carried out, checking for heat transfer.

## PART C-12

# On airport incidents

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## Introduction

**8C12.1** Fire and Rescue Services will be called to aircraft accidents on or adjacent to airports, due to the inherent hazards of aircrafts taking off and landing. These incidents will have a rapid emergency response from category 1 and 2 responders. The Rescue and Fire Fighting Service have clear protocols and standard operating procedures to deal with these types of incidents. Therefore Fire and Rescue Service intervention strategies need to be fully interoperable with Rescue and Fire Fighting Service standard operating procedures and the standard operating procedures of all category 1 and 2 responders, which should be detailed in the airport emergency plan. This plan needs to be practiced on a regular basis and forms part of the airport licensing Civil Aviation Authority requirements.

**Picture 1: Heathrow BA 777 accident 2008**



Source Marc-Antony Payne

## Passenger evacuation management systems

**8C12.2** A recent development at some licensed airports is the introduction of passenger evacuation management systems, to assist in the evacuation of passengers and crew away from the affected aircraft to an area of relative safety.

**Picture 2: Roof material for a passenger management evacuation system**



Source Gatwick AFS

**Pictures 3 and 4: Passenger evacuation management system, carried on an airport ground operation vehicle**



Source BAA AFS

**8C12.3** They differ in design from one airport to another, but primarily they are illuminated signs with a loud speaker capability (visual and audible directions) and are carried on the rear of airfield operations vehicles. These are erected in a safe location outside the inner cordon and within the outer cordon, up wind and uphill from the incident.

**8C12.4** Passengers evacuating the aircraft should be directed towards these vehicles and passengers who require medical treatment should be assisted or carried to this location for triage by the responding ambulance crews.

## **Civil Aviation Authority advice on incident command**

**8C12.5** The Civil Aviation Authority has issued an Information Paper (IP-1) entitled *Information on the Application of the Incident Command System at Aerodromes and Aircraft Incidents* available from the Authority's website.

- 8C12.6** This information paper was put together with the support of the Fire Service College and dovetails with *Fire and Rescue Manual Volume 2: Fire Service Operations – Incident Command (3rd Edition)*.
- 8C12.7** CAP 168, Chapter 9, Section 6.2 states:
- The licence holder should liaise with local emergency responders and establish responsibilities for incident command, particularly for the scene immediately adjacent to the aircraft. Any agreements should be recorded in the aerodrome manual.*
- 8C12.8** Fire and Rescue Services will need to discuss incident command issues at all airports in their area, with regard to joint working at aircraft incidents on or adjacent to the airport. It is good practice to agree a memorandum of understanding as to the level of joint working that will be undertaken between the Rescue and Fire Fighting Service and the Fire and Rescue Service, so that roles and responsibilities are clearly understood by both the Rescue and Fire Fighting Service and Fire and Rescue Service personnel.
- 8C12.9** The guidance given by the Civil Aviation Authority acknowledges that smaller aerodromes may find the IP-1 not appropriate; however it suggests that the principles of incident command should be applied at all incidents.
- 8C12.10** The advice given to airport managers in IP-1 is not a requirement but it is information to guide local arrangements with the Fire and Rescue Service and other responding emergency services.

## Fire and Rescue Service statutory responsibility

- 8C12.11** There is much debate as to when and who (level 3/level 2 or level 1 Fire and Rescue Service Officer) should take over an incident on an airport. This is something that each individual Fire and Rescue Services should decide and agree with the Rescue and Fire Fighting Service on their respective airports (memorandum of understanding).
- 8C12.12** However the legal position as to when this should occur is clear and has been clarified for the purpose of this guidance by the DCLG legal department.
- 8C12.13** “In the absence of statutory arrangements (see below), the Rescue and Fire Fighting Service do not have any legal standing in relation to fires within the perimeter of the airport. The responsibility remains the Fire and Rescue Service’s, and the Rescue and Fire Fighting Service’s status is that of any other helpful private person present at a fire, even though in practical terms the Rescue and Fire Fighting Service will have more specialist expertise in fighting airport fires than the Fire and Rescue Service. “
- 8C12.14** The Rescue and Fire Fighting Service would have a more solid legal standing if there were arrangements under section 15 or section 16 of the *Fire and Rescue Services Act 2004*.

- 8C12.15** Section 15 gives a Fire and Rescue Service power to enter into arrangements with a person who employs firefighters (which obviously includes the Rescue and Fire Fighting Service secure assistance for the purpose of the Fire and Rescue Services discharge of a function conferred by section 7, 8 or 9 of the 2004 Act (which includes firefighting).
- 8C12.16** Section 16 arrangements are arrangements for the discharge to any extent by another person (which could include an Rescue and Fire Fighting Service a function conferred on the Fire and Rescue Service under section 6 to 9 or 11 of the 2004 Act (including firefighting).
- 8C12.17** So, for example a Fire and Rescue Service could enter into an agreement containing section 16 arrangements for the Rescue and Fire Fighting Service discharge the Fire and Rescue Service's firefighting function within the perimeter of the airport, and section 15 arrangements for the Rescue and Fire Fighting Service to assist the Fire and Rescue Service with firefighting within, say, 5 km of the perimeter.

## Airport Incident Commander

**8C12.18** The Airport Incident Commander is the senior Rescue and Fire Fighting Service officer in attendance at the incident and their principal focus is on the safe and effective resolution of the incident by implementing tactics which are based on a dynamic management of risk utilising the limited resources available at the time of the incident.

**8C12.19** The Airport Incident Commander needs to be easily identifiable by wearing distinctive personal protective equipment or a surcoat/tabard. See picture below for an example. There is no common or agreed tabard system for Rescue and Fire Fighting Service, therefore Fire and Rescue Services need to liaise with local airports to understand how the Airport Incident Commander and other functional officers within the Rescue and Fire Fighting Service will be identified on the incident ground.

**Picture 5: Airport Incident Commander tabard**



Source BAA AFS

**8C12.20** Many Rescue and Fire Fighting Services have adopted the national Incident Commander tabard systems, but many have not.

## Tactical mode

**8C12.21** The IP-1 gives guidance on the utilisation of tactical modes and the need to declare and record a tactical mode for all incidents. In the same way as Fire and Rescue Service tactical modes are recorded and form part of their message procedures, most if not all radio communications at airports are recorded and therefore the tactical mode should be broadcast.

## Airport Incident Commander hand over protocol

**8C12.22** IP-1 states that until a Fire and Rescue Service senior officer is in attendance and has assumed overall command, the Airport Incident Commander is responsible for all fire and rescue operations.

**8C12.23** As previously mentioned, unless formal arrangements are in place, this should be the officer in charge of the first Fire and Rescue Service appliance to arrive.

**8C12.24** When the Airport Incident Commander has handed over operational command he/she should take on the function of airport command liaison and provide technical information, liaison and support to the Fire and Rescue Service Incident Commander. At this point the Airport Incident Commander must change any identification tabard to clearly represent the new role. The method of personal protective equipment/tabards identification of the Rescue and Fire Fighting Service command roles will differ between airports and should be included in the Fire and Rescue Service/ Rescue and Fire Fighting Service memorandum of understanding.

## Airport sector commanders

**8C12.25** The IP-1 gives guidance on the Airport Incident Commander delegating responsibility for sectors to sector commanders. The guidance also details the responsibilities of the sector commanders which does not differ from that utilised under the national Incident Command Structure.

**8C12.26** IP-1 identifies that at a suitable point in the incident the sector commander will be relieved of the sector command responsibility by the responding Fire and Rescue Service and at which point the airport sector commander will remain in the sector and provide technical information, liaison and support to the Fire and Rescue Service sector commander



**Picture 6: Airport sector commander tabard**

Source BAA AFS

(see picture below). This role then becomes an airport technical liaison role and will be identified by a suitable surcoat/tabard as per the memorandum of understanding.

## Inter agency liaison

**8C12.27** The Airport Incident Commander must establish and maintain effective liaison with all other agencies, where they are present at an incident. This will include tactical liaison with other emergency services to coordinate operational activities effectively, and liaison with technical specialists whose specialist knowledge may be critical in helping to resolve the incident.

**8C12.28** Management and command of a serious aircraft incident will not be a single agency task. Therefore the airport incident command system must be developed to ensure airport procedures fit seamlessly with those of partner organisations and the overall approach of integrated emergency management.

**8C12.29** The use and compatibility of radio systems and technology is key to achieving effective liaison at incidents. However Fire and Rescue Service personnel should be aware of the radio traffic demands on the Airport Incident Commander between:

- Aircraft pilot on channel 121.6
- Air Traffic Control
- Rescue and Fire Fighting Service appliances and watch room (if staffed)
- Airport ground operation vehicles
- Emergency services rendezvous points (police, ambulance and Fire and Rescue Service)
- Airport manager
- Aircraft engineers.

**8C12.30** There is no standard operating procedure that will work for every airport and therefore Fire and Rescue Services must liaise with their particular airport, be it civil or military and agree a standard operating procedure that works for them. This needs to be recorded in a memorandum of understanding, exercised on a regular basis and reflected in both the airport and local authority Fire and Rescue Service emergency plans and procedures.

**8C12.31** What is important is that both the Rescue and Fire Fighting Service and the Fire and Rescue Service fully understand the roles and responsibilities and command competence of personnel undertaking roles within the incident command system.

## Rendezvous point management

**8C12.32** All licensed airports will have predetermined and agreed rendezvous points and these will be identified by appropriate signage around the airport to direct responding emergency services.

**8C12.33** Rendezvous points will not necessarily hold all of the responding emergency services that may be called to an airport to deal with an emergency and therefore the management of the rendezvous points will prove critical in the efficient and effective management of an incident.

**8C12.34** Good practice has identified the need for an airport marshalling and liaison officer (Fire and Rescue Service crew manager or above) who will be given the following responsibilities:

- manage the rendezvous point
- act as a liaison point between airport fire service watch room/air traffic control – with regard to available assets
- liaison between other operating rendezvous points (if more than one rendezvous point is in use)
- park and brief oncoming Fire and Rescue Service appliances
- liaison with other emergency services using the rendezvous point
- establish liaison with the forward command point at the early stages of the incident, to inform the incident commander of the available personnel and equipment at the rendezvous point.

**8C12.35** This role is not to be underestimated both in its complexity and importance.

**Picture 7: Example rendezvous points signs**



Source Civil Aviation Authority CAP 168

## PART C-13

# Airport rescue and fire fighting service

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## International Civil Aviation Organisation

- 8C13.1** The International Civil Aviation Organisation was founded at the Chicago Convention in 1944. The convention established international standards for the safe, orderly and efficient operation of global air transportation. These standards and recommended practices are promulgated in a series of annexes and encompass a range of requirements for aviation safety.
- 8C13.2** Annex 14 titled 'Aerodromes' specifies the requirements for rescue and firefighting services at airports. In order to ensure these generic requirements are applied within countries, each country has established its own national aviation authority.
- 8C13.3** Within the UK this is the Civil Aviation Authority, which is sponsored by the Department for Transport.

## European Aviation Safety Agency

- 8C13.4** The European Union (EU) has established the European Aviation Safety Agency (EASA) which promotes operating standards of safety and environmental protection in civil aviation within Europe and worldwide. It is the centrepiece of a new system which provides a single European regulator in the aviation industry.
- 8C13.5** The agencies responsibilities include:
- expert advice to the EU for drafting of new legislation
  - implementing and monitoring safety rules, including inspections in member states
  - certification of aircraft and components including the approval of organisations involved in the design, manufacture and maintenance of aeronautical products
  - safety analysis and research.

## Civil Aviation Authority

- 8C13.6** The Civil Aviation Authority has a statutory duty imposed by the Secretary of State for transport to enforce safety standards at licensed airports within the UK.

- 8C13.7** Regulations stipulate that aircraft flying in the UK for specified purposes, principally the transport of fare paying passengers may only use licensed airports. A condition imposed on airport licences is the provision of Rescue and Fire Fighting Services in the event of an emergency at or adjacent to the airport.
- 8C13.8** Within the UK there are approximately 2200 airports of which 138 are currently licensed by the Civil Aviation Authority and will need to comply with the rules and regulations enforced by the Civil Aviation Authority, mainly contained within the *Civil Aviation Publication (CAP) 168 – Licensing of Airports*.
- 8C13.9** The remaining airports are unlicensed and operate under self-regulation; the Civil Aviation Authority offer guidance with regard to firefighting media and equipment (CAP 793 – Safe Operating Practices at Unlicensed Aerodromes).
- 8C13.10** Fire and Rescue Services should identify the number, type and size of operating airports/airstrips within their area. This will form part of the Fire and Rescue Service integrated risk management plan and planning will need to be proportionate to the risk identified.
- 8C13.11** Airports have flexibility in declaring a category depending on operations; this will affect the rescue and firefighting resources available at any one time.
- 8C13.12** This flexibility within the rules and regulations categorising airports means that Fire and Rescue Services need to understand the level of on airport Rescue and Fire Fighting Services. Firefighting provision may differ depending on the time of day and will need to consider this variation as part of its planning process and standard operating procedures.
- 8C13.13** There is a requirement for licensed airports to be a part of and linked to local emergency management arrangements. The arrangements will be set out in the 'Airport Manual' and clearly detail roles and responsibilities.

## Airport categorisation

- 8C13.14** All licensed civil airports within the UK are placed within categories for rescue and firefighting provision.
- 8C13.15** Categories are determined by the size of aircraft, see table.

Table 1: Heliport Rescue and Fire Fighting Services Categories		
Category	Helicopter overall length (helicopter length, including the tail boom and the rotors)	
H1	Up to but not including	15m
H2	Up to but not including	24m
H3	Up to but not including	35m

**Table 2: Civil Aviation Authority Airport Rescue and Fire Fighting Services categories**

Airport category	Aircraft overall length	Maximum fuselage width
1	Up to but not including 9m	2m
2	9m up to not including 12m	2m
3	12m up to but not including 18m	3m
4	18m up to but not including 24m	4m
5	24m up to but not including 28m	4m
6	28m up to but not including 39m	5m
7	39m up to but not including 49m	5m
8	49m up to but not including 61m	7m
9	61m up to but not including 76m	7m
10	76m up to but not including 90m	8m

**8C13.16** The scale of Rescue and Fire Fighting Services in terms of the number of vehicles, equipment and personnel is determined from the category and following a task and resource analysis of potential incidents. CAP 168 gives airports guidance on all of the above.

## Change to the Air Navigation Order

**8C13.17** A recent amendment to the Air Navigation Order (ANO) now permits flying training/instruction to occur from unlicensed airports with emergency arrangements and communications determined locally.

**8C13.18** This change in the Air Navigation Order means that potentially quite busy flying training operations can occur with varying degrees of emergency arrangements. Fire and Rescue Services will need to be aware of the location of these airports, which may be no more than a grass landing strip, the risks involved and the appropriate response required.

## Airport Rescue and Fire Fighting Service

**8C13.19** The number and type of appliances attached to an airport vary tremendously from airport to airport but will comply with ICAO specifications and requirements detailed by the Civil Aviation Authority.

**8C13.20** CAP 168 details the Rescue and Fire Fighting Services for each category of airport and this will include:

- the number of appliances required

- the minimum performance levels for those appliances
- training standards for firefighters
- quantity of water, type/quantity of foam and complementary firefighting media carried.

**8C13.21** It is the responsibility of the Airport Fire Manager (previously referred to as the senior airport fire officer – SAFO) to ensure that the standards required by the Civil Aviation Authority are met at all times. If for any reason the Rescue and Fire Fighting Service provision falls below that required by the Civil Aviation Authority, the airport will have to drop its category status and/or divert aircraft.

**8C13.22** However, in an emergency situation an aircraft (the pilot) may be forced to (or decide to) land at an airport that does not match its category size.

**8C13.23** For example, an airport could have a runway that is capable of landing a category 9 aircraft but it could normally operate at a lower category 5, due to the size of aircrafts that use its facility. In an emergency the pilot of an aircraft in distress may choose to land at the airport resulting in the Rescue and Fire Fighting Services falling short of the firefighting equipment required for such an aircraft.

**8C13.24** This is the risk carried by the pilot’s decision however the Fire and Rescue Service and Rescue and Fire Fighting Service will have to manage the incident.

**8C13.25** Below is a table of the quantity of firefighting media required by the Civil Aviation Authority for Rescue and Fire Fighting Services at different categories of airports.

