

AIRPORT STANDARDS DIRECTIVE 505

[ASD 505]

AERONAUTICAL STUDY



**AIRPORT STANDARDS DIVISION
DEPARTMENT OF CIVIL AVIATION
MALAYSIA**

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INTRODUCTION

1. In exercise of the powers conferred by regulation 66 of the Civil Aviation (Aerodrome Operations) Regulations 2016, the Director General makes this Airport Standards Directive.
2. This Airport Standards Directive is published by the Director General under section 24O of Civil Aviation Act 1969 [Act 3] – Amendment 2006.
3. Airport Standards Directive 103 states that aerodromes with facilities or services which do not fully meet or deviates from ICAO Annex 14 SARPS and Airport Standards Directives may still apply for aerodrome certificate. However, the Director General of Civil Aviation, if and where permitted, may be allow certification, after an aeronautical study has been conducted and an appropriate level of safety is assured, subject to certain conditions and procedures to be complied with by the aerodrome operator.

OBJECTIVE

4. An aeronautical study is conducted to assess the impact of deviations from the aerodrome standards specified in Volume I to Annex 14 to the Convention on International Civil Aviation, and the national regulations, to present alternative means of ensuring the safety of aircraft operations, to estimate the effectiveness of each alternative and to recommend procedures to compensate for the deviation.

APPLICABILITY

5. An aeronautical study may be carried out when aerodrome standards cannot be met as a result of development. Such a study is most frequently undertaken during the planning of a new airport or during the certification of an existing aerodrome.

Note.— Aeronautical studies may not be conducted in cases of deviations from the standards, if not specifically recommended in Annex 14, Volume I.

DEFINITION

6. An aeronautical study is a study of an aeronautical problem to identify possible solutions and select a solution that is acceptable without degrading safety.

TECHNICAL ANALYSIS

7. Technical analysis will provide justification for a deviation on the grounds that an equivalent level of safety can be attained by other means. It is generally applicable in situations where the cost of correcting a problem that violates a standard is excessive but where the unsafe effects of the problem can be overcome by some procedural means which offers both practical and reasonable solutions.
8. In conducting a technical analysis, inspectors will draw upon their practical experience and specialized knowledge. They may also consult other specialists in relevant areas. When considering alternative procedures in the deviation approval process, it is essential to bear in mind the safety objective of the aerodrome certification regulations and the applicable standards so that the intent of the regulations is not circumvented.

APPROVAL OF DEVIATIONS

9. In some instances, the only reasonable means of providing an equivalent level of safety is to adopt suitable procedures and to require, as a condition of certification, that cautionary advice be published in the appropriate AIS publications.
10. The determination to require caution will be primarily dependent on two considerations:
 - a) a pilot's need to be made aware of potentially hazardous conditions; and
 - b) the responsibility of the DCA to publish deviations from standards that would otherwise be assumed under certificate status.

AERONAUTICAL SAFETY

11. 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.

12. An aeronautical study should include the use of;
 - current state review (baseline position)
 - quantifiable data analysis
 - stakeholder interviews
 - safety/risk matrix
13. 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.
14. 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.
15. 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.
16. 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.
17. While this Airport Standards Directive 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 Airport Standards Directive 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.
18. However, the Airport Standards Directive 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.
19. 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.

20. 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.
21. 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

