Advisory Circular
AC139-15

Revision 0

Aeronautical Studies for Aerodrome Operators

23 February 2011

General

Civil Aviation Authority Advisory Circulars contain information about standards, practices, and procedures that the Director has found to be an **Acceptable Means of Compliance (AMC)** with the associated rule.

An AMC is not intended to be the only means of compliance with a rule, and consideration will be given to other methods of compliance that may be presented to the Director. When new standards, practices, or procedures are found to be acceptable they will be added to the appropriate Advisory Circular.

An Advisory Circular may also include **Guidance Material (GM)** to facilitate compliance with the rule requirements. Guidance material must not be regarded as an acceptable means of compliance.

Purpose

This Advisory Circular provides information and guidance to assist aerodrome operators and other parties to undertake an aeronautical study.

Related Rules

This Advisory Circular relates specifically to Civil Aviation Rule Part 139

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Chapter 1 Introduction

Aeronautical Safety

An aeronautical study is a tool used to review aerodrome and airspace processes and procedures to ensure that safety criteria in place are appropriate. The study can be undertaken in a variety of ways using various analytical methods appropriate to the aeronautical study requirements.

An aeronautical study should include the use of;

- current state review (baseline position)
- quantifiable data analysis
- stakeholder interviews
- safety/risk matrix

In general an aeronautical study should be viewed as providing an overarching document giving a holistic view of an aerodrome's operational environment e.g. the macro perspective as compared to a safety case study which is a task specific document e.g. the micro view. An aeronautical study may contain many elements; however risk assessment, risk mitigation and risk elimination are key components. Additionally there may be aviation system constraints.

The goal of risk management in an aeronautical study is to identify risks, and take appropriate action to minimise risk as much as is reasonably practicable. Decisions made in respect of risks must balance the technical aspects of risk with the social and moral considerations that often accompany such issues.

These decisions may have significant impact on an aerodrome's operation and for an effective outcome there should be a level of consensus as to their acceptability among the key stakeholders.

While this Advisory Circular focuses on the safety outcomes, there may also be non-safety consequences, such as financial loss and operational loss of the aircraft, increased insurance costs and damage to reputation. This Advisory Circular discusses the concept of risk and goes on to describe the trigger factors that may lead to an aeronautical study, the conduct of the study and the types of activities that should be included in the study.

However, the Advisory Circular does not, and cannot, include a formula that is guaranteed to give the correct solution, nor does it tell the individual or organisation conducting a study what it should value. The appropriate constraints and goals are left to the judgement of those carrying out the study. The aeronautical study should be seen as a framework for effective decision-making, rather than as a guaranteed process to come up with the correct outcomes.

This framework for conducting aeronautical studies proposes a systematic method, and some tools, for analysing complex risk issues so as to help the decision-maker to make decisions with confidence and, if necessary, to articulate these decisions.

Aerodrome operators should also undertake aeronautical studies when the aerodrome operating environment changes. These changes are normally precipitated by a trigger event such as a change, or a proposed change in; airspace design, aircraft operations, aerodrome infrastructure or the provision of an air traffic service.

It is the aeronautical study process that determines the site-specific need for services, and identifies and recommends a course of action, or presents options for decision makers to act upon. In all cases the aeronautical study should document and demonstrate the site-specific need and rationale for the level of service, procedure design or operational requirements.

Trigger Factors

The aeronautical study is a tool for the aerodrome management to use as part of its operations and strategic planning and is an integral part of the aerodrome's Quality Assurance and Safety Management Systems.

One of the purposes of the aeronautical study is to determine levels of operational safety, service or procedures that should apply at a particular location. The decision to undertake this type of study may be triggered by any one or more of a wide range of factors.

These may include changes to:

- the number of movements
- the peak traffic periods
- the ratio of IFR to VFR traffic
- the type of operations - scheduled, General Aviation (GA), training, etc
- the types, and variety of types, of aircraft using the aerodrome (jet, turbo-prop, rotary, etc)
- aerodrome layout
- aerodrome management structure
- runway or taxiway and associated manoeuvring areas
- operations of a neighbouring aerodrome or adjacent airspace.