<b>Table 3: Rescue and Fire Fighting Services quantities of firefighting media at airport categories, based on Class B Type Foam</b>						
<b>Airport Category</b>	<b>Water Litres</b>	<b>Foam Concentrate Litres (First Hit)</b>	<b>Discharge rate foam solution/ minute Litres</b>	<b>Dry Powder Kg</b>	<b>Halon BCF Kg</b>	<b>CO<sub>2</sub> Kg</b>
1	230	14	230	45	45	90
2	670	40	550	90	90	180
3	1200	72	900	135	135	270
4	2400	144	1800	135	135	270
5	5400	324	3000	180	180	360
6	7900	474	4000	225	225	450
7	12,100	726	5300	225	225	450
8	18,200	1092	7200	450	450	900
9	24,300	1458	9000	450	450	900
10	32,300	1938	11,200	450	450	900

- 8C13.26** The amount of foam concentrate detailed in the above table refers to the amount needed for the first foam hit. Airport appliances carry enough foam for two hits plus the airport must carry a 200 percent reserve.
- 8C13.27** Many airports will carry firefighting media in excess of that required by the Civil Aviation Authority. Fire and Rescue Service planners should take this into consideration when planning their operational response.
- 8C13.28** For example Gatwick, a category 9 Airport, has 65,000 litres of water on their appliances, more than twice that required by the Civil Aviation Authority.
- 8C13.29** Fire and Rescue Service personnel who may be called upon to attend an incident at an airfield need to familiarise themselves with the appliances, capability, media carried and additional rescue equipment carried by the airport fire service at their airport.
- 8C13.30** Airport firefighters are certificated to operate at the category of airport they work on. Their knowledge and expertise with airport topography and infrastructure, aircraft construction, hazards, firefighting techniques will be extensive and Fire and Rescue Service personnel should engage with their local airport Rescue and Fire Fighting Service to extend their own knowledge in this specialist area.
- 8C13.31** Principally large capacity water and foam tanks are the norm with airport fire appliances, giving them the capability to produce large amounts of finished foam/water via roof mounted or bumper mounted monitors whilst on the move. They are also capable of providing sidelines to support handheld hose lines and branches for internal and external firefighting. See picture 3.

**Picture 1: RFFS provision at a Category 9 Airport**



Source Ron Puttock GFS

**Picture 2: Rescue and Fire Fighting Service provision at a Category 3 Airport**



Source WSFRS

**Picture 3: Panther Rescue and Fire Fighting Service vehicle demonstrating roof and bumper monitors**



Source Rosenbauer

- 8C13.32** All airport fire appliances must be fit for purpose and comply with the stringent requirements laid down by ICAO. One of the design features of these appliances is that the amount of foam concentrate carried must be sufficient to give the appliance a two hit capability.
- 8C13.33** Therefore the rapid replenishment of airport fire appliances with water by responding Fire and Rescue Service will allow foam production to be sustained to maximise the foam carried on board the appliances.

**Pictures 4 and 5: Rescue and Fire Fighting Service supplementary firefighting media, bulk dry powder (Monnex) and bulk BCF mounted on a trolley assembly**



Source WSFRS

**8C13.34** Additionally, the appliances have the capability and requirement to carry complementary firefighting agents such as dry powder, halogenated hydrocarbons (BCF). However BCF is being phased out and must be replaced with an alternative media by 2016.

## Response time

**8C13.35** Response times for the Rescue and Fire Fighting Service are detailed in CAP 168 and have been set down to ensure a rapid knock down of post crash fires. Post incident learning from aircraft accidents from around the world have been used to establish these response times.

**8C13.36** A fuel fire involving Avtur (Jet A) can reach temperatures between 800°C and 1000°C within 45 seconds (dependant on wind conditions and ambient temperatures). Aluminium's melting point is 600°C and many aircraft are still constructed of stressed skin aluminium, therefore it is clear that speed of response is critical, if the spread of fire is to be controlled and survivable conditions within the aircraft maintained.

**8C13.37** Modern developments in aircraft construction, such as "GLARE" (composite material on the Airbus A380), offer greater fire resistance than aluminium and coupled with the advanced technology in airport fire fighting equipment over recent years (appliances and foam), will greatly enhance survivability at aircraft incidents in years to come. However, speed of response will always be a key for both Rescue and Fire Fighting Service and the Fire and Rescue Service at incidents involving aircrafts.

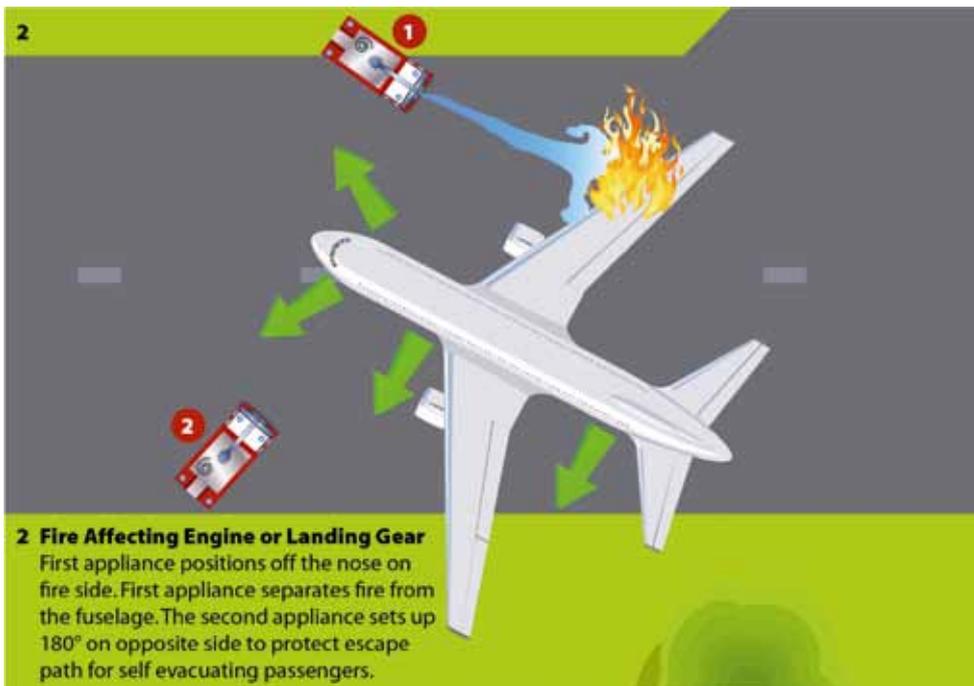
- 8C13.38** The Rescue and Fire Fighting Service has a response time objective of two to three minutes, depending on location, from the time of call to when the first responding vehicle(s) are in a position to produce 50 per cent of their required discharge rate.
- 8C13.39** To achieve this, appliances which weigh in the region of 40 tonnes can achieve 0 to 50 mph within 40 seconds.

## Principal objectives of the Rescue and Fire Fighting Service

- 8C13.40** The principal objective of a Rescue and Fire Fighting Service is to save life and a secondary objective is the protection of the aircraft and surrounding vehicles and buildings.
- 8C13.41** The operational objective of the Rescue and Fire Fighting Service is to respond as quickly as possible to aircraft accidents and/or incidents in order to create maximum opportunity for saving life and maintaining survivable conditions within the aircraft, to facilitate evacuation and rescue operations.

## Rescue and Fire Fighting Service tactics and techniques

- 8C13.42** On arrival at the crash site the first task for the Rescue and Fire Fighting Service will be to protect the fuselage of the aircraft from fire, thus protecting any passengers and crew who are still left inside the aircraft.
- 8C13.43** Overleaf are some examples of how the Rescue and Fire Fighting Service appliances might be positioned at different types of incidents.
- 8C13.44** Survivable conditions are achieved by the application of foam onto the fuselage utilising roof and or bumper monitors, which are controlled either from inside the appliance or from a roof mounted platform. Modern airport appliances have all controls within the cab and can be used by either the driver and/or a second rider.
- 8C13.45** The next task will be to run out delivery hose (sidelines) and once this has been achieved monitors will be switched off and firefighting will be tackled utilising handheld branches. The reason this is done is principally to conserve water and foam (a roof monitor can empty the appliance within one to two minutes) and to use the firefighting media more efficiently and effectively.
- 8C13.46** In protecting the fuselage from fire and protecting the evacuation points for passengers, the Rescue and Fire Fighting Service will have created the optimum conditions to allow passengers and crew to escape the aircraft.





Source: WSFRS

**Picture 6: Leeds Bradford Rescue and Fire Fighting Service tackling an engine/undercarriage fire**



Source WSFRS

**Picture 7: Leeds Bradford Rescue and Fire Fighting Service deploying sidelines**



Source WSFRS

**Picture 8: Leeds Bradford Rescue and Fire Fighting Service utilising sidelines**



Source WSFRS

- 8C13.47** Before entry can be made into the aircraft fuselage by firefighting teams all external fires must be extinguished or at least be under control and all passengers who are able to evacuate under their own capability must have left the aircraft.
- 8C13.48** Only then will firefighting teams in breathing apparatus, with charged hoselines enter the fuselage to continue internal firefighting, rescues and ventilation.

## Ministry of Defence airfields

- 8C13.49** MOD airfields are divided into five fixed wing and three rotary wing categories. Generally the larger the size of aircraft/helicopter the higher category of airfield is designated and consequently the establishment of rescue and firefighting capability is increased.
- 8C13.50** MOD airfield rescue and firefighting appliances vary in size and capability but are similar to those on civil airports and are established to meet the capability requirements for the category of the airfield. Whilst the categorisation of MOD airfields follows a similar pattern to that used for civil airports, specific factors are traditionally considered, these include:
- passengers
  - armaments
  - aircraft emergency escape systems and ejection seats
  - dangerous goods/air cargo/tanker aircraft
  - aircraft construction
  - multiple simultaneous aircraft movements
  - training and aerobatics.
- 8C13.51** In addition to national standards of structural firefighting, MOD firefighters receive enhanced levels of training in airfield crash firefighting dealing with all types of military aircraft and their specific risks.
- 8C13.52** The organisation, equipment, crewing and training is geared to a response time of two minutes to an aircraft crash with fires extinguished or brought under control within one minute from the start of firefighting operations, to allow commencement of rescue operations.
- 8C13.53** MOD Rescue and Fire Fighting Service on airfields provide an operational response capability to cover the domestic risks on/or adjacent to airfields such as aircraft hangars or service family housing.

- 8C13.54** Airfields in the United Kingdom (UK) used by the United States Air Force (USAF) have similar arrangements for fire cover. Their categorisation is similar to UK MOD airfields but set by the United States Department of Defence. The main difference between the USAF and the UK MOD is that the USAF refer to 'vehicle sets' as opposed to categorisation.
- 8C13.55** They have six vehicle sets and depending on the provision required by the airfield category, depends on which vehicle set is provided.
- 8C13.56** Fire and Rescue Services with USAF airfields needs to be fully engaged within the emergency plans for those airfields and the role of the airport liaison officer will be paramount in preplanning to ensure interoperability and joint working, should an incident occur.
- 8C13.57** The MOD provides all firefighters for USAF airfields and they work directly to American Fire Chiefs on the base.

## Aircraft emergency classifications

- 8C13.58** Classification of aircraft emergencies differ between those used by the Civil Aviation Authority and those used by the military authorities.

### Military classification of aircraft emergencies

- 8C13.59** State 1. A crash on or seen from an airfield.
- 8C13.60** State 2. An incident on the airfield where doubt exists about the safety of the aircraft or its occupants, or to anticipate a "STATE 1". The ARFF vehicles and emergency medical services are deployed to the incident or to pre-arranged positions on the airfield.
- 8C13.61** State 3. A precautionary measure to cater for a possible incident on the airfield or when an aircraft has crashed off the airfield but the position is unknown. ARFF vehicles are crewed with engines running at their normal locations.
- 8C13.62** To complicate matters, classifications or aircraft emergencies on American airbases within the UK differ again. Due to the complexity of classification and response terminology Fire and Rescue Services officers should liaise directly with American Airbases within their jurisdiction to fully understand terminology and response standards.

### Civil Aviation Authority definitions of emergencies and incidents – CAP 168

- 8C13.63** The Civil Aviation Authority (CAP 168) details and defines aircraft incidents for airports. However this categorisation of incidents can be changed or amended depending on local needs, but only with the approval of the Civil Aviation Authority.

**8C13.64** Fire and Rescue Services need to be aware that different airports within their area or neighbouring areas may have differing aircraft incident categories, which may have an impact on mobilising and predetermined attendance.

## Aircraft emergencies

### Civil Aviation Authority Classification of Aircraft Emergencies

**8C13.65** Aircraft accident/aircraft accident imminent

**8C13.66** Aircraft accidents which have occurred or are inevitable on, or in the vicinity of, the airport.

### Aircraft ground incident

**8C13.67** Where an aircraft on the ground is known to have an emergency situation other than an accident, requiring the attendance of emergency services.

### Full emergency

**8C13.68** When it is known that an aircraft in the air is, or is suspected to be, in such difficulties that there is a danger of an accident.

### Local standby

**8C13.69** When it is known that an aircraft has, or is suspected to have, developed some defect but the trouble would not normally involve any serious difficulty in effecting a safe landing.

### Weather standby

**8C13.70** When weather conditions are such as to render a landing difficult or difficult to observe.

### Unlawful acts

**8C13.71** Action to be taken in the case of any unlawful act will be contained in the airports contingency plan, which will be drawn up in conjunction with the local police.

### Off airport accidents

**8C13.72** Emergency orders should contain details of the action to be taken in the case of airport accidents occurring outside the airport boundaries.

**8C13.73** CAP 168 requires an assessment of areas adjacent to an airport and development of special procedures and availability of equipment. This assessment should be carried out as part of local emergency planning arrangements and the response to incidents adjacent to the airport should be set out in the airport emergency orders.

**8C13.74** Fire and Rescue Service commanders need to be aware that there will be extreme pressure placed upon the Airport Fire Manager if resources are deployed off airport. This is because their deployment off airport will reduce their ability to meet the required rescue and firefighting capability, under their licence and therefore the airport will need to drop its operating category, resulting in the flights being diverted or the airport having to close.

## PART C-14

# Off airport incidents

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## Introduction

**8C14.1** The purpose of this chapter will be to focus on the challenges that will be faced by Fire and Rescue Service personnel when dealing with aircraft incidents away from airports, where the Rescue and Fire Fighting Service/MOD are not in attendance.

## Low speed accidents

**8C14.2** Usually low speed accidents occur on or around the airport, as the aircraft is either taking off or landing. However there will be occasions when the aircraft pilot will be forced to make an emergency landing away from a designated landing area.

**8C14.3** In all air accidents, hazards will depend largely upon the size and type of aircraft, and the dynamics of the impact. In low speed accidents, the aircraft should remain recognisable, be significantly intact, and with survivability rates being high.

**Picture 1: Light aircraft accident into trees**



Source Durham Fire and Rescue Service

## High speed accidents

**8C14.4** High speed accidents often result in complete destruction of aircraft, with wreckage distributed over wide areas. Fire may occur in several areas, and survivability rates are expected to be low.

## Pictures 2 and 3: Crash sites



Source AAIB

- 8C14.5** High speed incidents off airfield will create many challenges for responding Fire and Rescue Service and other emergency services.
- 8C14.6** High speed accidents off airport can generate additional hazards and/or increase the risks to the Fire and Rescue Service when responding. Some of the hazards that will need to be addressed will be:
- difficulty of travel to and accessing accident sites
  - hazardous/exposed terrain
  - damaged/unstable structures
  - damaged utilities networks
  - lack of water supplies
  - wreckage trail
  - difficult access to aircraft and victims
  - firefighting and rescue
  - controlling flammable fluids and ignition sources
  - numerous hazards associated with aircraft construction
  - the hazardous nature and scale of cargo hazards
  - neutralising stored energy systems (batteries, pressure systems, pyrotechnics, weapons, ejector seats, ballistic recovery systems, etc)
  - controlling environmental risks
  - wide-spread body/tissue and associated blood borne pathogen hazards.
- 8C14.7** Fire and Rescue Service operations may well be hampered by fires involving fields or woodland that may have been burning for some considerable time. In many situations that involve remote locations fires will have burned themselves out by the time the Fire and Rescue Service reach the scene.

- 8C14.8** There will need to be a coordinated search spanning the crash site and slide path for any possible survivors and the preservation of evidence for the crash investigation teams will be of paramount importance.
- 8C14.9** Fires should be brought under control as soon as possible. Post impact fires or smouldering debris should be extinguished/cooled to limit the loss of evidence and reduce the occupational health risk at site.
- 8C14.10** The Air Accidents Investigation Branch request that firefighting foam is only used when necessary, as it can inadvertently increase risks. The foam blanket may hide safety hazards or increase the risk from exposure to hazards, as well as covering human remains and hiding or damaging vital evidence. Therefore, it is requested that the laying of a precautionary foam blanket should only be carried out when a real and significant fire hazard exists.
- 8C14.11** Close liaison between the Incident Commander and the responding investigation teams is of paramount importance.
- 8C14.12** The accounting of all occupants may be challenging and therefore liaison with the airline, operator or air traffic control may be able to provide details of the number of persons on board.
- 8C14.13** If the aircraft has disintegrated in flight, the wreckage, survivors and the casualties may be scattered over a large area.
- 8C14.14** The possibility of terrorist involvement must not be overlooked or forgotten and all aircraft accidents will be treated as a crime scene.

