Advisory Circular

NCAA-AC-ARD003

NIGERIAN CIVIL AVIATION AUTHORITY (NCAA)

ISSUE NO 2 **28TH SEPTEMBER, 2018**

AERONAUTICAL STUDIES

1.0 GENERAL

Nigerian Civil Aviation Authority Advisory Circulars from Aerodrome Standards Department contain information about standards, practices and procedures that the Authority has found to be an Acceptable Means of Compliance (AMC) with the associated Regulations.

An AMC is not intended to be the only means of compliance with a regulation, and consideration will be given to other methods of compliance that may be presented to the Authority.

2.0 PURPOSE

This Advisory Circular provides methods, acceptable to the Authority, for showing compliance with the Aeronautical Studies requirements of Nig.CARs Part 12 as well as explanatory and interpretative material to assist in showing compliance.

3.0 APPLICATION

The material contained in this Advisory Circular applies to the operation of aerodromes regulated under Nig.CARs Part 12 where exemption requests have been made by the operator.

4.0 REFERENCE

The Advisory Circular relates specifically to Nig.CARs Part 12.6.22 and ASM 2.1.4

5.0 STATUS OF THE AC

This is the second issue and first amendment of the AC and it supersedes the previous edition on this subject.

APPROVAL PAGE

AERONAUTICAL STUDIES

ADVISORY CIRCULAR-NCAA-AC-ARD003

NIGERIAN CIVIL AVIATION AUTHORITY

This document is approved by:

Capt. Muhtar Usman
Director General

Date: 19/02/19

NCAA

AMENDMENT PROCEDURES

The Director, Aerodrome and Airspace Standards is responsible for the development, issuance and control of amendments to this document. The Document Controller is responsible for distribution of amended copies of the AC to Departmental staff and technical library and in making it available on NCAA website: ncaa.gov.ng for public use.

Each page will show the document number, issue number/amendment number, issue date and page number at the base of the page.

All amendments must be recorded in the Record of Amendments.

Any observation made or contribution to the content of this document by the user should be directed to the following address for consideration and adoption:

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RECORD OF AMENDMENTS

Issue No/ Amendment No	Page(s) Affected	Date Entered	Entered By	Signature
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LIST OF EFFECTIVE PAGES

Chapter	Page	Issued Date	Chapter	Page	Issued Date
Approval page	2	28th September,2018	Appendix D	45	28th September,2018
Amendment procedure	3	28th September,2018	Appendix D	46	28th September,2018
Record of amendment	4	28th September,2018	Appendix D	47	28th September,2018
LEP	5	28th September,2018	Appendix D	48	28th September,2018
Table of content	6	28th September,2018	Appendix D	49	28th September,2018
Chapter 1	10	28th September,2018	Appendix D	50	28th September,2018
Chapter 2	11	28th September,2018	Appendix D	51	28th September,2018
Chapter 3	12	28th September,2018	Appendix D	52	28th September,2018
Chapter 4	13	28th September,2018	Appendix D	53	28th September,2018
Chapter 5	14	28th September,2018	Appendix D	54	28th September,2018
Chapter 5	15	28th September,2018	Appendix D	55	28th September,2018
Chapter 5	16	28th September,2018	Appendix D	56	28th September,2018
Chapter 5	17	28th September,2018	Appendix D	57	28th September,2018
Chapter 5	18	28th September,2018	Appendix D	58	28th September,2018
Chapter 5	19	28th September,2018	Appendix D	59	28th September,2018
Chapter 5	20	28th September,2018	Appendix D	60	28th September,2018
Chapter 5	21	28th September,2018	Appendix D	61	28th September,2018
Chapter 5	22	28th September,2018	Appendix D	62	28th September,2018
Chapter 5	23	28th September,2018	Appendix D	63	28th September,2018
Chapter 5	24	28th September,2018	Appendix D	64	28th September,2018
Chapter 5	25	28th September,2018	Appendix D	65	28th September,2018
Chapter 5	26	28th September,2018	Appendix D	66	28th September,2018
Chapter 5	27	28th September,2018	Appendix F	66	28th September,2018
Chapter 5	28	28th September,2018	Appendix F	67	28th September,2018
Chapter 6	29	28th September,2018	Appendix F	68	28th September,2018
Chapter 6	30	28th September,2018	Appendix G	69	28th September,2018
Chapter 6	31	28th September,2018	Attachment A	70	28th September,2018
Chapter 7	32	28th September,2018	Attachment A	71	28th September,2018
Chapter 7	33	28th September,2018	Attachment A	72	28th September,2018
Appendix C Table 1	34	28th September,2018	Attachment A	73	28th September,2018
Appendix C Table 1	35	28th September,2018	Attachment A	74	28th September,2018
Appendix C Table 2	36	28th September,2018	Attachment A	75	28th September,2018
Appendix C Table 3	37	28th September,2018	Attachment A	76	28th September,2018
Appendix C Table 4	38	28th September,2018	Attachment B	77	28th September,2018
Appendix D	38	28th September,2018	Attachment B	77	28th September,2018
Appendix D	39	28th September,2018			