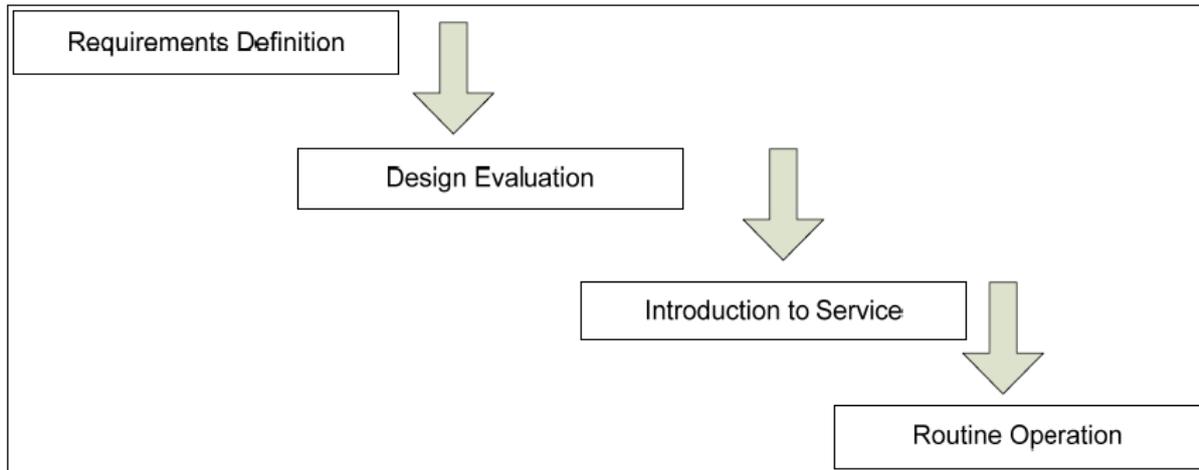
22. The aeronautical study is a tool for the aerodrome management to use as part of its operations and strategic planning and is an integral part of the aerodrome's Safety Management Systems.
23. One of the purposes of the aeronautical study is to determine levels of operational safety, service or procedures 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.
24. 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.
25. Feedback about any changes should be sought from aviation stakeholders including pilots, individuals and other representative groups as part of the study.
26. An aeronautical study may be initiated by the Director General Civil Aviation, an aerodrome operator or another interested party, such as an air traffic service provider or air operators.

27. The DCA 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 DCA Airport Standards Division on +60 8871 4000 or mahyuddin@dca.gov.my.

AERONAUTICAL STUDY

28. 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.
29. The scope of an aeronautical study usually reflects one of three situations:
 - a) the existing operation, e.g. the aerodrome, airspace or ATS (or sometimes just a particular part of the operation)
 - b) a change to the existing operation
 - c) a new operation.
30. 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.
31. 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).
32. 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.
33. 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.



INITIAL STUDY

34. The initial study of aeronautical study may have a six step process as follows :

- 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

35. An Aeronautical Study Process is provided in Appendix 1.

36. This is the preferred DCA model for aeronautical studies but operators should assess the type of process or model to be used as outlined in this directive.

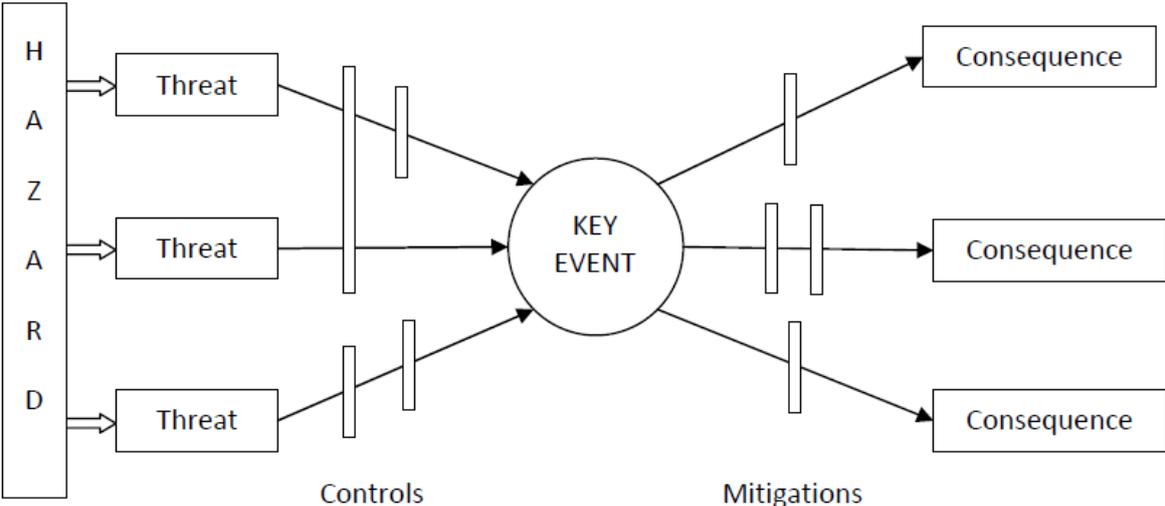
THE CONCEPT OF RISK

37. Risk Management is a key area in an aeronautical study. ICAO Doc 9859 : Safety Management Manual defines risk as following :

Risk mitigation. The process of incorporating defences or preventive controls to lower the severity and/or likelihood of a hazard's projected consequence.