## Accidents involving buildings

**Picture 4: American airlines flight 77 into the Pentagon**



Source copyright free

- 8C14.15** Aircraft accidents involving buildings and in highly populated urban areas will probably be the worst case scenario incident to deal with.
- 8C14.16** The aircraft will probably break up, resulting in fire and serious structural damage. There will be the possibility of a high number of casualties involved, many of whom were not on the aircraft itself.
- 8C14.17** Damage to the roofs and other storeys of buildings may occur; floors and walls may collapse or be on the verge of failure, and people inside and outside the affected properties may be injured.
- 8C14.18** Almost certainly the aircraft fuel tanks will be severely damaged and the contents dispersed over the crash site as well as entering surface drainage and watercourses. Wide bodied aircraft may carry large fuel loadings and therefore preventative steps to stop the fuel spreading into structures, watercourses and drains should be made a priority.
- 8C14.19** Responding Fire and Rescue Service personnel should where possible, eliminate other ignition sources in the immediate area as well as implementing their major incident plans and incident command procedures.
- 8C14.20** There is a high likelihood that the accident will have had a detrimental effect on local utilities such as:
- gas supplies
  - electrical installations both domestic and industrial
  - town water mains.

## Accidents into water

- 8C14.21** Fire and Rescue Services should follow their standard operating procedures for incidents involving water rescues. Further advice on water rescues can be found in the *Operational Guidance Manual – Flooding and Water Safety*.
- 8C14.22** Rescue and Fire Fighting Services that have water on or near to their airports may have enhanced water rescue capabilities suitable for inland and offshore rescues. Liaison with your local airport is essential to understand their full range of capabilities and training.
- 8C14.23** Some general considerations that might assist the incident commander are:
- early liaison with Maritime and Coastguard Agency and Royal National Lifeboat Institution (RNLI)
  - consider breaking up or moving large unburned areas of fuel using water jets
  - consider application of foam blanket
  - use ‘booming techniques’ to contain or move fuel to safe area

- be aware of floating sections that may contain survivors – with a constant risk of disturbance by rescue workers causing subsequent entrapment/sinking
- deploy crew downstream to search for survivors.

## Accident site security

**8C14.24** The guarding of the site can be very difficult given the variability of terrain and the sometimes extended areas involved e.g. Lockerbie incident. To ensure that all potential evidence is preserved it is essential that the number of people in or around the wreckage is kept to a minimum.

**8C14.25** If the flight deck of a public transport aircraft is intact, access should be prevented and documentation should not be removed from the cockpit unless there is a risk of loss or damage. The type of documentation that may be carried often includes:

- certificate of air worthiness
- certificate of registration
- certificate of maintenance
- technical log
- load and balance sheets
- passenger manifest
- freight manifest
- crew licenses
- crew log books
- navigation log sheets
- aircraft and operations manual
- maps, charts and notes.

## Flight recorders

**8C14.26** Flight data recorders and cockpit voice recorders, commonly referred to as 'black boxes' are carried on many civil aircraft and can provide vital information for the post accident investigations. These recorders are painted bright orange with white reflective strips on the sides and contain crash protected tape or memory modules where data is stored.

**8C14.27** Unskilled handling of these flight recorders after a crash can cause unnecessary damage which might lead to loss of the recording information, or at the very least, a delay in recovering that information. The Air Accidents Investigation Branch can be contacted for advice in handling of flight recorders in emergency situations.

**8C14.28** The retrieval of flight recorders after an accident is of prime importance. Once the flight recorder has been located, it is imperative that its location should be marked and protected. However if it needs to be moved, it should be handled as little as possible before retrieval by Air Accidents Investigation Branch specialists. Electromagnetic devices should not be used to search for these recorders because the electromagnetism can damage the recorded information.

**Picture 5: Example of typical flight recorder**



Source Ron Puttock GFRS

**8C14.29** The outer casing of older flight recorders can be damaged or even destroyed in an accident, leaving only the protected memory module remaining, containing the recorded data. If this module is subjected to fire or immersed in fluid it can become discoloured and difficult to identify.

**8C14.30** Other sources of recorded flight data are becoming more common on commercial aircraft. Of particular use to investigators are Ground Proximity Warning System units and Quick Access Recorders. These, together with many avionic boxes and engine control units, can store data into memory; however, the memory is not required to be crash protected. Therefore, as a precaution, any electric boxes found should be protected from further damage until they can be retrieved by Air Accidents Investigation Branch specialists.

**Picture 6 and 7: Damaged flight recorders**



Source AAIB

## Global positioning unit

**8C14.31** Global positioning units are being used more and more by pilots flying smaller aircraft such as business jets, general aviation aircraft and gliders. Some global positioning units are panel mounted or portable/hand-held units positioned somewhere in the cockpit by the pilot at the start of each flight.

**8C14.32** Many of these units are able to store and record/track information in their memory and therefore should be collected and where practical placed in anti-static bags and handed to Air Accidents Investigation Branch personnel.

**8C14.33** If an antenna is still connected to the unit then this should be disconnected to prevent possible further recording of track information.

**8C14.34** Further information is available from the Air Accidents Investigation Branch at: [http://www.aaib.gov.uk/guidance\\_and\\_regulations/guidance\\_for\\_police\\_\\_emergency\\_services\\_and\\_airfield\\_operators\\_2008.cfm](http://www.aaib.gov.uk/guidance_and_regulations/guidance_for_police__emergency_services_and_airfield_operators_2008.cfm)

**Picture 8: Typical global positioning units**



Source AAIB



# Section 9

Appendices

## APPENDIX A

# The role of the Police Casualty Bureau

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- A.1** In the event of a disaster the role of the Police Casualty Bureau is to provide a central contact point for all those seeking or providing information about persons who might have been involved and to collect data and collate all records. As part of this process the police will send documentation teams to each receiving hospital, the mortuary and the reception centres.
- A.2** The main functions of the bureau are:
1. Handling enquiries from the general public about relatives and friends who might have been involved.
  2. Collating details of survivors, their condition and whereabouts.
  3. Informing enquirers of the condition and whereabouts of the survivors.
  4. Confirming areas of evacuation and the location of evacuees.
  5. Gathering data to assist in the identification of casualties.
  6. Compiling a list of persons believed to have been involved who are now missing.
- A.3** Once the casualty bureau has been established, its telephone numbers will be published through the media, with the public being asked to provide information on persons thought to have been involved in the disaster who have not been accounted for.
- A.4** This information assists the police in their task of identifying casualties and the deceased. It is a police responsibility to inform the next of kin of death or serious injury. This will be done in person and coordinated by the casualty bureau.
- A.5** If foreign nationals have been involved in the disaster the casualty bureau is the focal point for enquiries with foreign consulates, embassies or high commissions.

## EPIC – Emergency Procedures Information Centre

- A.6** EPIC forms part of the British Airways Crisis Management Centre at London's Heathrow Airport. It is operated by British Airways and is staffed jointly by British Airways and the Metropolitan Police, Heathrow Division.
- A.7** EPIC acts as a focal point for public enquiries with a dedicated public telephone number and can handle an incident involving up to 1000 casualties. The volume of calls from concerned friends and relatives should not be underestimated, e.g. following the Pan Am incident at Lockerbie over 10,000 calls were handled by

EPIC most of which were received in the first 72 hours. It collates and controls all information related to the passengers and crew who were involved in the incident and provides the next of kin with support.

- A.8** Through EPIC the airline is able to provide the information above, to the authority managing the incident, which in the UK will be the police force in whose area the incident has occurred. Thus the role of the Metropolitan Police, Heathrow Division within EPIC is to act in a liaison capacity with the Incident Authority. This is done practically, by establishing a close working relationship with the Police Casualty Bureau of the police force concerned.
- A.9** EPIC will be activated in response to a major incident involving a British Airways aircraft anywhere in the world. It is also contracted to over 50 major UK and overseas based carriers and would activate following a major incident involving one of their aircraft operating a service to, from or within the UK, or a major incident involving an aircraft with a large number of British nationals on board.
- A.10** Following notification of an incident, or upon request from a contracted airline, EPIC will be activated within 25 minutes. A public number will then be released through the media, providing the public with an immediate point of contact.

**Note:**

It should be noted that not every airline operator is contracted to EPIC and the United Kingdom Airline Emergency Planning Group (UKAEPG) in partnership with the Association of Chief Police Officers (ACPO) has drawn up a Memorandum of Understanding (MoU) with regard to how those UK airlines outside of EPIC will work with the Police Casualty Bureau.

## APPENDIX B

# Air show management

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**Picture 1: Red Arrows display at the Royal Air Force Association (RAFA) Air Show at Shoreham Airport**



Source WSFRS

- B.1** Flying displays and special events form a significant part of the UK leisure industry and the organisation and administration of these events require meticulous planning to achieve the highest safety standards. Each year there are over three hundred events and Fire and Rescue Services officers and emergency planning experts will be asked to sit on and participate in emergency planning groups for many of these events.
- B.2** Regrettably some pilots are killed or injured in aircraft accidents associated with these events. Therefore detailed planning and exercised plans are critical for responding Fire and Rescue Service personnel and the event organisers. The purpose of the appendix is to give a general overview of air show management to assist Fire and Rescue Service personnel who will be asked to be part of the planning process.

## Civil Aviation Authority

- B.3** Article 162 of the Air Navigation Order 2009 (ANO) (as amended), empowers the Civil Aviation Authority (CAA) to regulate flying displays within the United Kingdom. Civil Aviation Publication (CAP) 403 sets out the safety and administrative procedures to be followed by the organisers and participants at such events.
- B.4** Fire and Rescue Service managers who are preparing operational plans or participating as part of an emergency planning group with air show event organisers, should make reference to the relevant guidance issued by the Civil Aviation Authority on air displays and special events, CAP 403.
- B.5** CAP 403 does not apply to flying displays on military airfields. These events have their own code of practice.
- B.6** CAP 403 also does not apply to military aircraft displays at civil events. Military flying displays and flypasts are conducted under the regulation of the Ministry of Defence (MOD) and in accordance with Joint Service Publication (JSP) 550.

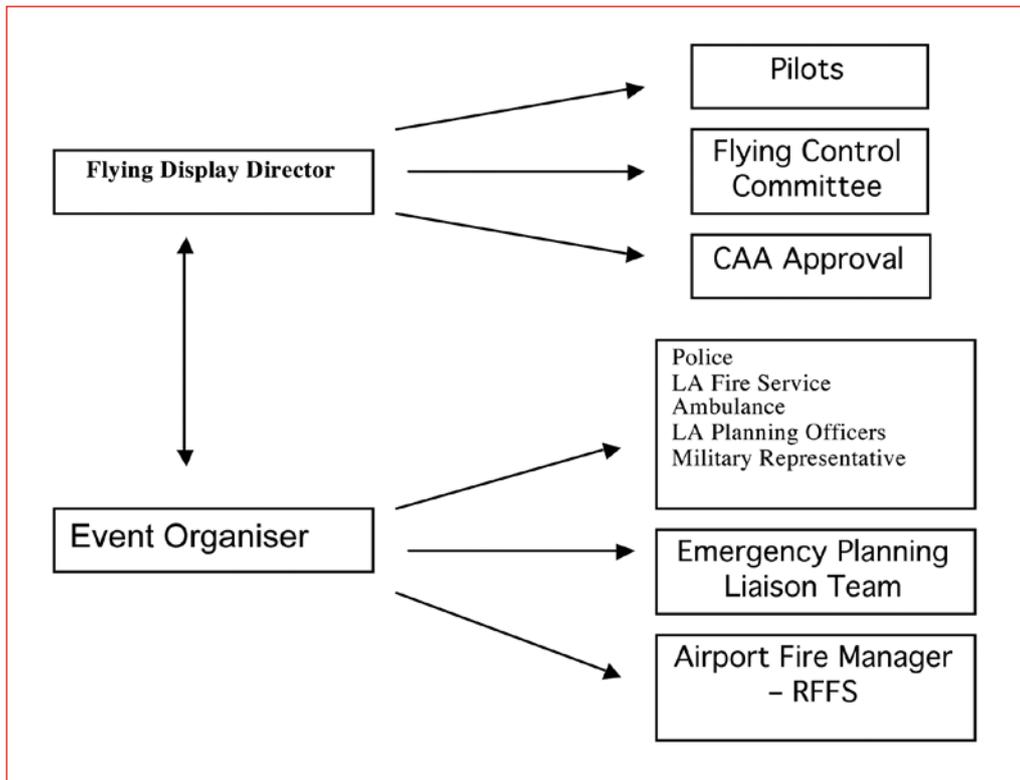
## Roles and responsibilities

- B.7** The key people in the management of air shows are the Event Organiser, the Flying Display Director and the Flying Control Committee.
- B.8** The Event Organiser is responsible for the planning of the event; they may delegate aspects of the event organisation to those individuals with relevant experience, skills and licences.
- B.9** The Flying Display Director is the person responsible to the Civil Aviation Authority for the safe conduct of the flying display and is named as such on the permission certificate issued under the Air Navigation Order (ANO).
- B.10** The Flying Display Director must obtain a permission in writing from the Civil Aviation Authority to hold the event. If this permission is granted the Civil Aviation Authority will issue an appropriate certificate which places various conditions on the event.
- B.11** A permission will contain conditions such as:
- number of aircraft display items
  - start and finish times of the flying activity
  - military aircraft must have prior approval from the MOD to take part
  - an attached schedule will detail display line distances, which must be strictly adhered to by participating aircraft.
- B.12** Flying displays held on or over MOD property are exempt from the need to hold a Civil Aviation Authority permission certificate, but will be subject to compliance with display limits approved by military authorities.

- B.13** At larger events a Flying Control Committee assists the Flying Display Director in monitoring display standards, and provides specialist knowledge for specific display items such as fast jets. They can be located in air traffic control or near the display line as they require unrestricted view of all flying activity, see example map. They observe minute to minute flying activity throughout the display.
- B.14** The Flying Control Committee has the authority of the Event Organiser to curtail or stop, on the grounds of safety, any display item or, in extreme cases, the whole flying display.
- B.15** Display aircraft are not permitted to overfly the spectator enclosures or car parks without specific written permission. Displaying aircraft perform relative to the display line which, on an airport, is usually parallel to a runway. The distance between the display line and the crowd line is related to the actual speed of the aircraft and the type of display. The minimum distances are as follows:

All aircraft			
Aircraft display speed	Type of display		
	Flypast	Aerobatics	V/STOL Aircraft Only Flypast or Hovering
Less than 100 kt IAS	50 metres	100 metres	150 metres
100 – 200 kt IAS	100 metres	150 metres	150 metres
200 – 300 kt IAS	150 metres	200 metres	150 metres
Above 300 kt IAS	200 metres	230 metres	200 metres

- B.16** Where an air show occurs on a licensed airfield or airport, due to the nature of aircraft displaying, the airport may need to increase its fire category status. As a consequence it is the responsibility of the Airport Fire Manager and Event Organiser to provide the necessary increase in rescue and fire fighting provision, as detailed in CAP 168.
- B.17** Not all air displays will be located on airports and as such it will be the responsibility of the Event Organiser to liaise with the local Fire and Rescue Service with regards to its onsite or offsite response should an incident occur.
- B.18** Below is a diagram to show the principal people and organisations involved in the running of a sizable air show.