Feedback about any changes should be sought from aviation stakeholders including pilots, individuals and other representative groups as part of the study.

An aeronautical study may be initiated by the Director of Civil Aviation, an aerodrome operator or another interested party, such as an air traffic service provider or air operators.

The CAA can assist in identifying whether an aeronautical study is required and the appropriate methodology for the aeronautical study and in reviewing the aeronautical study.

For further assistance please contact the CAA's Aeronautical Services Unit on 04 560 9400 or aero@caa.govt.nz.

Chapter 2 Overview

Aeronautical Study

An aeronautical study can be undertaken at anytime. It is constructed to consider all relevant factors, including traffic volume, mix and distribution, weather, aerodrome role, aerodrome and airspace configuration, surface activity and the efficiency requirements of operators using the service. The scope of studies can range from minor adjustments to aerodrome configuration, e.g. from the widening of a taxiway to a complete review of aerodrome airspace with the introduction of a new runway.

The scope of an aeronautical study usually reflects one of three situations:

1. the existing operation, e.g. the aerodrome, airspace or ATS (or sometimes just a particular part of the operation)
2. a change to the existing operation
3. a new operation.

Where the aeronautical study is used to consider a change to existing operations or a new operation, it may not initially be possible to provide all the safety assessment and evidence required.

An aeronautical study can identify and evaluate aerodrome service options, including service increases or decreases or the introduction or termination of services (such as the introduction of a rapid exit taxiway or removal of a grass runway). The initial baseline study will be followed by a review of operational issues; this will typically involve an in-depth safety analysis based on quantifiable data and extensive consultation with customers and stakeholders using various interview and data gathering processes. This may identify any changes that are required to ensure the safe, orderly and efficient operation of the aerodrome.

Larger projects may have distinct phases such as requirements definition, design evaluation, introduction to service and routine operation. The aeronautical study can be presented in parts corresponding to these phases as information becomes available; this is illustrated in the flow chart below.

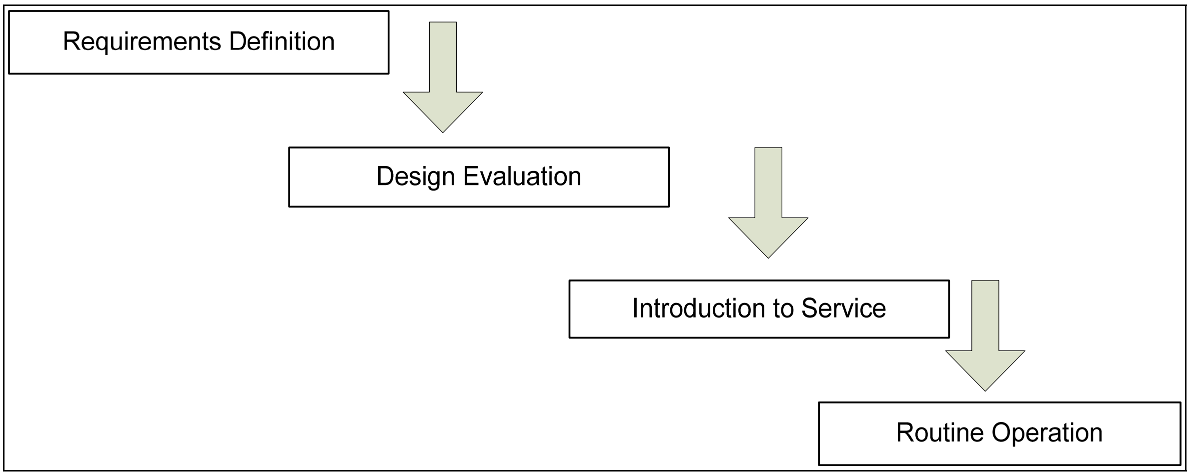


Figure 1: (UKCAA CAP 728 Chap 3)