Safety risk. The predicted probability and severity of the consequences or outcomes of a hazard.

38. Risk is 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

39. 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.
40. 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

41. "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-to-day activities, and higher for single fatality accidents than for those with multiple fatalities.
42. 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.
43. 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.
44. 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.

SAFETY RISK

45. Safety risk management is also a key component of safety management system and aeronautical study. The term safety risk management is meant to differentiate this function from the management of financial risk, legal risk, economic risk and so forth. This

section presents the fundamentals of safety risk and includes the following topics:

- a) a definition of safety risk;
- b) safety risk probability;
- c) safety risk severity;
- d) safety risk tolerability; and
- e) safety risk management.

DEFINITION OF SAFETY RISK

- 46. Safety risk is the projected likelihood and severity of the consequence or outcome from an existing hazard or situation. While the outcome may be an accident, an “intermediate unsafe event/consequence” may be identified as “the most credible outcome”. Provision for identification of such layered consequences is usually associated with more sophisticated risk mitigation software. The safety risk mitigation worksheet illustrated in Appendix 2 also has this provision.

RISK MANAGEMENT PROCESS

- 47. 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.
- 48. The process becomes one of iteration following the steps below :
 - a) Systematically identify possible hazards.
 - b) Evaluate the seriousness of the consequences of the key event occurring.
 - c) Consider the chances of it happening.
 - d) 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.

SAFETY RISK PROBABILITY

49. The process of controlling safety risks starts by assessing the probability that the consequences of hazards will materialize during aviation activities performed by the organization. Safety risk probability is defined as the likelihood or frequency that a safety consequence or outcome might occur. The determination of likelihood can be aided by questions such as:
- a) Is there a history of occurrences similar to the one under consideration, or is this an isolated occurrence?
 - b) What other equipment or components of the same type might have similar defects?
 - c) How many personnel are following, or are subject to, the procedures in question?
 - d) What percentage of the time is the suspect equipment or the questionable procedure in use?
 - e) To what extent are there organizational, managerial or regulatory implications that might reflect larger threats to public safety?
50. Any factors underlying these questions will help in assessing the likelihood that a hazard may exist, taking into consideration all potentially valid scenarios. The determination of likelihood can then be used to assist in determining safety risk probability.
51. Figure 2-11 presents a typical safety risk probability table, in this case, a five-point table. The table includes five categories to denote the probability related to an unsafe event or condition, the description of each category, and an assignment of a value to each category.

<i>Likelihood</i>	<i>Meaning</i>	<i>Value</i>
Frequent	Likely to occur many times (has occurred frequently)	5
Occasional	Likely to occur sometimes (has occurred infrequently)	4
Remote	Unlikely to occur, but possible (has occurred rarely)	3
Improbable	Very unlikely to occur (not known to have occurred)	2
Extremely improbable	Almost inconceivable that the event will occur	1

Figure 2-11. Safety risk probability table

52. It must be stressed that this is an example only and that the level of detail and complexity of tables and matrices should be adapted to be commensurate with the particular needs and complexities of different organizations. Also, it should be noted that organizations may include both qualitative and quantitative criteria that may include up to fifteen values.

SAFETY RISK SEVERITY

53. Once the probability assessment has been completed, the next step is to assess the safety risk severity, taking into account the potential consequences related to the hazard. Safety risk severity is defined as the extent of harm that might reasonably occur as a consequence or outcome of the identified hazard. The severity assessment can be based upon:
- a) *Fatalities/injury*. How many lives may be lost (employees, passengers, bystanders and the general public)?
 - b) *Damage*. What is the likely extent of aircraft, property or equipment damage?
54. The severity assessment should consider all possible consequences related to an unsafe condition or object, taking into account the worst foreseeable situation. Figure 2-12 presents a typical safety risk severity table. It includes five categories to denote the level of severity, the description of each category, and the assignment of a value to each category. As with the safety risk probability table, this table is an example only.