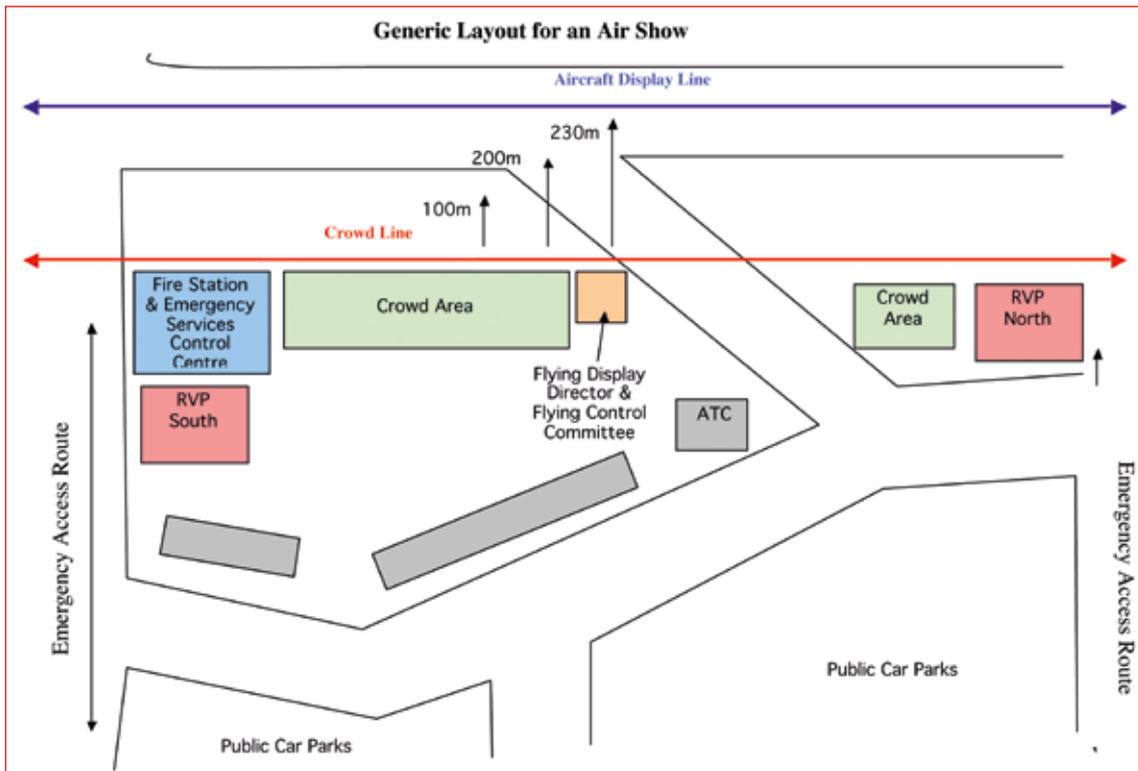


## Airspace

- B.19** Airspace Utilisation and Off-Route Airspace (AU&ORA). This is the body responsible for facilitating airspace use. A copy of the Civil Aviation Authority Flying Display Permission is passed to AU&ORA for NOTAM action and information.
- B.20** Notices to Airmen (NOTAM) – Issued for all displays where Civil Aviation Authority permission has been granted, and for all military displays. AU&ORA issue NOTAMS. This is a document that alerts pilots to hazards at a specific location. For example, areas of airspace where an air display will be taking place will be notified as a NOTAM – Navigational Warning. NOTAMS are available for pilots to view on the internet ([www.ais.org.uk](http://www.ais.org.uk)).
- B.21** Major events require a Restricted Area (Temporary) (RA(T)) notice, which is issued by AU&ORA. A RA(T) notice closes the affected airspace to all aircraft not taking part in the event. Also, a RA(T) notice is automatically provided for Red Arrows and other major military jet formation display teams at smaller events but only for the duration of their display plus a small margin.
- B.22** RA(T) notices may be available for medium and large flying displays where these are sited at natural choke points, in otherwise unprotected airspace such as coastal events or where the size and nature of the event warrant the setting up of a RA(T) notice.

## Emergency planning committee

- B.23** It is vital for safe planning of the event that the Event Organiser has good liaison links with the local authority, Fire and Rescue Service, police, ambulance and other emergency services (which could include Maritime and Coastguard Agency and Royal National Lifeboat Institution (RNLI) for offshore display sites). Emergency services perform a vital role in providing guidance and support to the Event Organiser.
- B.24** CAP 403 requires an integrated emergency plan as an essential pre-requisite for any flying display and strongly recommends that one should be produced for special events. An emergency plan should be a comprehensive written plan that specifies the responsibilities of all the parties in the event of an accident or incident.
- B.25** It should be stressed that small displays (of up to three items) should have an appropriate level of emergency plan for that particular display site and display content and may not need such a comprehensive emergency plan as for a larger show. For many 'off-airfield' smaller events (up to three display items), prior notification of the event to the local emergency services is sufficient.
- B.26** The emergency plan must be agreed by all emergency services prior to the event with the aim to provide a cohesive response to an incident. The emergency plan should cover strategies for crowd management and welfare, transport management, fire, first aid, major incident and contingency planning.
- B.27** It is good practice that Fire and Rescue Services are represented on the Air Display Emergency Planning Committee as they play a key role in the formulation of the event emergency plan.
- B.28** The emergency plan will be a very detailed document covering every aspect of the event and will include crash maps, site maps of the event, access points and crowd control.
- B.29** For larger shows it is not uncommon for planning to start one year before the event with the meeting cycle ramping up prior to the air show and culminating in a table top exercise to prove key elements of the plan.
- B.30** CAP 403 sets out model timescales for the Event Organiser to contact local authorities and emergency services as follows:
- small event (1-3 items) 2 months
  - medium event (4-12 items) 5 months
  - large event (12+ items) 10 months.
- B.31** Small air shows – will have a table top exercise prior to the event.



**B.32** Larger air shows – will have a tabletop exercise that covers a range of scenarios. This may occur a month prior to the event so the plan can be amended and changed where necessary but it is essential that Fire and Rescue Services are represented and play a full part in this process. A live exercise may also be held shortly before the event.

**B.33** Above: Typical plan of an airport air show.



Source WSFRS

**Picture 3: Multi Agency Control Room  
Farnborough Air Show**



Source WSFRS

## On the day

- B.34** Depending on arrangements, Fire and Rescue Services may decide to dedicate assets to the event to provide day on-site response and support the Rescue and Fire Fighting Service or alternatively they may decide to provide an off-site response.
- B.35** Whether an on-site or off-site response is agreed, it is good practice to have a Fire and Rescue Service liaison officer at the display location throughout the event. They are normally located with the Event Organiser's emergency planning team.
- B.36** Prior to each days flying a joint emergency services briefing will be held on-site to discuss the flying schedule and any issues that may affect the emergency response should an incident occur. This meeting will be chaired by the Event Organiser or a selected member of the emergencies team and the Fire and Rescue Service liaison officer should be in attendance.

## Terminology used in air show management

- Flying Display – Any flying activity deliberately performed for the purpose of providing an exhibition or entertainment at an advertised event open to the public.
- Special Event – Any flying activity during which aircraft may not necessarily comply with the Rules of the Air and normal air traffic control rules and which requires consideration of one or more of the following:
  - the issue of special procedures
  - the level of an 'air traffic service' to be provided
  - the establishment of Restriction of Flying Regulations

- Crowd Line – The forward edge of the areas intended for spectators and any car park to which the public has access during a flying display.
- Display Line – A line defining the closest a display aircraft should approach the crowd line.
- Event Organiser – The organiser of an event which includes a flying display.
- Flying Display Director – The person responsible to the CAA for the safe conduct of a flying display.
- Display Pilot – A pilot who holds a Display Authorisation or Exemption, issued by his appropriate national authority, which allows him to take part in a flying display. (Note: In the UK this only applies to civil Display Pilots. Military Display Pilots are approved and authorised as specified by the MOD.)
- Display Item – A single aircraft, or formation of aircraft, flying as one display “act”.
- Spectator – A person attending a flying display and remaining in the areas set-aside for the public.
- Display Authorisation – A national document detailing the types or groups of aircraft in which a pilot is authorised to display, together with any limitations and other specific endorsements.
- Pleasure Flights – Any passenger flight starting from, or arriving at, the display site purely for the purpose of commercial air transport pleasure flying.
- Static Aircraft Park – A park for aircraft to which the public has access.
- Aircraft Parking Area – A park for aircraft to which the public has no access.
- Car Parks – Where the words ‘car parks’ are used they are only intended to apply to those car parks to which the public has access during the flying display.

## Further reading

- B.37** CAP 403 is available to download free from the CAA website [www.caa.co.uk](http://www.caa.co.uk)
- B.38** The *Fire Safety “Purple Guide” – Guide to health and safety and welfare at music and similar events*, is available to download for free from the Health and Safety Executive website [www.hse.gov.uk](http://www.hse.gov.uk)

## APPENDIX C

# Polymer composites

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- C.1** The purpose of this appendix is to give Fire and Rescue Service a balanced overview of the problems associated with polymer composites in relation to aircraft accidents.
- C.2** Over recent years there has been much speculation as to the extent of the hazards associated with this material and this chapter has been written with and is supported by, the Institute of Naval Medicine, Defence Fire Risk Management Organisation the Aircraft Accidents Investigation Branch, the Civil Aviation Authority, Airport Operators Association and the Rescue and Firefighting Working Group.
- C.3** The recommendations from this chapter are supported by the Airport Liaison Group of which membership is made up from Chief Fire Officer Association (CFOA), the Civil Aviation Authority, the Airport Operators Association and the Defence Fire Risk Management Organisation.
- C.4** With advances in technology polymer composites, also known as machine/man made mineral fibres, are being used to a far greater degree in the construction, maintenance and repair of modern civil and military aircraft. The major types of composite materials used on modern aircraft include a wide range of materials:
- carbon
  - glass
  - Aramid (Kevlar)
  - graphite
  - boron
  - GLARE™ (GLAss REinforced Laminate)
  - plus Hybrids of any of the above.
- C.5** GLARE™ (relatively new to the aviation world) is formed of several very thin layers of metal (usually aluminium) located within layers of glass fibre and bonded together with an epoxy matrix. This product can be found on the A380 Airbus and has a much increased fire resistant capability/strength over earlier composite materials.
- C.6** There is also a wide range of resins that are used to bond the materials together. The term composite (also known as organic matrix compound) is applied to any material utilising two or more substances in its basic construction e.g. carbon fibre/epoxy resin, carbon fibre/epoxy resin/honeycomb matrix.

**Note:****GLARE™**

Extended burn through times will mean that an external fire will not penetrate the fuselage as quickly as it previously would with more conventional materials resulting in survivability levels within the fuselage being extended.

Internal fires within the fuselage may not ventilate themselves quickly as in previous aircraft design resulting in a potential increased risk of backdraught or flashover.

**C.7** Polymer composites are popular in the world of aviation due to a number of factors:

- they possess an excellent strength to weight ratio
- they do not fatigue like metals
- they are lightweight
- they can be moulded into a variety of complex shapes
- they are relatively inexpensive to manufacture and have no finite life.

**C.8** Modern airframes can incorporate composite materials throughout their construction, for example in structures (floor beams, spars, skins, tail sections, etc), and in components (cowlings, panels, control surfaces etc).

**C.9** Rotary wing aircraft often incorporate composite materials within their construction (e.g. in cabin structure and tailcone) and in components such as rotor blades and cowlings.

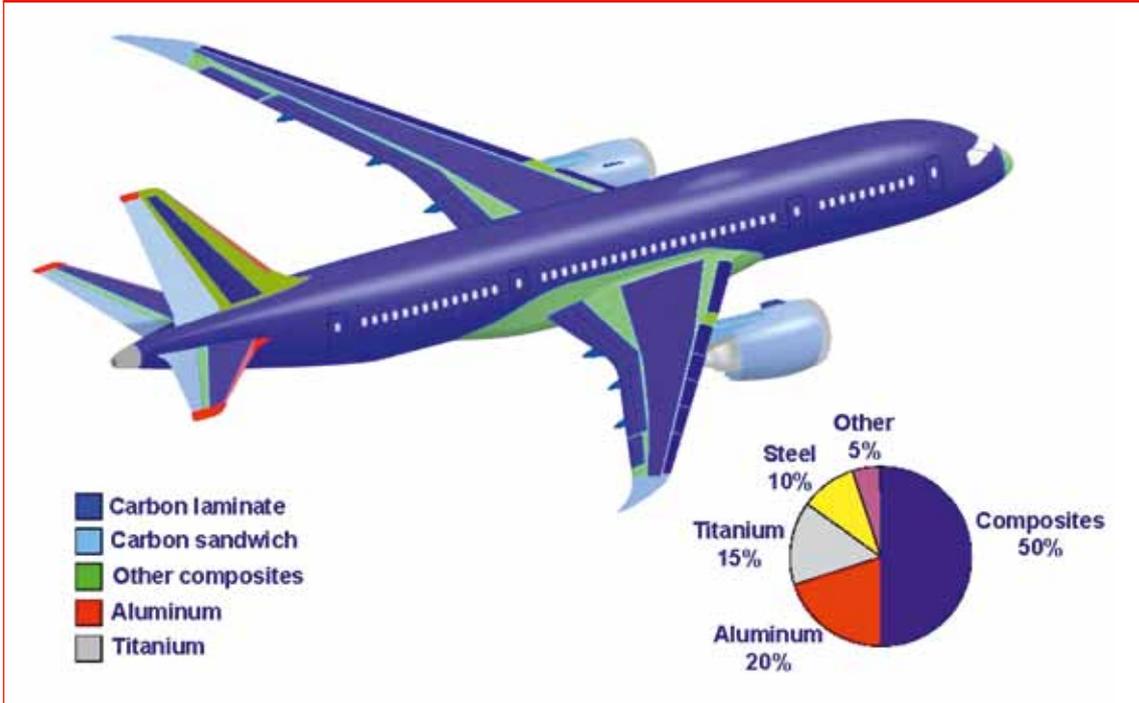
**C.10** It is extremely difficult to give guidance on the quantity of polymer composites that can be found in aircraft, as it depends on the aircraft's age and use. Polymer composite can be found in almost any aircraft as it is a material that can be retrofitted or be an original component from the initial construction.

**C.11** Military aircraft use polymer composites extensively, for example approximately 35 per cent to 40 per cent of the structure of a Harrier and 70 per cent of the structure of a Typhoon (Eurofighter) are made from composites. The diagram below is of the Boeing 787 Dreamliner and shows the extensive use of polymer composites in modern aircraft design.

**C.12** There is a wide variation in the proportion of polymer composite used throughout aviation. Some lightweight general aviation aircraft can be constructed entirely from polymer composites (typically 300kg by weight), whilst in the largest civil airliner, the A380, polymer composites account for 16 per cent (30 metric tonnes) of the airframes total weight of 170 metric tonnes.

**C.13** An indication of the increase in use of polymer composites can be gained by comparing the Boeing 777 construction (first built in 1995) with the Boeing 787. The diagram below shows that the 777 has just 17 per cent non-metallic materials in its structural materials whilst the 787 will have 60 per cent.

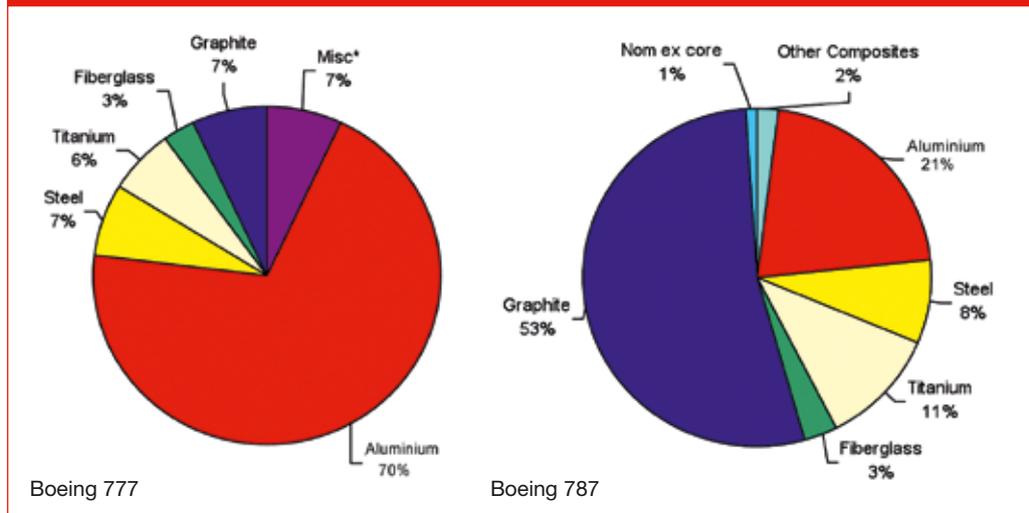
**Picture 1: Boeing 787 Dreamliner**



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Source Boeing

**Picture 2: Composites found on Boeing 777 and 787**



Source Boeing

**Note:**

Polymer composites are increasingly utilised in the construction of many everyday objects such as vehicles, boats and is used extensively through the construction industry. Therefore polymer composites can no longer be deemed as an aviation specific issue and should be addressed and considered throughout all Fire and Rescue Service activities.

**C.14** Note: Structural weight is defined as the total weight of wing, fuselage, empennage (tail fin and tailplane), propulsion and landing gear structure.