Model developed for CAA

CAA NZ has developed a risk assessment model for aerodrome and airspace. This model is detailed in the report “Development of Standards and Practices for the Management of Aerodrome Airspace Risk” prepared by The Ambidji Group Ltd for the CAA. (The report is available on the CAA website at http://www.caa.govt.nz/aeronautical_services/Full_Ambidji_Report.pdf)

This model had a six step process for an initial study- (Report Page 26)

Step 1 Initiation

Step 2 Analysis & risk Evaluation

Step 3 Action & monitoring

Step 4 Study

Step 5 Consultation with stakeholders

Step 6 Use of Risk model

NB: Reviewing other case studies is also recommended.

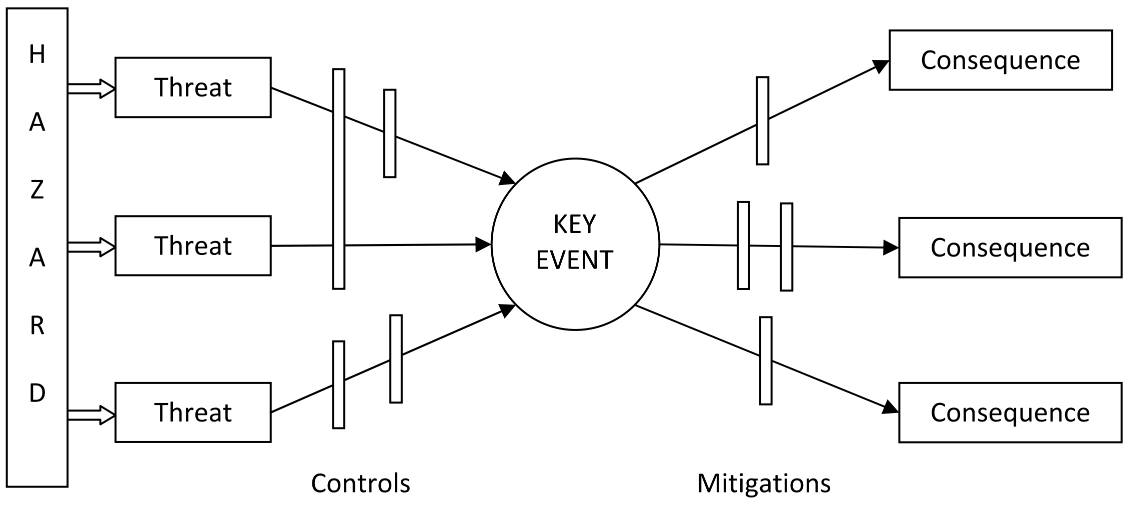
An Aeronautical Study Process is provided in Appendix 1.

This is the preferred CAA model for aeronautical studies but operators should assess the type of process or model to be used as outlined in Chapter 3 of this Advisory Circular.

The Concept of Risk

Risk assessment is a key area in an aeronautical study. The Joint Australia/New Zealand International Standard ASNZS ISO 31000:2009, Risk Management – Principles and Guidelines, defines risk as “the effect of uncertainty on objectives”; the Standard notes that “risk is often measured in terms of a combination of the consequences of an event (including changes in circumstances) and the associated likelihood of occurrence”.

A risk scenario is a sequence of events with an associated frequency of occurrence and consequence. This sequence of events may be summarised as “hazard – threats – controls – key event – mitigations – consequences”. The hazard is what ultimately generates the loss; it may present a number of threats, each of which, without controls, will lead to the “key event”. The key event is the point at which control of the hazard is lost. Once this point has been reached, mitigations may still avoid or reduce undesirable consequences. Controls are proactive defences, while mitigations may be proactive or reactive.



Generic Risk Scenario diagram

For example, a rainstorm (the hazard) may result in sheet water on runways (a threat) and reduced braking performance (another threat). The key event in this case is loss of control of the aircraft on the runway; this may result in damage or injury (the consequences). Controls might include tyre design and anti-skid braking systems, while mitigations could include runway end safety areas. The consequences are the damages and injuries that may result.