SAFETY RISK TOLERABILITY

55. The safety risk probability and severity assessment process can be used to derive a safety risk index. The index created through the methodology described above consists of an alphanumeric designator, indicating the combined results of the probability and severity assessments. The respective severity/probability combinations are presented in the safety risk assessment matrix in Figure 2-13.
56. The third step in the process is to determine safety risk tolerability. First, it is necessary to obtain the indices in the safety risk assessment matrix. For example, consider a situation where a safety risk probability has been assessed as occasional (4), and safety risk severity has been assessed as hazardous (B). The composite of probability and severity (4B) is the safety risk index of the consequence.

<i>Severity</i>	<i>Meaning</i>	<i>Value</i>
Catastrophic	<ul style="list-style-type: none"> — Equipment destroyed — Multiple deaths 	A
Hazardous	<ul style="list-style-type: none"> — A large reduction in safety margins, physical distress or a workload such that the operators cannot be relied upon to perform their tasks accurately or completely — Serious injury — Major equipment damage 	B
Major	<ul style="list-style-type: none"> — A significant reduction in safety margins, a reduction in the ability of the operators to cope with adverse operating conditions as a result of an increase in workload or as a result of conditions impairing their efficiency — Serious incident — Injury to persons 	C
Minor	<ul style="list-style-type: none"> — Nuisance — Operating limitations — Use of emergency procedures — Minor incident 	D
Negligible	<ul style="list-style-type: none"> — Few consequences 	E

Figure 2-12. Safety risk severity table

57. The index obtained from the safety risk assessment matrix must then be exported to a safety risk tolerability matrix (see Figure 2-14) that describes the tolerability criteria for the particular organization. Using the example above, the criterion for safety risk assessed as 4B falls in the “unacceptable under the existing circumstances” category. In this case, the safety risk index of the consequence is unacceptable. The organization must therefore:
- a) take measures to reduce the organization’s exposure to the particular risk, i.e. reduce the likelihood component of the risk index;
 - b) take measures to reduce the severity of consequences related to the hazard, i.e. reduce the severity component of the risk index; or
 - c) cancel the operation if mitigation is not possible.

Note.— The inverted pyramid in Figure 2-14 reflects a constant effort to drive the risk index towards the bottom APEX of the pyramid. Figure 2-15 provides an example of an alternate safety risk tolerability matrix.

Risk probability	Risk severity				
	Catastrophic A	Hazardous B	Major C	Minor D	Negligible E
Frequent 5	5A	5B	5C	5D	5E
Occasional 4	4A	4B	4C	4D	4E
Remote 3	3A	3B	3C	3D	3E
Improbable 2	2A	2B	2C	2D	2E
Extremely improbable 1	1A	1B	1C	1D	1E

Figure 2-13. Safety risk assessment matrix

Tolerability description	Assessed risk index	Suggested criteria
Intolerable region	5A, 5B, 5C, 4A, 4B, 3A	Unacceptable under the existing circumstances
Tolerable region	5D, 5E, 4C, 4D, 4E, 3B, 3C, 3D, 2A, 2B, 2C, 1A	Acceptable based on risk mitigation. It may require management decision.
Acceptable region	3E, 2D, 2E, 1B, 1C, 1D, 1E	Acceptable

Figure 2-14. Safety risk tolerability matrix

Risk index range	Description	Recommended action
5A, 5B, 5C, 4A, 4B, 3A	High risk	Cease or cut back operation promptly if necessary. Perform priority risk mitigation to ensure that additional or enhanced preventive controls are put in place to bring down the risk index to the moderate or low range.
5D, 5E, 4C, 4D, 4E, 3B, 3C, 3D, 2A, 2B, 2C, 1A	Moderate risk	Schedule performance of a safety assessment to bring down the risk index to the low range if viable.
3E, 2D, 2E, 1B, 1C, 1D, 1E	Low risk	Acceptable as is. No further risk mitigation required.