- C.15** It is impossible to state with any accuracy the exact toxic hazards that will arise from any incident involving a modern aircraft, due to the diversity of the pyrolysed products produced at the various temperatures. Also the manner in which the polymer composite has been constructed will play a major part with regards to how it reacts when involved in fire i.e. layered, solid construction, honeycomb matrix etc.
- C.16** On a modern aircraft there may be anything up to thirty different polymer composite materials used within the construction of the aircraft. Therefore the issue of polymer composites should not be viewed as a single issue but one of many hazards to be controlled.
- C.17** Whilst intact, polymer composite material is deemed to be inert and non hazardous however during an aircraft crash these materials may be subjected to extreme forces, fragmentation, immersion in aviation fuel and other flammable liquids and ultimately ignited by an ensuing fire. When these substances are exposed to elevated and extreme temperatures, that may occur as a consequence of an aircraft crash (1000°C – 2000°C), these compounds become unstable and decompose.
- C.18** Hazards from damaged composites will be present in a variety of forms at accident sites and depending upon the volume and concentration of these hazards, will present a range of risks to those responding to the accident. Hazards can be presented in the following forms:
- toxicity
  - particulates (fibres and dusts)
  - conductivity
  - change in structural strength (affects upon rescue operations)
  - contamination.

## Toxicity

- C.19** The risk to Fire and Rescue Service personnel arises from decomposition of materials during and after a fire. Burning composites will produce toxic gases which will add to those produced by other materials involved in the fire, and particularly those generated by burning fuel. The resins that bond fibres together account for around 40 per cent of composite materials, and when subjected to fire will liberate gases such as isocyanate and carbon monoxide.
- C.20** The various fibres in use will react differently to heat and fire, but generally will support a flame at around 200°C, adding further to the range of toxic emissions in the fire, e.g. Cyanide may be released at 150°C from Aramid (Kevlar) fibres however glass fibre is neutral and does not support combustion.

- C.21** Post-crash wreckage should have all fires extinguished and debris cooled to below 150°C before the decision to withdraw breathing apparatus is taken by the incident commander. This can be achieved by the use of thermal imaging cameras if available, if not available then the use of breathing apparatus is to be maintained until suitable and sufficient risk assessment identifies it is no longer required.
- C.22** Once all debris is cooled and has stopped ‘fuming off’ dust masks are considered an appropriate level of respiratory personal equipment for composites. However composites are just one of many materials that will have been affected by the fire and therefore the level of respiratory personal equipment and personal protective equipment must be subject to a comprehensive risk assessment.

## Particulates (fibres and dusts)

- C.23** If fire intensity is sufficient, both resins and fibres will be consumed. However, with partial decomposition of composites, once the resins have decomposed, the fibre matrix becomes exposed and is easily disturbed by firefighting operations, weather and thermal uplift. Some fibres will be small enough to be inhaled, and if there is sufficient volume, fibres may also plume and be carried downwind.
- C.24** Impact damaged composites can produce razor sharp edges and needle sharp fragments. All types of damage are capable of producing free fibres that are irritant in nature, and particularly when these affect the eyes.
- C.25** Fire damage often produces large volumes of dust (from resins and other materials) as well as significant volumes of fibres. These are capable of absorbing substances found on the accident site including products of combustion, hydrocarbons, etc. This residue presents a potential skin contact hazard capable of producing skin reactions such as dermatitis where exposure is concentrated or protracted.
- C.26** In addition to respiratory protection, it is recommended that personnel consider the potential for skin and eye contact hazards when exposure to dusts/fibres is likely. If eye contact risks are considered significant, the use of protective goggles is essential.

**Pictures 3 and 4: Example of delaminated and exposed fibre post aircraft crash**



Source MOD Crown Copyright

**C.27** The hazards associated with exposure to dusts and fibres include:

- skin irritation and potential skin conditions
- respiratory tract irritation and, in severe cases, reduced respiratory capacity
- eye irritation.

**Note:**

when working at aircraft crash sites different agencies will undertake different tasks and may therefore wear different standards of personal protective equipment.

**C.28** The Fire and Rescue Service Incident Commander will need to risk assess the likelihood of fibre liberation by fire service operations or by other causes such as wind and weather, other aircraft movements or other agency activities and implement more enhanced levels of respiratory protective equipment/personal protective equipment as appropriate.

## Conductivity

**C.29** Some fibre types may be electrically conductive, such as carbon/graphite, and there have been concerns that these will present a hazard to electrical equipment and installations.

**C.30** The AAIB has seen no evidence to suggest that this has been a problem at accident sites, or indeed that is likely to be a significant risk of this occurring. The generally low volume and concentration of airborne fibres produced, and the wide range of fibre sizes experienced, suggests that the potential for electrical shorting is not high.

## Change in structural strength (Effects upon rescue operations)

**C.31** When undertaking rescue operations where polymer composites have been identified additional respiratory protection should be considered for the casualties being rescued/extricated i.e. dust masks, as cutting operations can release fibres, dust etc. The application of water in the location of cutting operations will help to reduce the liberation of fibres, similar to the application of water for cutting through a bonded windscreen of a motor vehicle.

**C.32** Extrication activities and cutting operations can also create razor-sharp edges both from polymer composites and other aircraft materials such as aluminium.

**C.33** Most composite materials can be cut relatively easily using hand or powered tools, however, due to the inherent strength of polymer composite materials, Fire and Rescue Service personnel carrying out rescue operations may well find

particular difficulties in cutting through some materials. Hydraulic rescue equipment has been known to shear when trying to cut seat mountings and other similar components.

- C.34** Although polymer composites are inherently very strong once exposed to heat they can have significant reduction in their structural strength. Floor panels and superstructures may appear intact but could fail with the weight of a firefighter in certain conditions. Therefore extreme care needs to be taken when tasking rescue operations.

## Contamination

- C.35** In light of the hazards associated with the liberation of dusts and fibres at accident sites, it is recommended that consideration should be given to the need to clean non-disposable personal protective equipment at the earliest opportunity.
- C.36** Casualties contaminated with fire residues from composites should have outer clothing removed where possible, to prevent fibres being transported away from the crash site and ambulance/medical teams advised as to the irritant nature of these products.
- C.37** The treatment of casualties with serious/life threatening injuries should not be delayed. Medical teams must be advised of the hazards posed by contaminated clothing.
- C.38** The table overleaf gives a guide to the minimum level of personal protective equipment an Incident Commander should consider when deploying crews within the inner cordon, were polymer composites are known or suspected.

## Post accident management of polymer composites

- C.39** The application of foam blankets to suppress airborne pollution by polymer composites is no longer recommended due to the following reasons:
- foam presents an environmental hazard
  - foam creates a hazard by covering sharps and trip hazards
  - foam creates difficulties for the responding Air Accident Investigation Branch and police body recovery units as it masks and covers up body parts and evidence.
- C.40** Generally accepted good practice is to keep the wreckage damp utilising fine mist water spray. If the aircraft is small then the wreckage can be covered in a salvage sheet. Further advice can be obtained by contacting the Aeronautical Rescue Coordination Centre and the Air Accidents Investigation Branch as to how best to preserve the wreckage and evidence for the investigating teams.

# Guidance table personal protective equipment within the inner cordon

Scenario	Task	Minimum PPE	PPE
Aircraft crash – fire  Post fire – debris fuming off temp over 150°C	Firefighting and rescue	Full fire kit – BA  Subject to RA	
Aircraft crash – no fire  Structural damage only	Rescue	Full fire kit – dust mask  Subject to RA	
Post fire – debris cooling off/cold – below 150°C	Rescue	Full fire kit – dust mask  Subject to RA	
Post incident – preservation of scene	Application of fine water spray  Assisting AAIB/MOD crash response team	Full fire kit – dust mask  Subject to RA	

**C.41** Ministry of Defence Post Crash Management Response Teams and the Air Accidents Investigation Branch use dust/fibre suppressant substances to reduce the potential for airborne particulates to be generated. These bond the surface of debris as they dry.

**Note:**  
 Fibre Suppression  
 Only use foam if there is an operational reason to do so.  
 Fine mist water spray is the preferred method of fibre control.

## Decontamination

- C.42** It is generally considered that normal washing protocols for personal protective equipment will suffice following normal Fire and Rescue Service operations at aircraft fire/crash scenarios. Incident commanders may wish to liaise with Air Accident Investigation Branch or MOD on the scene advisers with regards to cleaning protocols.
- C.43** Fire and Rescue Service personal protective equipment cleaning contractors should be informed of the potential irritant hazard with regard to fibres and this should be risk assessed accordingly.
- C.44** Where there is likelihood of body fluids/biohazards/chemicals contamination being absorbed by fibres, then personal protective equipment should be managed in accordance with Fire and Rescue Service contaminated personal protective equipment protocols.

**Note:**

REMEMBER

Composite materials are found in cars – boats – buildings (roof insulation) – sporting equipment, etc

This is a material the Fire and Rescue Service deal with EVERY DAY.

## The use of gas tight protection at an aircraft incident

- C.45** The need for use of gas tight suits is considered unlikely for situations where hazards are limited to composite dusts and fibres. However, if exposure to dust and fibre is likely, then suitable protective clothing is recommended, depending upon the task to be conducted.

**Pictures 5 and 6: Wide spread wreckage containing polymer composites at the scene of a Harrier aircraft crash**



Source MOD Crown Copyright

## Aide memoire

- consider the extent of polymer composites at site
- determine the damage sustained
- identify tasks to be conducted
- identify and continue to assess correct level of personal protective equipment/ respiratory protective equipment
- evacuate personnel from the immediate vicinity – work upwind
- restrict ground and flight operations as appropriate
- establish/strictly manage inner cordon with a single entry and exit point
- restrict access to essential personnel only
- extinguish fires and cool composite materials below 150°C
- use thermal imaging cameras to assess temperature of wreckage
- avoid excessive disturbance of wreckage
- consider structural weakness and instability due to crash and fire damage
- for fibre control keep wreckage damp with a fine mist spray as recommended by the Air Accidents Investigation Branch
- remain alert to changes in wind direction/weather conditions
- handover to competent person/agency
- do not become involved in site clearance/aircraft recovery.

## APPENDIX D

# Ministry of Defence search and rescue facilities

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- D.1** In the event of a military aircraft accident or aircraft emergency (mayday) being reported, the Aeronautical Rescue Coordination Centre will coordinate the search phase of the incident. Depending on the circumstances, the Coordination Centre might also bring aeronautical search and rescue assets to a heightened level of readiness or deploy them to offer immediate assistance if required. It is possible that this activity will be initiated before any incident has been reported to the Fire and Rescue Service or other authorities.
- D.2** The Coordination Centre has primacy over coordinating the incident until the aircraft is found, at which point they hand over the incident to the relevant authority, be that the police, Fire and Rescue Service, Maritime and Coastguard agency etc.

## Responsibility

- D.3** The MOD provides search and rescue facilities to cover military operations, exercises and training within the UK search and rescue regions. Although the coverage provided by these resources has been established for military purposes, it is MOD policy to render assistance whenever possible to any persons, aircraft or vessels in distress. Where the coverage provided by military search and rescue assets meets the civil search and rescue requirement, they will be made available for civil aeronautical, maritime and land based search and rescue operations.

## Organisation

- D.4** MOD declared aeronautical search and rescue assets consist mainly of Royal Air force and Royal Navy search and rescue helicopters, supplemented by other aircraft, and surface vessels as necessary. On land, the MOD has specialist RAF mountain rescue teams. In the event of large scale disasters, additional military resources can be made available through the military aid to the civil authorities route.

## RAF mountain rescue teams

- D.5** The RAF has four mountain rescue teams based at Kinloss, Leuchars, Leeming and Valley. Each mountain rescue team is available at one hour's notice and is operationally controlled by the Aeronautical Rescue Coordination Centre. The teams are fully equipped with their own vehicles and have a comprehensive communications suite which includes VHF, UHF and HF radios as well as a

Satcom capability and Tetra/Airwave. The teams work closely with the military search and rescue helicopters and can provide a rapid response to both military and civilian incidents in all areas of inhospitable terrain. RAF mountain rescue teams maintain a close liaison with the police and civil mountain rescue organisations.

- D.6** These teams are trained to identify associated hazards with military aircraft accidents. However, they are not equipped to deal with these hazards, but will be able to provide the incident commander with valuable on scene advice.

## Aeronautical Rescue Co-ordination Centre

- D.7** The Aeronautical Rescue Coordination Centre is the only organisation that may task an aeronautical search and rescue asset in the UK and it also coordinates aeronautical search and rescue activity. Embedded within the Coordination Centre is the UK Mission Control Centre, which is the facility responsible for the detection and notification of emergency distress beacon alerts. The Coordination Centre operates 24 hours a day and coordinates the use of military and Maritime and Coastguard Agency search and rescue assets, including RAF mountain rescue teams, within the UK Special Reconnaissance Regiment in incidents involving civil or military aircraft in distress, irrespective of nationality. It also coordinates aeronautical search and rescue operations in support of and requested by UK first responders, search and rescue or authorities, including operations by military or civil aircraft, whether national or foreign.
- D.8** To fulfil its responsibilities the Coordination Centre has extensive communications links with other search and rescue authorities, including a considerable network of exclusive voice, fax and data circuits for communication with UK first responders, backed up by normal military operational links. Other search and rescue authorities are to request search and rescue helicopter and mountain rescue team assistance for civil maritime or land search and rescue operations from the Coordination Centre.
- D.9** Exceptionally, on rare occasions when it is believed that to delay a response could be life threatening, provision has been made for police to make direct contact with the nearest search and rescue helicopter unit and request assistance. In this instance, the requesting authority is to inform the Coordination Centre as soon as possible afterwards. On such occasions, if the Coordination Centre subsequently assesses that a different response would be more effective, it may task an alternative means of response. All Fire and Rescue Service mobilising centres have a restricted emergency number for contacting the Coordination Centre. This emergency assistance line is staffed 24 hours a day and indicates to the receiving call taker that the incoming call is from the Fire and Rescue Service.

## Fixed wing aircraft

- D.10** The MOD may agree to provide fixed wing aircraft to assist in search and rescue operations on a case-by-case basis. Relevant aircraft include C-130 Hercules and the E3D Sentry, both of which have capabilities predominantly relating to off shore search and rescue. MOD fast jet aircraft have previously been considered, to assist with providing aerial photography and imaging during major incidents, and even locating missing persons. Requests for MOD fixed wing assistance for search and rescue must be made to the central MOD; for search and rescue incidents in which the Coordination Centre is already involved, such a request would most effectively be made by and in consultation with the Coordination Centre or a RAF Regional Liaison Officer. The Coordination Centre can directly task non MOD fixed wing Cessna aircraft, which are declared for search and rescue and operated on behalf of the Maritime and Coastguard Agency.

## Helicopters

- D.11** The RAF Sea King helicopters at Boulmer, Chivenor, Leconfield, Lossiemouth, Valley and Wattisham have a normal endurance of approximately 3 hours, but can increase fuel loads to achieve a maximum endurance of 6 hours. At each location, one helicopter is available at 15 minutes readiness between 0800 and 2200 hours; and 45 minutes readiness between 2200 and 0800 hours. This readiness can locally alter if a helicopter is engaged in a prolonged period involving heavy workloads, or if the helicopter is diverted temporarily away from its usual operating base.
- D.12** All RAF/RN search and rescue helicopters are equipped for full day and night operations over land and sea. Some limitations exist with regard to freezing conditions, heavy snow and fog, but in general terms the helicopters and crews are capable of operating in most weather conditions. Search and rescue helicopters also have a full night vision goggle capability and are equipped with forward looking infra red and conventional imaging devices. Crews are well practised in night vision goggles and forward looking infra red operations operations, which are major enhancements to search capabilities.
- D.13** All RAF/RN search and rescue helicopter rear crew are medically trained, with many winchmen trained up to paramedic standard; there is an aspiration that all winchmen will become registered paramedics. Up to 17 passengers can be carried on board search and rescue aircraft, however, this capacity can vary depending on a variety of factors, including weather conditions and the distance of the incident from the helicopter's operating base.
- D.14** All RAF/RN search and rescue helicopters are equipped with VHF (Marine and Air Band), UHF, HF, mountain rescue radios and Tetra/Airwave. They are also capable of homing to some international distress frequencies.

**D.15** The RN Sea Kings at Culdrose and Prestwick have an endurance of 5.5 hours. These helicopters are held at similar readiness to the RAF search and rescue helicopters and are available for military and civilian tasking through the Coordination Centre. Other RAF and RN helicopters can be used on search and rescue missions when available, but requests for such assistance should be made through the Coordination Centre.