The risk is the likelihood (or probability) of the damage or injury resulting from the loss of control of the aircraft; it therefore includes the probability of loss of control and the probability of damage or injury. A study scenario example is attached in Appendix 1

Acceptable Risk

"Acceptable risk" is based on the concept that no activity is without some risk, however small. The level of risk that is acceptable varies with the type of activity and according to the consequences; in general, the acceptable level of risk for adventure activities is higher than that for normal day-today activities, and higher for single fatality accidents than for those with multiple fatalities.

Perceptions of risk can be divided into three broad categories:

- risks that are so high that they are intolerable;
- risks that are low enough to be acceptable; and
- risks between these two categories, these need to be reduced/mitigated to an acceptable level.

If the risk does not meet the pre-determined acceptability criteria, an attempt must always be made to reduce it to a level that is acceptable, using appropriate mitigation procedures. If the risk cannot be reduced to or below the acceptable level, it may be regarded as tolerable if:

- the risk is below the pre-determined intolerable level; and
- the risk has been reduced to a level that is as low as reasonably practicable (ALARP); and
- the benefits of the proposed system or changes are sufficient to justify accepting the risk.

The issue of voluntary and involuntary risk needs to be considered as a factor of acceptable risk . Tolerance of risk depends on the extent to which a person (who is the subject of the consequences of that risk) perceives they have control of the decision to accept the risk or not. Typically people are willing to take voluntary risks with probabilities of occurrence a thousand times greater than those of involuntary or imposed risks e.g. a person will accept higher levels of risk in choosing to drive a car, than they will tolerate as a bus passenger. Most of our aviation risk relates to involuntary or imposed risk for those affected by the consequences eg a passenger of an aircraft.

Risk Management Process.

Risk mitigation measures may work through reducing the probability of occurrence, or the severity of the consequences, or both. Achieving the desired level of risk reduction may require the implementation of more than one mitigation measure.

The process becomes one of iteration following the steps below,

1. Systematically identify possible hazards.
2. Evaluate the seriousness of the consequences of the key event occurring.
3. Consider the chances of it happening.
4. Determine whether the consequent risk is tolerable and within the organisation's acceptable safety performance criteria. If not, take action to reduce the risk to a tolerable level by reducing the severity of the consequences or the probability of them arising.

Risk mitigation strategies can include:

- revision of the system design;
- modification of operational procedures;
- changes to staffing arrangements;
- training of personnel to deal with the hazard;
- development of emergency and/or contingency arrangements and plans;
- ultimately, ceasing operation.

Summary of the Seven Step system risk process

Risk assessment and mitigation requires a systematic approach. The complete process can be divided into seven steps and may be iterative. These are illustrated in the flow chart below:

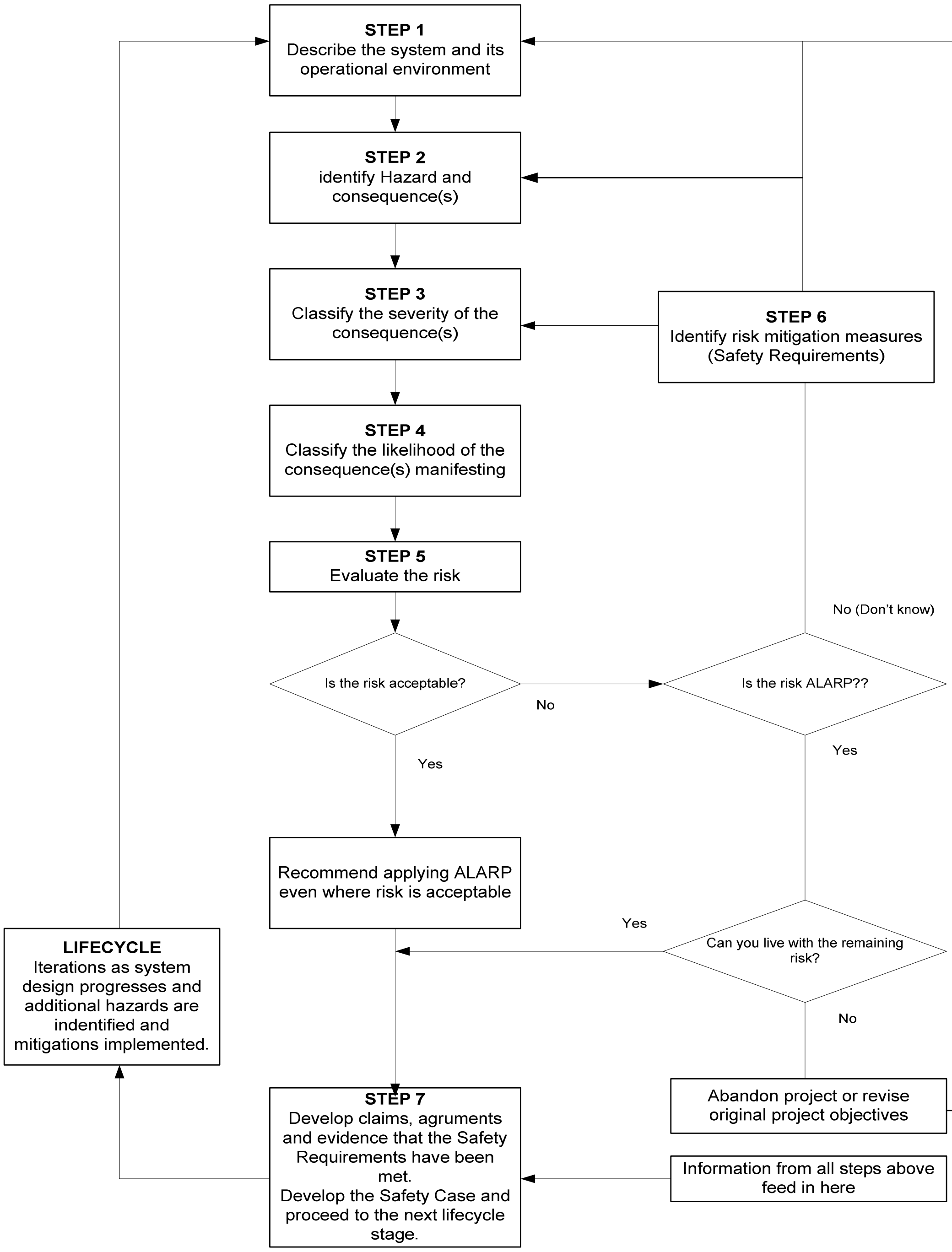


Figure 3: The Seven Step Approach (CAP 760 Chap 2)

Note: Having decided that a mitigation measure may be suitable it will be necessary to repeat steps 3, 4 and 5 in order to evaluate the acceptability of the risk with that proposed mitigation measure in place

An example of an Aeronautical Study methodology

By way of explanation a generic model of an Aeronautical Study methodology consists of initiation, preliminary analysis, risk estimation, risk evaluation, risk control and action/monitoring and is related to the flow diagram above.

1. Initiation: **Step 1**

This step consists of defining the opportunity or problem and the associated risk issues; setting up the risk management team; and beginning to identify potential users who may be affected by any change.

2. Preliminary Analysis: Step 2.

The second step consists of defining the basic dimensions of the risk problem and undertaking an initial identification, analysis and evaluation of potential risks. This preliminary evaluation will help determine:

- whether a situation exists that requires immediate action;
- whether the matter requires further study prior to any action being taken; or,
- whether the analysis should be ended as the risk problem is determined not to be an issue.

3. Risk Estimation: Steps 3 & 4.

These steps estimate the degree of risk. Step 3 estimates the severity of the consequences and step 4 estimates the probability of their occurrence.