Appendix D	40	28th September,2018			
Appendix D	41	28th September,2018			
Appendix D	42	28th September,2018			
Appendix D	43	28th September,2018			
Appendix D	44	28th September,2018			

Table of Contents

1. GENERAL

A. Paragraph 5 of this Advisory Circular (AC) recommends and explains parts of a typical aeronautical study. By comprehensively addressing all the suggested parts, the aerodrome operator should be able to complete an aeronautical study to assess the viability of solution to an aeronautical problem. An aeronautical problem may refer to an issue related to:

(i) Operational regulations such as lack of procedures, insufficient maintenance programmes and competence issue; or

(ii) Design regulation such as terrain of object penetrating the Obstacle Limitation Surface (OLS), insufficient strip and Runway End Safety Area (RESA) (dimensions and/or quality), insufficient runway/taxiway separation and lack of or wrongly designed visual aids.

B. Appendix A to this AC contains a suggested checklist with the requirements to be included in an aeronautical study. The checklist can be used by the aerodrome operator as a guide to ascertain that all requirements have been taken into consideration and documented in the aeronautical study. However, not all the requirements found in Appendix A will be applicable to every aeronautical study conducted. The aerodrome operator should therefore examine each requirement carefully to determine what is applicable.

2. APPLICABILITY

This AC applies to all aerodromes required to be certified under Nig.CARs Part 12

3. INTRODUCTION

A. An aeronautical study is a study of an aeronautical problem to identify possible solutions and to select a solution that is acceptable without degrading safety. A comprehensive aeronautical study allows both the aerodrome operator and the Authority to be convinced that safety and regularity of operations of aircraft are not compromised in any way.

B. An aeronautical study is most frequently undertaken during the planning of new airport or new airport facility, or during the certification of an existing aerodrome or subsequently, when the aerodrome operator applies for an exemption, as a result of development or a change in the aerodrome operational conditions from specific standard or recommended practice contained in the ASM.

C. Aerodrome operators should consult their stakeholders, senior management and affected divisions/departments in their organisations prior to the conduct of an aeronautical study. These consultations would allow the proposed deviation to be viewed from different perspectives and the different parties involved would be aware of the proposed deviation. The aeronautical study should also be approved by the senior management of the organisation before it is submitted to the Authority for consideration or acceptance.

D. Aerodrome operators should note that the Authority may choose to participate in the conduct of an aeronautical study as an observer where appropriate

4. OBJECTIVES

The objectives of an aeronautical study are as follows:

(1) To study the impact of deviations from the Part 12 of Nig.CARs and ASM;

(2) To present alternative solutions to ensure the level of safety remains acceptable;

(3) To estimate the effectiveness of each alternative; and

(4) To recommend operating procedures/restrictions or other measures to compensate for the deviation.

5. A TYPICAL AERONAUTICAL STUDY

5.1 Parts of an Aeronautical Study

An aeronautical study submitted to the Authority for determination of acceptability should comprise the following parts:

(1) Aim of the Study;

(2) Background;

(3) Safety Assessment;

(4) Recommendations;

(5) Conclusion; and

(6) Monitoring of the deviation

(7) Submission and Approval of aeronautical study

5.2 Aim of the Study

a. The aim of the study should be explicitly stated. It should:

(1) Address the safety concerns;

(2) Identify safety measures to be put in place to ensure safe aircraft operation at an aerodrome; and

(3) Make reference to the specific SARP in the Nig.CARs Part 12 and/or ASM which the study is meant to address.

b An example to illustrate this would be as follows:
"The aim of this aeronautical study is to address the operation of Code 4F aircraft in a code 4E airport (name of airport) and to put in place (list of safety measures) necessary to ensure safe operation of Code 4F aircraft in (name of airport) with reference made to (reference to specific SARP)…."

5.3 Background

a. Information on the current situation faced by the aerodrome operator, current procedures that have been put in place and other relevant details should be clearly stated and explained in this subsection. Clear explanation should be provided, particularly on the following:

(1) What is the current situation?

(2) Where are the areas that will be affected by the proposed deviation?

(3) When will the operator be able to comply with the specific standard if it is due to development of the aerodrome?

(4) Why is there a need to review the current processes and procedures?

5) Who is responsible for mitigating the problem?

(6) How will the proposed deviation affect the operation of aircraft at the aerodrome?

b. An example to illustrate this would be as follows:

"Currently, (name of airport) is Code 4E airport with some Code 4F capabilities. These Code 4F capabilities includes (list of the Code 4F capabilities)… (name of airport) is required to handle Code 4F aircraft by (proposed date) and the following (list of affected areas) will be affected. Development of the (affected areas) is proposed to commence on (proposed date) and to be completed by (proposed date). By then, (name of airport) will be upgraded to a Code 4F airport.

Upgrading (name of airport) from Code 4E to Code 4F airport requires the reviewing (name of processes and procedures that need to be reviewed) to ensure safe aircraft operation. In addition, during this development, operation of aircraft at (name of airport) will be affected in the following ways….."

5.4 Management of change

5.4.1 As part of their SMS, aerodrome operators should have in place procedures to identify changes and to examine the impact of those changes on aerodrome operations.