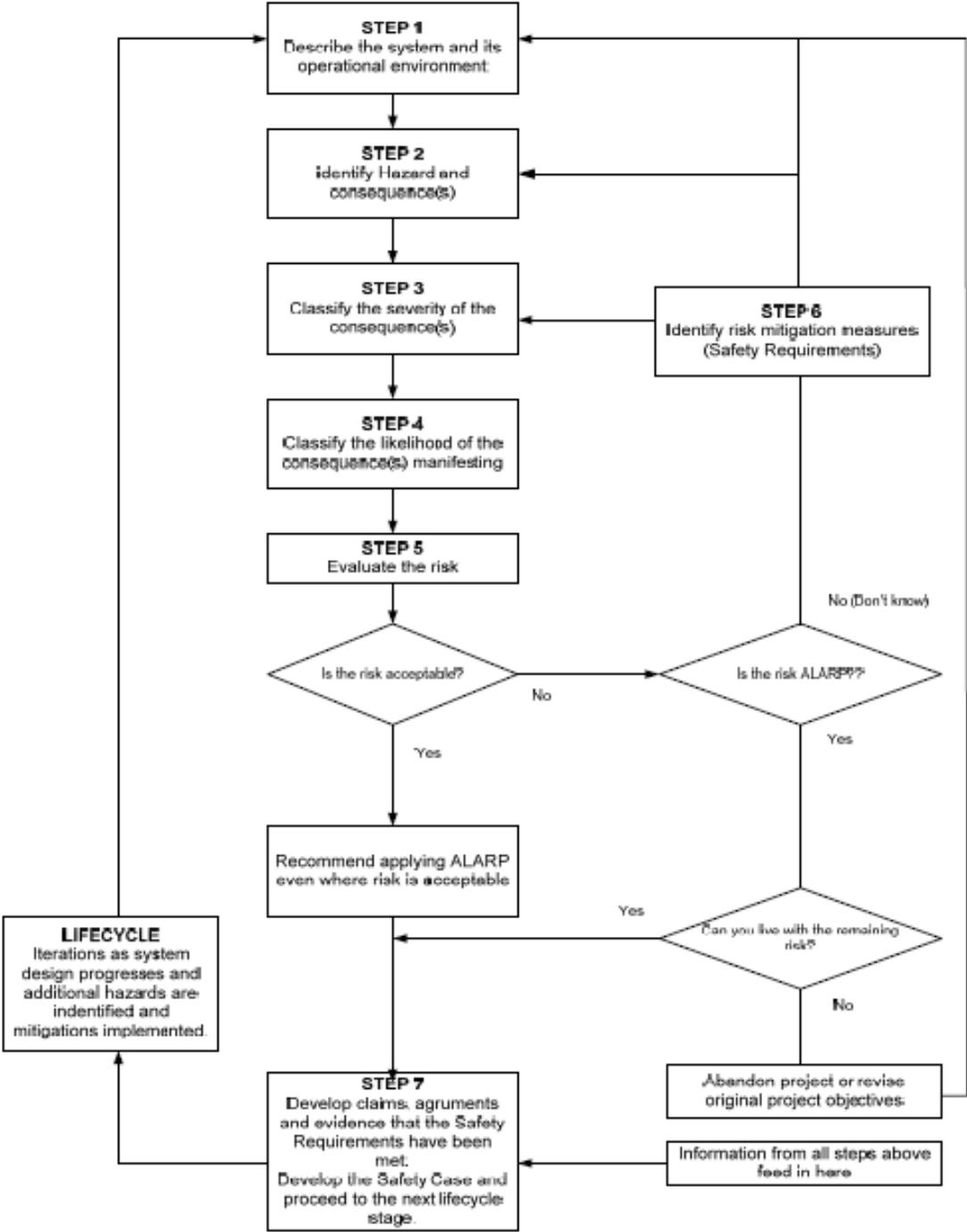
Figure 2-15 An alternate safety risk tolerability matrix

58. 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.

SEVEN STEP SYSTEM RISK PROCESS

59. 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:



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.

EXAMPLE OF AN AERONAUTICAL STUDY METHODOLOGY

60. 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.