4. Risk Evaluation: Step 5

The benefits and operational costs of the activity are integrated into the analysis and the risk is evaluated in terms of the safety implications of the activity and of the needs, issues, and concerns of affected users.

5. Risk Control: Step 6

This step identifies feasible risk controls and mitigations which will act to reduce either the probability of the event or the consequence of the event should it occur.

6. Action/Monitoring:

7. Step 7.

This step entails implementing the chosen risk control options, evaluating the effectiveness of the risk management decision process, and implementing an ongoing monitoring program.

Chapter 3 Process

The study content

There will be a number of hazards in any aerodrome environment; these must be identified so that the risks that each bears can be determined. It can be very useful to start the process by identifying a number of key events and then deciding what hazards and threats can lead to those events and their possible consequences.

The class of airspace or type of air traffic service required is primarily determined by the level of risk at the aerodrome and in its immediate airspace.

The next stage is to assess the risk levels. The relative risk levels can then be used to identify the threats that have the highest risk, after which it will be possible to determine what, if any, controls can be put in place to reduce the risks.

While this type of study is aimed at determining the appropriate airspace environment at and around an aerodrome, these tools may highlight other risk areas.

There are several tools that can be used in this type of risk assessment; two of them, the Collision Risk Model and the Aerodrome Complexity Model, are discussed later but there are several others and the following documents are hosted on the CAA website under Aerodromes - http://www.caa.govt.nz/aerodromes/aerodromes.htm.

CAP 760 - Guidance on the Conduct of Hazard Identification, Risk Assessment and the Production of Safety Cases for Aerodrome Operator and Air Traffic Service providers.

CAP 728 - The Management of Safety, Guidance to Aerodromes and Air Traffic Service Units on the Development of Safety Management Systems.

Nav Canada - Aeronautical Study Standards and Guidelines.

A useful understanding of safety cases and in the wider context also of aeronautical studies is given below.

"A safety case regime provides a comprehensive framework within which the duty holder's arrangements and procedures for the management of safety can be demonstrated and exercised in a consistent manner. In broad terms the safety case is a document – meant to be kept up to date – in which the operator sets out its approach to safety and the safety management system which it undertakes to apply. It is, on the one hand, a tool for internal use in the management of safety and, on the other hand, a point of reference in the scrutiny by an external body of the adequacy of that management system – a scrutiny which is considered to be necessary for maintaining confidence on the part of the public." Lord Cullen (2001).

Collision Risk Model

A widely-used tool for this type of study is the collision risk model (CRM). This tool is normally used by airspace designers, air navigation service providers or specialist consultants.

The basic output of the CRM is the relative risk of collision between two aircraft (or an aircraft and a parachute) whose intended tracks would bring them into a collision zone. Such pairs are referred to as "conflict pairs". The relative risk is affected by the environment (type of airspace, service, aircraft) but not by the number of movements. Multiplying the relative risk of collision by the annual number of conflict pairs gives an annual collision risk, which can then be compared to some measure of acceptable risk.

The CRM estimates the risk of collision from failure to take considered action (failure of the control) and failure to take evasive action (failure of the mitigation). As its name suggests, the pilot has some time to initiate a considered action, which is generally the result of information received by radio. A problem close to the collision zone is generally detected visually and requires evasive action. An action initiated within a few seconds of the collision zone is typically too late to alter the flight path sufficiently, so whether a collision takes place or not is a matter of chance.

The model considers the various factors that can lead to the need for considered action and to evasive action, and arranges them in a tree leading to the collision zone. The linking of the branches of the tree is by arithmetical 'AND' and 'OR' operators. Thus to reach the collision zone, both considered action and evasive action must fail. If one aircraft has no radio or is on the wrong frequency, then radio communication fails.

A numerical risk is assigned to each contributory factor, and thus the risk of reaching the collision zone can be calculated. Whether the aircraft will actually collide in the collision zone depends on the collision geometry and a collision geometry factor is applied to allow for this.