## APPENDIX E

# Hot air balloons

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- E.1** Fire and Rescue Service personnel may be called to deal with incidents involving Lighter Than Air aircraft. These may include airships, hot air airships, gas or hot air balloons; however, the most likely Lighter Than Air aircraft incident will probably involve hot air balloons. It is therefore important that Fire and Rescue Service personnel have an appreciation of this type of aircraft and the associated hazards they may pose.
- E.2** In the UK pilots of balloons (and airships) must hold a valid Private Pilot's Licence issued by the Civil Aviation Authority for the type they are flying. Like all aircraft balloons and airships are issued with a Certificate of Airworthiness revalidated by an annual or 100 hour inspection (whichever comes soonest) along with an annual "Airworthiness Review".
- E.3** Hot air balloons are dependent on the difference between the ambient air temperature and the internal temperature of the envelope to provide lift. Heat is provided by a specially designed propane burner (or burners). The normal operating temperature inside the envelope is 100°C. They are dependent on wind speed and direction. They are most commonly flown early in the morning or late in the afternoon about an hour before sunset.

**Picture 1: Hot air balloon**

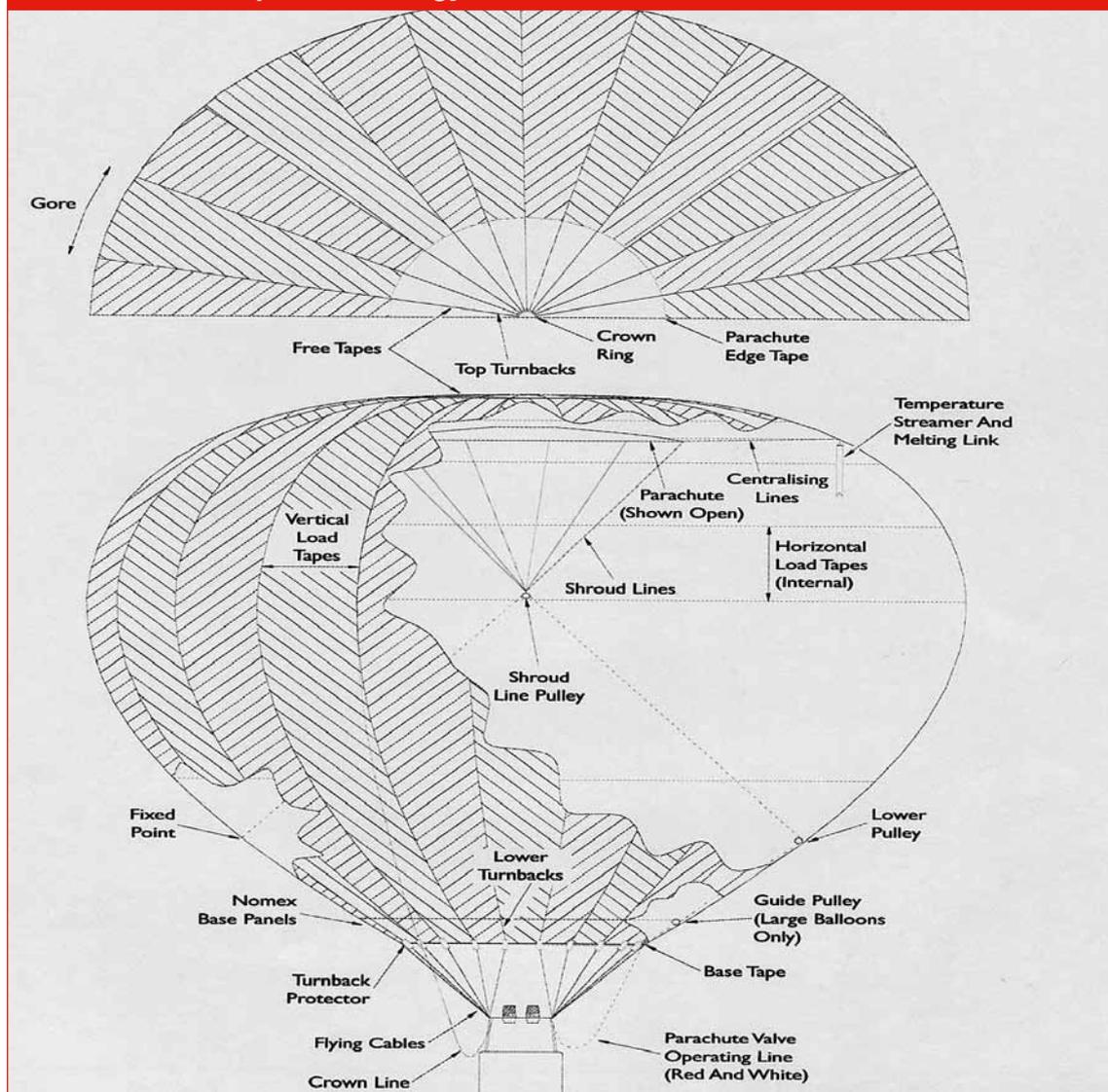


Source Cameron Balloons Ltd

## The envelope

- E.4** Apart from the commercially operated special shape balloons the vast majority of hot air balloons are of the traditional teardrop shape. Most of the privately operated balloons range from 21,000cu.ft one man basketless 'hoppers' to 105,000cu.ft four man open basket types. Commercial ride balloons range in size from 120,000cu.ft five/six man to 400,000cu.ft, carrying upwards of 16 passengers.
- E.5** The envelopes are made of very strong lightweight synthetic coated fabrics such as ripstop nylon, polyester and close-woven nylons. The material is cut into panels which are then sewn together within vertical and horizontal tapes that carry the load (basket, burners, fuel and occupants). The vertical row of panels that run from the mouth (bottom) to the top rim tape are known as gores. Depending on make, style and size there are generally between eight and thirty two gores. At the very top of the envelope is a crown ring, a circle of (usually) aluminium to which the vertical load tapes are attached and a self-sealing parachute, a separate circular panel that can be opened to release air from the envelope if required.

**Picture 2: Envelope terminology**

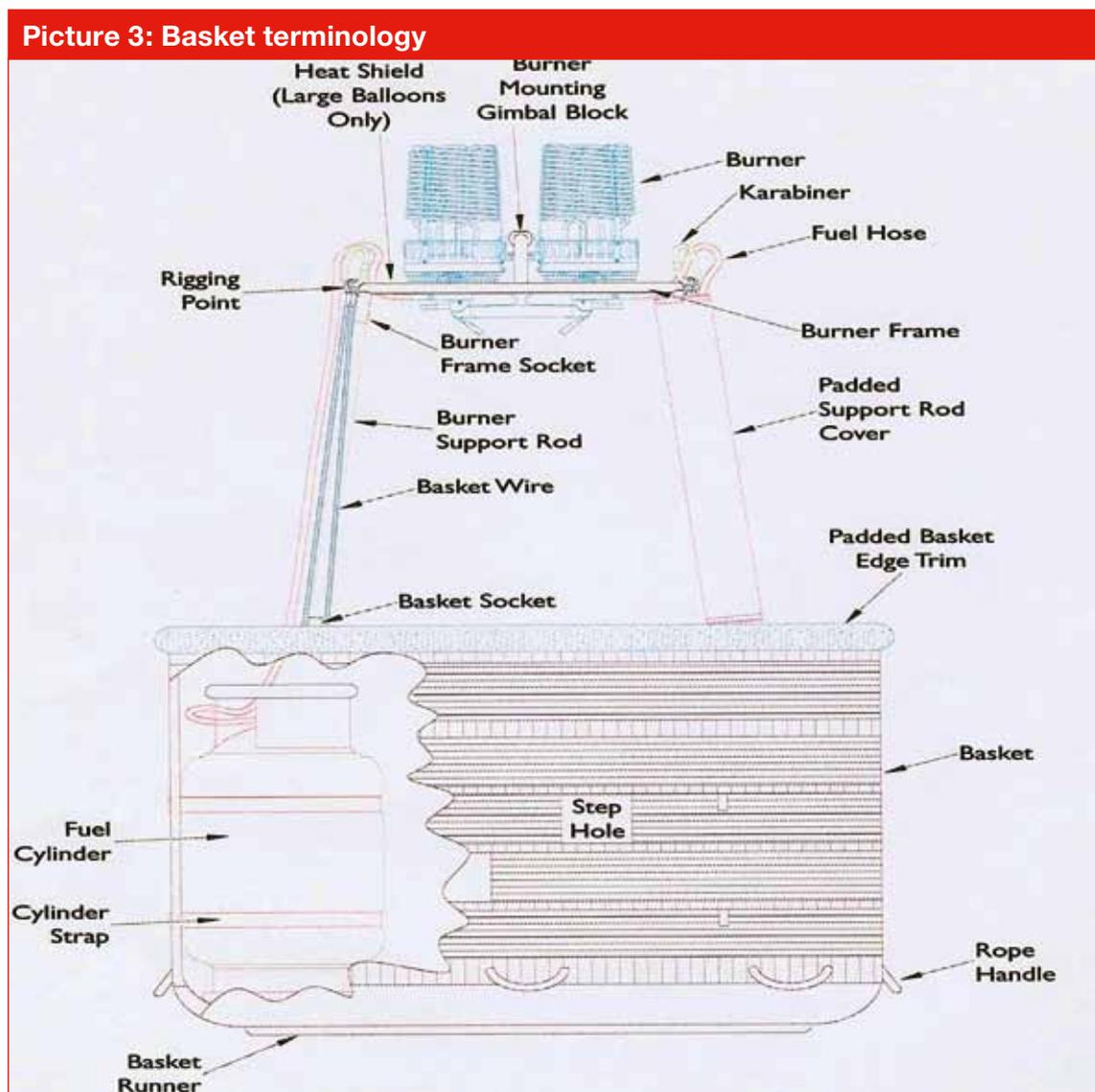


Source Cameron Balloons Ltd

- E.6 The envelope is flammable and for this reason the first row of panels above the mouth are made from Nomex or similar fire retardant material.

## Baskets

- E.7 Baskets are commonly made from woven wicker or rattan with internal aluminium or stainless steel frames woven or tied in. These materials have proven to be sufficiently light, strong and durable for balloon flight and, most importantly, balloon landings.
- E.8 Baskets are generally square or rectangular and vary greatly in size. The smaller privately operated balloons tend to use open baskets about four foot square while the larger balloons tend to use partitioned baskets with a separate pilot/fuel compartment. These are referred to as single or double T partitioned. In the case of the single T the pilot and fuel cylinders are at one end of the basket whilst the double T has the pilot and fuel cylinders in a central compartment.



Source Cameron Balloons Ltd

## E.9 The burner

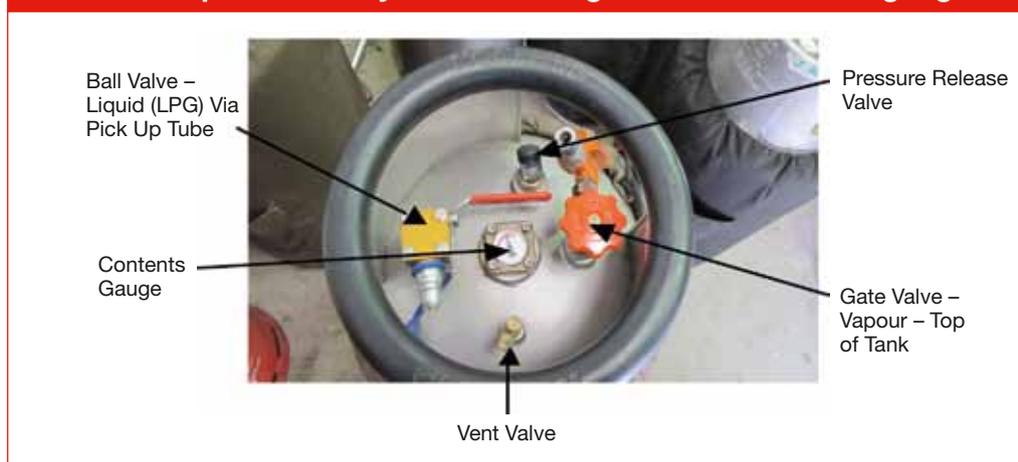
- E.10** Propane (Liquefied Petroleum Gas) is used in all UK hot air balloons (and hot air airships) to provide fuel for the burners; this is carried in dedicated fuel cylinders strapped into the corners of the basket. Three or four cylinders are usually carried. The cylinders are designed to be used upright and are made from aluminium, titanium and stainless steel and generally have capacities of 40, 60 and 80 litres.
- E.11** All cylinders are fitted with liquid take-off ball valves or screw gate-type valves, a pressure relief valve, filling vent valve and fuel contents gauge (reads from 40 per cent). Depending on the type of burner used a vapour take-off valve (gate-type), with a pressure regulator attached may be fitted.
- E.12** Liquefied Petroleum Gas supply to the burner is via a ½in bore hose and vapour (if fitted) via a smaller ¼in hose. Two types of liquid hose fittings are used. Push on Tema and screw on Rego. The Tema fitting is removed by lifting the outer ring upwards and pulling off. There is a locking ring fitted which may have to be rotated before the sleeve can be pulled up. In the case of vapour hoses these use push fit connectors and are released by pulling the outer collar down which 'pops' the connector out.
- E.13** The contents gauge indicator informs the pilot when there is 40 per cent or less content in the cylinder.
- E.14** All burners work on the same basic principle. Liquid propane is fed through a series of stainless steel coils and exits at the bottom through a jet ring where it is ignited by a pilot light. The burning propane in turn heats the coils increasing the pressure and thus provides a very powerful flame to heat the air in the envelope. Output can be in the region of 8million British Thermal Units.

**Picture 4: Two propane cylinders strapped into basket**



Source WSFRS

**Picture 5: Top view of a cylinder showing control valves and gauges**



Source WSFRS

- E.15** The burners are mounted above the basket and separated from it by nylon poles, usually covered by leg leathers inside which run the hoses and basket wires. These poles do not support the burner in flight but are there to prevent the burners coming down on the occupants during landing. The burners themselves are gimbaled allowing the pilot to direct the flame more accurately through the envelope mouth.
- E.16** Throughout flight a pilot light runs. This may be fed via the liquid hose and a regulator built into the burner or by a separate vapour feed. Both types use small ball or lever valves to operate them. The pilot light is ignited by a built-in piezo, however it is also possible to light it using matches, igniters or flint striker.
- E.17** There are always at least two liquid feeds to the burner. The burner is fed through valves which, depending on the burner type, may be operated by spring loaded self-closing toggle valves or ball valves that require opening and shutting. These supply propane to the coils and are referred to as blast valves. A secondary valve is often fitted and feeds liquid to a separate jet which burns the liquid in a non pressurised form (much quieter) and is referred to as a cow burner.

## Operational considerations

- E.18** Balloon accidents in the UK are extremely rare but usually quite newsworthy. Where accidents do occur they are either on the ground during the inflation and take-off or during the landing phase.
- E.19** Pilots (and often ground crew) undergo training in the handling and use of propane so fires as a result of mishandling seldom occur. There is mandatory fire and first aid training every three years for commercial pilots which often extends to their crews. Pre-flight checks are carried out before every flight so leaks from valves and seals are detected prior to flight and appropriate action taken.

## Pictures 6, 7 and 8



Double Burner Unit



Blast Valve



Pilot light and  
Burner Ring

Source WSFRS

- E.20** Balloons are at their most vulnerable during take-off and landing. Collisions with overhead cables do sometimes occur. This is most likely during landings where the wind drags the balloon before it has completely deflated and can result in the envelope draping over the cables. This can result in arcing as the cables short circuit under the weight of the envelope. In more serious cases the basket, envelope or, flying wires may make contact and this can result in severing of cables, flying wires and hoses. Pilots are trained to close all valves prior to a contact and deflate the balloon as quickly as possible, to prevent a high level strike occurring.
- E.21** There is a likelihood that fire may break out following power line strikes both in relation to the balloon and also to the surrounding vegetation, especially if a cable breaks and it shorts to the ground.
- E.22** It has been known for balloons to end up in trees or baskets suspended from lamp posts, where rescue of the occupants or retrieval of the envelope, by the Fire and Rescue Service is required.
- E.23** In all cases it is important that the propane supply is turned off at source and any residual flames are extinguished before rescue or recovery is attempted. Vapour pilot lights may run on for some time after the valve at the cylinder is turned off. If the vapour valve is closed and the hose is disconnected at the cylinder the pilot light will go out immediately.

- E.24** If the pilot or passengers are incapacitated during the landing then ensure all valves are closed and all flames are extinguished before attempting to remove them. If possible always check with the pilot whether the balloon has been made safe. If the crew are present their help should be enlisted, if appropriate, as they will be familiar with the systems.
- E.25** More often than not, the call may not be an emergency. Hot air balloons normally fly around an hour before or after sunrise and sunset. As the balloon comes into land the pilot will often put in one long continuous burn at around tree height to arrest the descent before landing. At twilight this can often give the impression that the balloon is ‘crashing in flames’ resulting in a number of calls to the Fire and Rescue Service and emergency services being made each year.