PROCESS

THE STUDY CONTENT

61. 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.
62. 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.
63. 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.
64. A useful understanding of safety cases and in the wider context also of aeronautical studies is given below.
65. "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

66. 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.
67. 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.
68. 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.
69. 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.
70. 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.
71. 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

72. 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.
73. 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

74. 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.
75. 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.

76. The Appendices to this Directive shall be taken, construed, read and be part of this Directive.

DATO' SRI AZHARUDDIN ABDUL RAHMAN
Director General
Department of Civil Aviation
Malaysia

Dated : 26 APRIL 2016

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:

- o 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.
- o 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;
- o The Bow Tie methodology to determine the risk scenario.

APPENDIX 2

Example of a Safety Risk Mitigation Worksheet

Table 2-A2-1. Hazard and consequence

Operation/process:	Describe the process/operation/equipment/system being subjected to this HIRM exercise.
Hazard (H):	If there is more than one hazard to the operation/process, use a separate worksheet to address each hazard.
Unsafe event (UE):	If there is more than one UE to the hazard, use a separate worksheet to address each UE-UC combination.
Ultimate consequence (UC):	If there is more than one UC to the hazard, use a separate worksheet to address each UC.

Table 2-A2-2. Risk index and tolerability of consequence/UE (see Attachment 1)

	Current risk tolerability (taking into consideration any existing PC/RM/EC)			Resultant risk index and tolerability (taking into consideration any new PC/RM/EC)		
	Severity	Likelihood	Tolerability	Severity	Likelihood	Tolerability
Unsafe event						
Ultimate consequence						

Table 2-A2-3. Risk mitigation

Hazard (H)	PC	EF	EC		RM	EF	EC	
H	PC1 (Existing)	EF (Existing)	EC1 (Existing)	UE	RM1	EF (to RM1)	EC (to EF)	UC
			EC2 (New)					
	PC2 (Existing)	EF1 (New)	EC (New)		RM2	EF (to RM2)	EC (to EF)	
			EC (New)					
	PC3 (New)	EF (New)	EC (New)		RM3	EF (to RM3)	EC (to EF)	
			EC (New)					

Explanatory notes.—

1. *Operation/process (Table 2-A2-1)*. Description of the operation or process which is being subjected to this hazard/risk mitigation exercise.

2. *Hazard (H)*. An undesirable condition or situation which may lead to unsafe event(s) or occurrence(s). Sometimes the term “threat” (e.g. TEM) is used instead of “hazard”.

3. *Unsafe event (UE)*. A possible intermediate unsafe event before any ultimate consequence, accident or most credible outcome. Identification of an unsafe event is applicable only where there is a need to distinguish and

establish mitigating actions upstream and downstream of such an intermediate event (before the ultimate consequence/accident)

(e.g. “over temperature event” before an “engine failure”). If this intermediate UE state is not applicable for a particular operation, then it may be excluded as appropriate.

4. *Ultimate consequence (UC)*. The most credible outcome, ultimate event or accident.

5. *Preventive control (PC)*. A mitigating action/mechanism/defence to block or prevent a hazard/threat from escalating into an unsafe event or ultimate consequence.

6. *Escalation factor (EF)*. A possible latent condition/factor which may weaken the effectiveness of a preventive control (or recovery measure). Use where applicable only. It is possible that an escalation factor may sometimes be referred to as a “threat”.

7. *Escalation control (EC)*. A mitigating action/mechanism to block or prevent an escalation factor from compromising or weakening a preventive control (or recovery measure). Use where applicable only.

8. *Current risk index and tolerability*. Risk mitigating action (Table 2-A2-3) is applicable whenever an unacceptable current tolerability level of an unsafe event or ultimate consequence is identified in Table 2-A2-2. Current risk index and tolerability shall take into consideration existing preventive controls, where available.

9. *Resultant risk index and tolerability*. Resultant risk index and tolerability are based on the combined current preventive controls (if any) together with the new preventive controls/escalation controls/recovery measures put in place as a result of the completed risk mitigation exercise.