For a collision to take place, the two aircraft must initially be on a collision course, at least to the extent that, uncorrected, they will occupy the collision zone at the same time. These pairs are termed "conflict pairs". The total number of pairs that may become conflict pairs can be calculated from traffic data.

Aerodrome Complexity Model

Another tool to estimate risk is an aerodrome complexity model. This type of model assumes that the complexity of operating at, and in the environment of, an aerodrome bears a relationship to pilot workload and hence to the risk of accident. The model therefore identifies a number of complexity factors and scores these according to the relative influence that they are deemed to have. The number of movements and the VFR/IFR mix are then taken into account and an overall complexity score calculated.

Typical complexity factors include the number and disposition of runways and taxiways, the types of operation, the topography and extreme weather conditions that may be expected.

This type of tool allows an aerodrome operator, for example, not only to determine a score that may be compared against some criterion, but also interactively to identify those areas of aerodrome planning where complexity may be reduced.

Consultation

It is essential that, in conducting the aeronautical study, there is consultation with as wide a range of aerodrome users and other stakeholders as possible. Different users have different views of hazards and the corresponding threats, controls, mitigations and consequences. The following should be included in the consultation:

- Aerodrome operators (including adjacent affected aerodrome operators).
- Aerodrome users.
- Airspace user groups.
- Aircraft operators and operator groups.
- Pilot organisations.
- Air traffic service providers.

Experience has shown that consultation undertaken in open meetings, where ideas can be exchanged and debated, generally results in consensus being achieved. Individual consultation, on the other hand, tends to result in dissatisfaction for those whose proposals or viewpoints are not eventually accommodated.

References

CAP 760 - Guidance on the Conduct of hazard identification, Risk Assessment and the Production of Safety Cases for Aerodrome Operator and Air Traffic Service providers: UKCAA (2006)

CAP 728 - The Management of Safety, Guidance to Aerodromes and Air Traffic Service Units on the Development of Safety Management Systems: UKCAA (2003)

Aeronautical Study Standards and Guidelines: Nav Canada (1997)

Aerodrome Airspace Collision Risk Model: CAANZ (2007)

AC71-1(0) Guidelines for airspace risk management and associated Aeronautical study methodology: CASA (2002)

AC 172-02 (0) Guidelines for preparing safety cases covering CASR Part 172: CASA (2005)

Guidelines for preparing safety cases covering airways system: CASA AsA MOU (1998)

Appendix 1

Sample Aeronautical Study Considerations

A basic aerodrome aeronautical study would consider matters like but not limited to the elements below;

Scenario:

An operator of a commercial flight training flying organisation is considering a start-up or expanded operation on an aerodrome.

The aerodrome operator considers as part of its review of the impact on this possible new operation that it should conducted an aerodrome airspace review.

Aeronautical Study elements may include the following elements:

- Modelling a number of levels of aircraft operations covering a range of options for the fleet size from the initial start up fleet size to the expected "final/optimum" size of the fleet.
- Modelling a number of local aerodrome operational factors, including:
  - Runway/taxiway design; note the taxiway design has a major influence of the runway and hence airspace capacity.
  - Location of the flight line apron in relation to the runways and taxiways and other facilities e.g. fuel, maintenance, etc;
  - Location of navigational aids in the adjacent and regional airspace required for IFR training e.g. VOR, ILS, NDB;
  - Location of controlled airspace both locally and in the region;
  - Location of suitable areas of airspace for general handling (VFR) training;
  - Location of other aerodromes in the region suitable for cross country operations;
  - Local and regional meteorological conditions and seasonal patterns;
  - Location of suitable aircraft maintenance support services;
  - The current level (baseline) of aerodrome operations, e.g. airline and local operations;
  - Aerodrome air traffic density, e.g. circuit training, etc. Various modelling tools are available;
  - Aerodrome air traffic complexity, e.g. Crosswind runway, IFR approaches, etc;
- The Bow Tie methodology to determine the risk scenario. (See Chapter 3, Risk).