## Key points

- E.26** Most likely causes for a call, in order of seriousness:
- power line strike (serious, possible threat to life)
  - field fire caused after landing (threat to property)
  - unmanned balloon (rare, but has happened that everyone fell out)
  - false alarm (no threat, public misunderstanding “crashed in flames”).
- E.27** Attending the scene:
- balloon landing sites are (usually) deliberately ‘in the middle of nowhere’ – the location given is likely to be ill-defined and among the most difficult to reach
  - possibility of getting appliance bogged down therefore consider 4x4 vehicles for PDA
  - baskets can also end up suspended from the cables or trees, which will require the Fire and Rescue Service to carry out a rescue from height.
- E.28** Controlling the propane supply:
- fires can occur as a result from a propane leak that may be due to over filling or defective tank fittings
  - tanks may have both liquid and vapour off-takes to secure
  - valves are either ball valve or gate valve design
  - the pilot light may still continue to burn as there will be residue gas in the pipe work, this can be dealt with by disconnecting the pipeline connections.
- E.29** Post incident consideration:
- all serious balloon incidents are reportable to the Civil Aviation Authority and may be investigated by the Air Accidents Investigation Branch.

## APPENDIX F

# Gliders

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- F.1** The British Gliding Association operates through 85 flying clubs and has over 8,000 flying members operating some 2,600 gliders.
- F.2** Each year gliders are involved in air accidents or forced emergency landings away from the airstrip, resulting in the aircraft landing in precarious locations and/or suffering serious structural damage.
- F.3** Precautionary landing by a glider in a field is a routine procedure when a glider is unable to reach a recognised airfield. These landings are usually achieved without any damage or injury. Because gliders have a single wheel located in the centre of the fuselage they generally rest one wing on the ground with the other one pointing upwards at what may look like an alarming angle. In the past this has misled members of the public into reporting a routine field landing as a crash.
- F.4** Due to the weight and design of these aircraft they generally do not present Fire and Rescue Services with major operational problems. However modern gliders are becoming more high-tech in design and therefore worthy of mentioning in this operational guidance manual.
- F.5** Hazards associated with modern gliders will be:
- fuel
  - electrical supplies
  - propeller hazards
  - polymer composite
  - oxygen cylinders.

## Traditional gliders

- F.6** The majority of gliders are traditional in design and construction and range from basic wood, fabric to aluminium, glass reinforced plastics and advanced polymer composites. The aircraft will carry one or two occupants who will be strapped into their seats by a four-point harness. Canopies open easily and access for rescue should not present Fire and Rescue Service personnel with too many problems.

**Picture 1: LGS K13 training glider Lasham Gliding Club Hampshire**



Source Barry Alderslade

## Motor gliders

- F.7** Motor gliders are fixed wing gliders that can be flown with or without engine power and they can contain 50 litres to 100 litres of fuel. The aircraft will have a 12 volt battery for delivering power to the avionic equipment.

**Picture 2: Grob touring motor glider**



Source Airpringstone Copyright free image

## Pictures 3, 4 and 5: Retractable propeller and two stroke 20 litre fuel tank



Source Barry Alderslade

## Retractable propellers

- F.8** Retractable propellers are usually mounted on a mast that rotates up and forward out of the fuselage (aft of the cockpit). The function of these units is to provide propulsion for the aircraft to take off without the need for a tow or ground launch.
- F.9** The fuselage will be fitted with engine bay doors that open and close automatically, similar to landing gear doors.
- F.10** The propeller is powered by a two stroke engine and will carry approximately 20 litres of two stroke fuel. The aircraft will again have a 12 volt power supply.

## Centrifugal propellers

- F.11** Some gliders are now fitted with centrifugal propellers which spin out under centrifugal force when the engine is in operation.
- F.12** These aircraft are technically advanced and more like a general aviation light aircraft than a traditional glider.
- F.13** A few gliders use a five or six point harness. Each harness can be released by operating a single buckle or lever. Most glider pilots wear a parachute, therefore after a crash the pilot(s) may not be in or close to the glider, but have parachuted out of the aircraft and be some distance away from the crash site. t consideration:

**Pictures 6 and 7: Centrifugal propeller shown in the stowed and operating positions**



Source Barry Alderslade

**Picture 8: Cockpit showing advanced avionic equipment in glider**



Source Barry Alderslade

- F.14** all serious balloon incidents are reportable to the Civil Aviation Authority and may be investigated by the Air Accidents Investigation Branch.



# Section 10

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# Section 12

Record of obsolete or superseded  
previous operational guidance

The table below lists the aircraft guidance, issued by Her Majesty's Government that is now deemed to be obsolete or, is superseded by this Operational Guidance document.

The following abbreviations are used in the table:

- FSM Fire Service Manual
- MoF Manual of Firemanship
- DCOL Dear Chief Officer Letter
- TB Technical Bulletin
- FSC Fire Service Circular

Type of Guidance	Document Title
FSM 1999	Fire service manual. Volume 2: operations: aircraft incidents
FSC 2008 no 67	Aircraft Ballistic Recovery Systems
DCOL 1999 no 15	Military Aircraft Hazard Databases
DCOL 2003 no 3	Helicopter Incidents
DCOL 1993 no 7 sect 3	Management of emergencies at civil airports and aerodromes
DCOL 1963 no 30	Crashed aircraft carrying nuclear weapons
DCOL 1962 no 625	Danger points and rescue procedure from crashed aircraft
DCOL 1957 no 166	Ejection seats
TB 1/1950	Refers air ministry guidance on ejector seats.
MoF 1988	Part 6b Practical firemanship II
MoF 1988	Book 4 – Incidents involving aircraft
DCOL 1976 no 3	Crashed aircraft carrying nuclear weapons
DCOL 1978 no 32	Hazard identification system for crop spraying aircraft
DCOL 1979 no 37	Hazard identification scheme for crop spraying aircraft
TB 2/1957	Breathing apparatus. Rescue from crashed aircraft
DCOL 12/1966	Crashed aircraft carrying nuclear weapons
DCOL 1983 no 12 Item B	Crashed aircraft carrying nuclear weapons
DCOL 1991 no 10 Item 6	Safety hazards associated with carbon fibre materials
DCOL 1992 no6	Safety hazards associated with carbon fibre materials
DCOL 1964 no 719	Helicopter flights
DCOL 1956 no 297	Air Ministry poster no.6038A

Type of Guidance	Document Title
DCOL 1991 no 5 Item 9	Fire Brigade Incident Communications
DCOL 1993 no 7 Item C	Management of emergencies at civil airports and aerodromes
FSC 1955 no 29	Civil defence helicopter
DCOL 1993 no 2	RAF search and rescue helicopter equipment upgrade – night vision goggles
DCOL 1957 no 363	Fire hazards of titanium



# Section 13

Glossary of terms

## A

**Access point (AP)** – A gate in the airport perimeter fence that allows access from landside to airside on an airport.

**Aeronautical Rescue Coordination Centre (ARCC)** – This is the nominated RAF centre for military aircraft crash hazard information, offering 24/7 helpline advice.

**Aft** – A term used to describe the rear section of an aircraft.

**Ailerons** – Hinged control surfaces attached to the trailing edge of the wing of a fixed-wing aircraft, used to control the aircraft in roll.

**Air Accidents Investigation Branch (AAIB)** – An independent organisation embedded within the Department for Transport and responsible for the investigation of civil aircraft accidents and serious incidents within the UK.

**Air bridge** – Telescopic arm that creates a walkway from the terminal building to the aircraft.

**Air conditioning (AC)** – The treatment of interior air for comfort, designed to stabilise the air temperature and humidity within the aircraft.

**Air Navigation Order (ANO)** – The key Statutory Instrument through which aviation regulations are implemented in the UK.

**Air Traffic Control (ATC)** – A service provided for the purpose of:

- a) preventing collisions:
  - i) between aircraft, and
  - ii) in the manoeuvring area between aircraft and obstructions; and
- b) expediting and maintaining an orderly flow of air traffic.

**Aircraft accident** – Occurrence during the operation of an aircraft in which any person suffers death or serious injury or in which the aircraft receives damage.

**Aircraft assisted escape system (AAES)** – The collective term used to describe the ejection seat and all associated components of the ejection seat system.

**Aircraft incident** – Occurrence, other than an accident, associated with the operation of an aircraft that affects or could affect the safety of the aircraft and its occupants. [NB the AAIB definition is: “an incident involving circumstances indicating that an accident nearly occurred”; it is unlikely to involve the police or emergency services other than those based at airports.

**Aerodrome** – Means any area of land or water designed, equipped, set apart or commonly used for affording facilities for the landing and departure of aircraft and includes any area or space, whether on the ground, on the roof of a building or elsewhere, which is designed, equipped or set apart for affording facilities for the landing and departure of aircraft capable of descending or climbing vertically.

**Airport** – Means the aggregate of the land, buildings and works comprised in an aerodrome within the meaning of the CAA 1982 Act.

**Airport emergency plan (AEP)** – A required document by the CAA that is prepared by airport operator, to facilitate the timely and appropriate response to emergencies occurring on or in the immediate vicinity of the airport.

**Airport Fire Service** – Alternative name for RFFS.

**Airport Fire Manager (AFM)** – Senior Airport Fire Service Manager, responsible for the rescue and firefighting services on an airport.

**Airport Incident Commander (AIC)** – Senior airport fire officer, in attendance at an incident.

**Airport Liaison Group (ALG)** – The UK rescue and firefighting aviation liaison group.

**Airport topography** – Layout and location of airport buildings, runways, taxiways, access points and road infrastructure.

**Airside** – The controlled area of an airport only accessible through security gates, that requires all Fire and Rescue Service vehicles to be escorted by leader vehicles unless drivers have the required airside permit to drive licence issued by the airport operator.

**Airspace Utilisation and Off Route Airspace (AU&ORA)** – This is the CAA department responsible for facilitating air space use

**Apron** – Defined area on airports intended to accommodate aircraft for purposes of loading or unloading passengers, mail or cargo, refuelling, parking or maintenance, also known as ramp.

**Automatic deployable emergency locator transmitter (ADELT)** – An emergency transmitter used on helicopters operating off shore, which gives a continuous signal for search and rescue aircraft to locate.

**Auxiliary fuel tanks** – Aircraft may be fitted with additional fuel tanks and generally these will be found in/under the fuselage, under wing or at the wingtips.

**Auxiliary Power Units (APU)** – Usually a small engine carried on board an aircraft to provide an independent power source for such services as electrics, hydraulics, pneumatics, ventilation and air conditioning.

**Avcat** – Military aircraft fuel

**Avgas** – Aircraft fuel used by piston engine.

**Avpin** – A military fuel used in aircraft starter motor, not in common use.

**Avtag (Jet B)** – Aircraft fuel used by naval and foreign civil aircraft.

**Avtur (Jet A1)** – Most commonly used aircraft fuel for jet turbine engines.

## B

**Backdraft** – Instantaneous explosion or rapid burning of superheated gases that occurs when oxygen is introduced into an oxygen-depleted confined space.

**Ballistic Parachute System (BPS)** – System utilising a rocket propelled parachute which is deployed by the pilot, if the aircraft or pilot experiences a severe in flight emergency. Trade name for this system includes Ballistic Recovery System (BRS), Cirrus Air Frame Parachute System (CAPS) and the Galaxy Recovery System (GRS).

**Basket** – Hot air balloon baskets are traditionally made from woven wicker or rattan with internal aluminium or stainless steel frames woven or tied in. Baskets are usually square or rectangular and vary greatly in size.

**Blood borne pathogens** – Micro-organisms that are spread through the contamination of blood or body fluids through contact with open cuts, skin abrasions, eye, nose and mouth.

**Bogie** – Tandem arrangement of landing gear wheels with a central strut, swivels up and down so all wheels stay on the ground as the attitude of the aircraft changes or as the slope of the ground surface changes.

**Breathing apparatus (BA)** – Self contained compressed air breathing apparatus, which is the highest level of Fire and Rescue Service respiratory protective equipment.

**British Airports Authority Airport Fire Service (BAA AFS)** – The provision of RFFS on BAA licensed airports.

**British Microlight Aircraft Association (BMAA)** – The British Microlight Aircraft Association looks after the interests of microlight owners in the UK. It is an organisation approved by the Civil Aviation Authority (CAA).

**Bulkhead** – Partition that separates one aircraft compartment from another and may strengthen or help give shape to the structure and may be used for the mounting of equipment and accessories. This may or may not be fire resisting.

**Burner Ring** – Component located above the control valves in a hot air balloon, through which propane gas is burnt.

## C

**Cabin** – The section of an aircraft in which passengers travel.

**Canopy** – Transparent enclosure over the cockpit of some aircraft.

**Cargo Manifest** – Document or shipping paper listing all cargo carried by an aircraft on a specific trip.

**CBRNE (Chemical, Biological, Radiological, Nuclear, Explosive)** – An acronym that can be applied to a criminal or terrorist event caused by chemical, biological, radiological, nuclear and explosive materials.

**Chief Fire and Rescue Adviser (CFRA)** – Provides strategic advice and guidance to ministers, civil servants, Fire and Rescue Authorities in England and other stakeholders (including the devolved administrations), on the structure, organisation and performance of the Fire Rescue Service.

**Civil Aviation Authority (CAA)** – The United Kingdom’s specialist aviation regulator. Its activities include economic regulation, airspace policy, safety regulation and consumer protection.

**Civil Aviation Publication (CAP)** – Publication issued by the CAA that must be adhered to in the UK.

**Cockpit** – Fuselage compartment occupied by pilots whilst flying the aircraft.

**Cockpit voice recorder (CVR)** – Recording device installed in most large civil aircraft to record crew conversations and communications and is used to assist in an accident investigation to determine probable cause of the accident.

**Communities and Local Government (CLG)** – Government department whose remit includes fire and resilience.

**Compressed air foam system (CAFS)** – System that mixes small amounts of foam with compressed air and water to make a large quantity of wet or dry foam for firefighting. It is generally not recognised as a suitable foam system for aircraft firefighting, by the CAA for large category airports.

**Cordon control** – Cordons are employed as an effective method of controlling resources and maintaining safety on the incident ground.

**Countermeasures** – Devices or systems designed to prevent sensor guided weapons from locating, identifying, locking onto and or destroying an aircraft.

**Cowling** – Removable covering around the aircraft engine.

**Critical National Infrastructure (CNI)** – A term used by governments to describe assets that are essential for the functioning of society and economy.

## D

**Dangerous goods** – Any product, substance or organism included by its nature in the regulation of any of the nine United Nations classifications of hazardous materials.

**Defence Suites** – Systems on aircraft to provide countermeasures for self defence.

**Detection Identification Monitoring Teams (DIM)** – Specialist teams used at hazardous material incidents.

**Digital flight data recorder (DFDR)** – Digital recording device on large civil aircraft to record aircraft airspeed, altitude, heading, acceleration, etc. Used as an aid to accident investigation and commonly referred to as the “black box” (although it is bright orange to aid location).

**Disaster Victim Identification (DVI)** – Police team who undertake the role of victim identification as a result of an aircraft accident or other man made and natural disaster.

## E

**Ejection seat** – Aircraft seat capable of being ejected clear of the aircraft in an emergency. Found only in military aircraft.

**Elevator** – Hinged control surface at the rear of the horizontal tailplane, used to control the up and down pitch motion of the aircraft.

**Elevons** – The combination of ailerons and elevators found on delta wing aircraft.

**Emergency escape slides** – A device fitted to an emergency exit for emergency evacuation of passengers and crew.

**Emergency Procedures Information Centre (EPIC)** – The British Airways crisis management centre.

**Engine** – a power unit designed to produce thrust required to propel the aircraft forward and can also drive other systems that support the operation of an aircraft.

**Envelope** – the balloon part of the hot air balloon, which is traditionally a tear drop shape, made from strong lightweight synthetic coated fabrics.

**European Aviation Safety Agency (EASA)** – An agency of the European Union with regulatory and executive powers in the field of civilian aviation..

**Exhaust area** – Area behind an engine where hot exhaust gases present a danger to personnel.

**Extinguishing agent** – Substance used for the purpose of controlling or extinguishing a fire.

## F

**Fin** – A fixed vertical surface, usually at the tail, designed to contribute to both directional and lateral stability. Often called the “tail **fin**” and usually used to carry the rudder.

**Fire and Rescue Service (FRS)** – Local Authority Fire and Rescue Service or Local Authority Fire and Rescue Authority.