Attachment to APPENDIX 2. Example Severity, Likelihood, Risk Index and Tolerability Tables

Table Att-1. Severity table (basic)

<i>Level</i>	<i>Descriptor</i>	<i>Severity description (customize according to the nature of the product or the service provider's operations)</i>
1	Insignificant	No significance to aircraft-related operational safety
2	Minor	Degrades or affects normal aircraft operational procedures or performance
3	Moderate	Partial loss of significant/major aircraft systems or results in abnormal application of flight operations procedures
4	Major	Complete failure of significant/major aircraft systems or results in emergency application of flight operations procedures
5	Catastrophic	Loss of aircraft or lives

Table Att-2. Severity table (alternate)

<i>Level</i>	<i>Descriptor</i>	<i>Severity description (customize according to the nature of the product or service provider's operations)</i>					
		<i>Safety of aircraft</i>	<i>Physical injury</i>	<i>Damage to assets</i>	<i>Potential revenue loss</i>	<i>Damage to environment</i>	<i>Damage to corporate reputation</i>
1	Insignificant	No significance to aircraft-related operational safety	No injury	No damage	No revenue loss	No effect	No implication
2	Minor	Degrades or affects normal aircraft operational procedures or performance	Minor injury	Minor damage Less than \$__	Minor loss Less than \$__	Minor effect	Limited localized implication
3	Moderate	Partial loss of significant/major aircraft systems or results in abnormal flight operations procedure application	Serious injury	Substantial damage Less than \$__	Substantial loss Less than \$__	Contained effect	Regional Implication
4	Major	Complete failure of significant/major aircraft systems or results in emergency application of flight operations procedures	Single fatality	Major damage Less than \$__	Major loss Less than \$__	Major effect	National Implication
5	Catastrophic	Aircraft/hull loss	Multiple fatality	Catastrophic damage More than \$__	Massive loss More than \$__	Massive effect	International implication

Note.— Use the highest severity level obtained to derive the risk index in the risk index matrix table.

Table Att-3. Likelihood table

<i>Level</i>	<i>Descriptor</i>	<i>Likelihood description</i>
A	Certain/frequent	Is expected to occur in most circumstances
B	Likely/occasional	Will probably occur at some time
C	Possible/remote	Might occur at some time
D	Unlikely/improbable	Could occur at some time
E	Exceptional	May occur only in exceptional circumstances

Table Att-4. Risk index matrix (severity × likelihood)

<i>Likelihood</i>	<i>Severity</i>				
	<i>1. Insignificant</i>	<i>2. Minor</i>	<i>3. Moderate</i>	<i>4. Major</i>	<i>5. Catastrophic</i>
A. Certain/frequent	Moderate (1A)	Moderate (2A)	High (3A)	Extreme (4A)	Extreme (5A)
B. Likely/occasional	Low (1B)	Moderate (2B)	Moderate (3B)	High (4B)	Extreme (5B)
C. Possible/remote	Low (1C)	Low (2C)	Moderate (3C)	Moderate (4C)	High (5C)
D. Unlikely/improbable	Negligible (1D)	Low (2D)	Low (3D)	Moderate (4D)	Moderate (5D)
E. Exceptional	Negligible (1E)	Negligible (2E)	Low (3E)	Low (4E)	Moderate (5E)

Table Att-5. Risk acceptability (tolerability) table

<i>Risk Index</i>	<i>Tolerability</i>	<i>Action required (customize as appropriate)</i>
5A, 5B, 4A	Extreme risk	Stop operation or process immediately. Unacceptable under the existing circumstances. Do not permit any operation until sufficient control measures have been implemented to reduce the risk to an acceptable level. Top management approval required.
5C, 4B, 3A	High risk	Caution. Ensure that risk assessment has been satisfactorily completed and declared preventive controls are in place. Senior management approval of risk assessment before commencement of the operation or process.
1A, 2A, 2B, 3B, 3C, 4C, 4D, 5D, 5E	Moderate risk	Perform or review risk mitigation as necessary. Departmental approval of risk assessment.
1B, 1C, 2C, 2D, 3D, 3E, 4E	Low risk	Risk mitigation or review is optional.
1D, 1E, 2E	Negligible risk	Acceptable as is. No risk mitigation required.