**Fire resistant bulkhead** – Fire resistant partition that separates one aircraft compartment from another.

**Fixed Electrical Ground Power (FEGP)** – A ground power supply for an aircraft parked at a stand, provided by means of a cable and plug.

**Fixed wing** – an aircraft with wings that are attached to the fuselage of the aircraft.

**Flaps** – Adjustable aerofoils attached to the trailing edges of aircraft wings to improve aerodynamic performance during takeoff and landing. [Slats are aerofoils on the leading edge ditto].

**Flash point** – Lowest temperature required to raise the vapour pressure of a liquid such that vapour concentration in air near the surface of the liquid is within the flammable range, and as such the air/vapour mixture will ignite in the presence of a suitable ignition source.

**Flashover** – Stage of a fire at which all surfaces and objects within a space have been heated to their ignition temperature, causing the near simultaneous ignition of all combustible materials with the area.

**Flexible fuel tanks** – These fuel tanks are flexible bags made of plastic, nylon or neoprene rubber, which are fitted into the wings or the fuselage and secured by press studs.

**Flight data recorder** – Recording device on large civil aircraft that records aircraft airspeed, altitude, heading, acceleration etc. It is used as an aid to accident investigation. Known as the “black box” despite being bright orange to aid location.

**Floatation gear** – Water actuated devices known as buoyancy floatation gear is fitted to helicopters which operate over water. These units can be found in wheel hubs, carried in sponsons and can be manually operated by the crew.

**Foam** – Extinguishing agent formed by mixing a foam concentrate with water.

**Foreign Object Debris (FOD)** – Substance, debris or article alien to the vehicle or system which could potentially cause damage. Usually used in connection with ingestion by engines to detrimental effect.

**Fuel tanks** – Fuel is carried in a number of structurally separate but interconnected tanks can be found in the wings, fuselage and tailplane of an aircraft.

**Fuselage** – Main body of an aircraft to which the wings and tail are attached, it houses the crew, passengers and cargo.

## G

**General aviation (GA)** – A term used to describe all aircraft that weigh below 5700kg without fuel loading.

**Generic Risk Assessment (GRA)** – This is a document that details the assessment of hazards, risks and control measures that relate to any incident attended by the Fire and Rescue Service.

**Generic Standard Operating Procedure (GSOP)** – Is a list of possible operational actions and possible operational considerations viewed against the ‘Managing Incident – Decision Making Model’ which has been divided into the six phases of an incident.

**Global positioning system (GPS)** – An American constellation of satellites that provide signals for the purposes of determining a fixed position. [The generic term is satellite navigation system (satnav)].

**Ground Power Unit (GPU)** – A mobile power unit used by aircraft parked on the stand.

## H

**Halon** – Halogenated firefighting agent that extinguishes fire by inhibiting the chemical reaction between fuel and oxygen.

**Hazardous Area Response Team (HART)** – Ambulance specialist response teams trained and equipped to work within the inner cordon of an incident.

**Hazardous Material (HazMat)** – Are referred to as dangerous/hazardous substances or goods, solids, liquids, or gases that can harm people, other living organisms, property, or the environment. They not only include materials that are toxic, radioactive, flammable, explosive, corrosive, oxidizers, asphyxiates, biohazards, pathogen or allergen substances and organisms. Also materials with physical conditions or other characteristics that render them hazardous in specific circumstances; such as compressed gases and liquids, or hot/cold materials.

**Hydraulic system** – Aircraft system that transmits power by means of force applied to a fluid, usually oil.

**Hydrazine** – Specialist military fuel that causes a health hazard in both the liquid and vapour form, it is a clear oily liquid with a smell similar to ammonia. Only found in the American F-16 strike aircraft.

## I

**Inboard/outboard** – Refers to location with reference to the centreline of the fuselage, e.g. inboard engines are the ones closest to the fuselage and out board engines are those farthest away.

**Incident Command System (ICS)** – The nationally accepted incident command system, as detailed in Fire and Rescue Manual Fire Service Operations Volume 2 – Incident Command.

**Incident Commander (IC)** – The nominated competent officer having overall responsibility for incident tactical plan and resource management.

**Incursion** – Any occurrence in the airport runway environment involving an aircraft, vehicle, person or object on the ground that creates a collision hazard for aircraft taking off, intending to take off, landing or intending to land.

**Instrument Landing System (ILS)** – Electronic navigation system that provides guidance information to allow aircraft to approach and land, including during inclement weather conditions.

**Intake area** – Hazard area in front of and to the side of a jet engine with engines running.

**Integral fuel tank** – Integral tanks used in the aircraft airframe compartments for storing fuel, mostly found in the wings, but can be found in the fuselage and tailplane.

**Integrated Risk Management Plan (IRMP)** – This is the Fire and Rescue Service published assessment of risk within their county/metropolitan boundaries and subsequent action plan to address these risks.

**International Civil Aviation Organisation (ICAO)** – A specialised agency of the United Nations that governs international standards for the safe, orderly and efficient operation of global air transportation.

**International Fire Service Training Association (IFSTA)** – Organisation based in the United States that provides non profit educational guidance for American firefighters on firefighting techniques and safety training.

## J

**Jet A1** – See *Avtur*

**Jet blast** – Hazard area behind an aircraft with engines running.

**Jettison** – The deliberate discarding of aircraft components such as external fuel tanks or canopies.

**Joint Aircraft Recovery and Transport Squadron (JARTS)** – The RAF response team who are experts in the area of military aircraft accidents and associated hazards.

## L

**Landside** – This refers to all areas outside the control span of the airport, where members of the public have free movement without passing through a security gate.

**Leading edge** – Front or forward edge of an aircraft's wings or fin.

**Light Aircraft Association (LAA)** – The UK's principal representative body for amateur-built and vintage light aircraft.

**Lighter Than Air (LTA)** – Aircrafts such as hot air balloons or airships.

**Linear detonating cord (LDC)** – See *miniature detonating cord (MDC)*.

**Liquid Oxygen System (LOX)** – A system to supply one or more liquid oxygen converters, which supply the aircraft with oxygen whilst in flight.

**Local Authority (LA)** – Local government body in a specific area that has the responsibility for providing local facilities and services, e.g. County or District Council.

**Longerons** – Internally-placed stringers running continuously along the length of the fuselage, to which other assemblies are attached e.g. cabin flooring

**LOX** – Liquid oxygen system found on military aircraft.

## M

**Magneto** – Device used in gasoline engines that produces a periodic spark in order to maintain fuel combustion, this is a self generating device.

**Main rotor** – Formed by two or more rotating aerofoils that provide lift and propulsion for helicopter flight. Some helicopters such as the Chinook have two rotors whilst others more commonly have one.

**Mainplane** – The major lifting surface of the aircraft (wing), which may contain fuel and incorporates housing for engines, control surfaces and undercarriage units.

**Maritime and Coastguard Agency** – A UK executive agency working to prevent the loss of lives at sea and is responsible for implementing English and International maritime law and safety policy.

**Memorandum of Understanding (MoU)** – Local agreement between the Fire and Rescue Service and Rescue and Fire Fighting Service in respect to operational procedures when working on or adjacent to airports.

**Military Aviation Authority (MAA)** – The MAA, a department of the Ministry of Defence, is the regulatory body that will regulate, audit and quality assure military aviation. It has its own military section for aircraft accident investigations.

**Miniature detonating cord (MDC)** – May also be referred to as a linear cutting cord (LCC) or a mild detonating cord. This is an explosive cord that once operated will explode outwards, shattering the canopy material to allow the seat to pass through easily.

**Mogas (motor gasoline)** – Fuel (petrol) used in certain light aircraft.

**Movement area** – Runways, taxiways and other areas of an airport that are used for taxiing or hover taxiing, air taxiing and takeoff and landing of aircraft exclusive of loading ramps and aircraft parking areas.

## N

**Nacelle** – Housing for an externally mounted aircraft engine.

**Narrow bodied aircraft** – this is a general description of a smaller passenger aircraft whose internal cabin of the aircraft has a single passenger aisle.

**North Atlantic Treaty Organisation (NATO)** – This is an intergovernmental military alliance based on the North Atlantic Treaty which was signed on 4 April 1949. The organisation constitutes a system of collective defence whereby its member States agree to mutual defence in response to an attack by any external party.

**Notice to Airmen (NOTAM)** – A NOTAM is a notice issued by the CAA containing information about the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations.

**Notification To The Commander (NOTOC)** – A ‘special load form’ that must be given to the commander of the aircraft, identifying what dangerous goods have been placed on board in the cargo and where they have been loaded.

**Nuclear Accident Response Organisation (NARO)** – A military department that will assume command of the incident, if an incident involving military assets has nuclear weapons or materials involved.

## O

**Oleo** – A shock absorber consisting of a telescoping cylinder that forces oil into an air chamber, thereby compressing the air; used on aircraft landing gear.

**Ordnance** – Bombs, rockets, ammunition and other explosive devices carried on most military aircraft.

**Overshoot** – A misjudged landing in which the aircraft touches down too far along the runway to pull up safely.

## P

**Payload** – the part of an aircraft's total weight from which revenue can be obtained i.e. passengers or freight.

**Personal Protective Equipment (PPE)** – Provided personal protective equipment issued by the Fire and Rescue Service, includes fire kit, boots, gloves etc.

**Personnel Equipment Connector (PEC)** – A clip connector located on the side of ejection seats that connect the aircrew's flight suit and associated equipment to the aircraft systems. This unit must be released before the aircrew can be lifted clear of the cockpit.

**Piston engine** – A reciprocating engine, also often known as a piston engine, is a heat engine that uses one or more reciprocating pistons to convert pressure into a rotating motion.

**Pitch** – The angle of the propeller blade to the vertical sweep area. Or the oscillation of the aircraft in rough conditions fore and aft or the distance measured longitudinally between corresponding points and aircraft seats.

**Police Casualty Bureau** – The central control point for anybody seeking information about persons who may have been involved in a major incident.

**Polymer composites materials** – General term to describe all composite materials used in aircraft construction.

**Positive Pressure Ventilation (PPV)** – Mobile fan used by Fire and Rescue Services for ventilating a compartment from smoke and fire gases.

**Predetermined Attendance (PDA)** – The pre planned Fire and Rescue Services response to accidents/incidents.

**Pressurisation** – the process of making an aircraft interior airtight and maintaining the pressure inside the aircraft higher than the pressure outside the aircraft.

**Pylon** – a streamlined fairing on a wing or the fuselage to carry a fuel tank, weapon etc.

**Pyrotechnics** – a general term to describe smaller explosive devices other than weapons on military aircraft include: chaff, infra red flares, signal cartridges, distress flares and large smoke markers.

## R

**Radial engine** – Internal combustion, piston driven aircraft engines with cylinders arranged in a circle.

**Ramp** – Area at airports intended to accommodate aircraft for purposes of loading or unloading passengers or cargo, refuelling, parking or maintenance; also known as Apron.

**Reciprocating engine** – Internal combustion, piston driven aircraft engine with cylinders arranged in opposition.

**Remotely piloted air system (RPAS)** – These aircrafts are remotely piloted from a ground location and the aircraft themselves may contain all the hazards associated with military aircraft.

**Rendezvous Points (RVP)** – Pre planned locations for the holding/gathering of emergency services when attending incidents on or adjacent to airports.

**Rescue and Fire Fighting Service (RFFS)** – This is the CAA terminology for the provision of Fire and Rescue Services on Airports.

**Respiratory Personal Equipment (RPE)** – Equipment provided for the protection of the Fire and Rescue Service's personnel's respiratory system.

**Restricted Area (Temporary) (RA(T))** – Notice issued by Airspace Utilisation and Off-Route Airspace designating a volume of airspace in which major events such as air shows may take place, to prevent aircraft movements other than those taking part in displays.

**Rigid fuel tank** – Usually constructed by sheet aluminium with internal baffles, which reduce surge and strengthen the tank.

**Risk Assessment (RA)** – A risk assessment is a careful examination of what could cause harm to people, environment, business continuity, heritage, property etc...in order to weigh up whether enough precautions have been taken or more should be done to prevent harm. The law does not expect the elimination of all risk, but the protection of people as far as is 'reasonably practicable'.

**Rotor** – Rotating aerofoil assemblies of helicopters and other rotary wing aircraft, providing lift.

**Royal National Lifeboat Institution (RNLI)** – An independent charity that saves lives at sea. It operates 444 lifeboats around the coasts of Great Britain, Ireland, Isle of Man and the Channel Islands.

**Rudder** – Hinged, moveable control surface attached to the rear part of the vertical fin and used to control the yaw or turning motion of the aircraft.

**Runway** – Defined rectangular area on airports prepared for takeoff and landing of aircraft along its length.

## S

**Safe system of work (SSoW)** – A formal procedure resulting from systematic examination of a task to identify all the hazards. Defines safe methods to ensure that hazards are eliminated or risks controlled as far as reasonably practicable.

**Senior Airport Fire Officer (SAFO)** – Old terminology, replaced with the Airport Fire Manager.

**Shipping papers** – See *air bill*.

**Side lines** – RFFS terminology for a charged length of delivery hose.

**Significant incident** – Incident involving a large number of casualties or fatalities, no exact number however AAIB define this as six or more persons involved.

**Single seat de-regulated (SSDR)** – Aircraft or microlights which weigh less than 115kg, without pilot or fuel.

**Slat** – a small section of a wings leading edge, which can be moved to improve airflow under certain conditions.

**Spars** – the main support frames for a wing, running from the centre section of the wingtips or from wingtip to wingtip.

**Speed brakes** – Aerodynamic devices located on the wing or along the rear or underside of the fuselage that can be extended to help slow the aircraft.

**Sponsons** – small attachments to the fuselage or wheels on aircraft, often a helicopter, sometimes in the shape of a stub-wing, to accommodate wheel mechanisms, flotation gear etc

**Stabilisers** – Airfoil on an aircraft used to provide stability. This is the aft horizontal surface to which the elevators are hinged (horizontal stabiliser) and the fixed vertical surface to which the rudder is hinged (vertical stabiliser).

**Standard Operating Procedure (SOP)** – Standard methods or rules in which an organisation or Fire and Rescue Service operates to carry out a routine function. Usually these procedures are written in policies and procedures and all firefighters should be well versed in their content.

**Stringers** – metal struts running horizontally along the length of the fuselage, spaced around the circumference of the mainframes. There are also internally-placed stringers called longerons.

**Strut** – Aircraft structural components designed to absorb or distribute abrupt compression or tension such as the landing gear forces.

**Struts** – The Light Aircraft Association network of flying clubs across the UK.

## T

**Tactical plan** – The operational plan formulated by the incident commander taking into account the objectives to be achieved balanced against identified operational hazards.

**Tail fin** – The fixed vertical surface towards the rear of the aircraft used to provide yaw (directional) stability.

**Tail rotor** – Gives the helicopter control in yaw by counteracting the torque force created by the main rotor.

**Tailplane** – Horizontal aerofoil of an aeroplane's tail assembly or empennage. Provides longitudinal stability in flight. (Known as the stabilizer in US aviation parlance).

**Thermal imaging camera (TIC)** – Type of thermographic camera that renders infrared radiation as visible light, it allows firefighters to see and in some cases record temperatures of material.

**Trailing edge** – The rear edge of the mainplane (housing the flaps and ailerons) or tailplane (elevators).

**Turbofan** – Turbofan engines are the most commonly found jet engines on aircraft today, especially large commercial aircraft. They contain a large fan at the front of the engine, which the turbojet does not have.

**Turbojet** – Turbojet engines consist of an air inlet, an air compressor, a combustion chamber, a gas turbine (that drives the air compressor) and a nozzle.

**Turboprop** – The turboprop engine is widely used in small and medium sized commuter, GA and cargo aircraft. Instead of the fan previously discussed, the turboprop consists of a propeller that is driven by a small turbojet engine.

**Turboshaft** – Turboshaft engines are most commonly found in helicopters. The principle is essentially the same as the turboprop however the output shaft is not connected to a propeller but instead to the power turbines.

## U

**Undercarriage** – The undercarriage or landing gear is the structure (usually wheels, but sometimes skids, floats or other elements) that supports an aircraft on the ground and allows it to taxi, takeoff and land.

**Urban Search and Rescue (USAR)** – Specialist Fire and Rescue Service teams that are equipped to deal with incidents involving the location, extrication, and initial medical stabilisation of casualties trapped in confined spaces.

## W

**Wide bodied aircraft** – The centre section of the aircraft has dual aisles.

## Other

**7(2) (d) familiarisation visits** – Requirement of Fire and Rescue Services Act 2004 for Fire and Rescue Services to make arrangements for obtaining information needed for the purpose of extinguishing fires in its area, and protecting life and property in the event of fires in its area.

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