Note 1. — Changes on an aerodrome can include changes to procedures, equipment, infrastructures and special operations.

Note 2. — Further guidance on the management of change can be found in Doc 9859 — Safety Management Manual (SMM), Section 4.

5.4.2 A safety assessment will be carried out to identify hazards and propose mitigation actions for all changes that are found to have an impact on the aerodrome operations.

Note 1. — Depending on the scope of the envisaged change as well as the level of the impact on operations, the methodology and level of detail required to carry out the required safety assessment may vary.

Note 2. — The types of changes that have to be assessed are described in section 5.4.3, and the key principles on safety assessments are available in 5.5, Safety Assessments.

5.4.3 Need for a safety assessment according to the category of changes

5.4.3.1 Routine tasks. Changes related to routine tasks do not have to be assessed using the safety assessment methodology developed in section 5.5 because these tasks are established and managed through specific procedures, training, feedback and reviews.

Note.— Routine tasks can be described as the actions related to an activity or service that are detailed in formal procedures, which are subject to periodic review, and for which the personnel in charge are adequately trained. These tasks may include movement area inspections, grass cutting on runway strips, sweeping of apron areas, regular and minor maintenance of runways, taxiways, visual aids, radio navigation and electrical systems.

5.4.3.1.1 The actions resulting from the regular assessment, feedback and review process related to these tasks should ensure that any changes related to them are managed, thus ensuring the safety of the specific task. However, a change related to a routine task for which feedback is not yet sufficient cannot be considered as sufficiently mature. Therefore, a safety assessment using the methodology developed in section 5.5 should be carried out.

5.4.3.2 **Specific changes**: Impact on the safety of aerodrome operations may result from:

a) Changes in the characteristics of infrastructures or the equipment;

b) Changes in the characteristics of the facilities and systems located in the movement area;

c) Changes in runway operations (e.g. type of approach, runway infrastructure, holding positions);

d) Changes to the aerodrome networks (e.g. electrical and telecommunication);

e) Changes that affect conditions as specified in the aerodrome's certificate;

f) Long-term changes related to contracted third parties;

g) Changes to the organizational structure of the aerodrome; and

h) Changes to the operating procedures of the aerodrome.

Note. — When the change involves an aeroplane type/model new to the aerodrome, a compatibility study, as specified in section 6.0, is conducted.

5.4.3.2.1 For any change in aerodrome operations as defined above, a safety assessment should be conducted.

5.5 Safety Assessments For Aerodromes

Note 1. — The objective of a safety assessment, as part of the risk management process of an SMS, is described in 5.5.1.

Note 2.— Where alternative measures, operational procedures and operating restrictions have been developed arising from safety assessments, these should be reviewed periodically to assess their continued validity. The procedures in this section do not substitute or circumvent the provisions contained in Aerodrome Standards Manual. It is expected that infrastructure on an existing aerodrome or a new aerodrome will fully comply with the requirements in the Aerodrome Standards Manual.

5.5.1 Introduction

5.5.1.1 A certified aerodrome operator implements an SMS acceptable to the NCAA that, as a minimum.

a) Identifies safety hazards;

b) Ensures that remedial action necessary to maintain safety is implemented;

c) Provides for continuous monitoring and regular assessment of the achieved safety; and

d) Aims to make continuous improvement to the overall safety of the aerodrome.

Note 1. — Nig.CARs Part 20, IS 20.3.1.1 — Safety Management contains the framework for the implementation and maintenance of an SMS by a certified aerodrome. Nig.CARs Part 20, IS 20.3.1.1, contains a description of the four components comprising the framework, i.e. safety policy and objectives, safety risk management, safety assurance and safety promotion.

Note 2. — Further guidance on SMS is available in Doc 9859, Safety Management Manual (SMM).

5.5.1.2 This section describes how a safety assessment can be undertaken as part of the aerodrome's SMS. By applying the methodology and procedures described here, the aerodrome operator can demonstrate compliance with the minimum requirements described in 5.5.1.1.

5.5.2 Scope And Applicability

5.5.2.1 The following sections present, inter alia, a general methodology to conduct safety assessments on an aerodrome. Additional tools and particularly appropriate checklists, such as those found in Section 6.0, can help identify hazards, assess safety risks and eliminate or mitigate those risks when necessary. The suitability of the mitigation proposed and the need for alternative measures, operational procedures or operating restrictions for the specific operations concerned should be comprehensively evaluated. Section 5.5.4 details how the NCAA will validate the conclusion of the safety assessment, when appropriate, to ensure safety is not compromised. Section 5.5.5 describes procedures on the approval or acceptance of a safety assessment. Section 5.5.6 specifies how to promulgate appropriate information for use by the various aerodrome stakeholders and particularly by the pilots and aircraft operators.

5.5.2.2 The safety assessment process addresses the impact of a safety concern, including a change or deviation, on the safety of operations at the aerodrome and takes into consideration the aerodrome's capacity and the efficiency of operations, as necessary.

5.5.3 Basic Considerations

5.5.3.1 A safety assessment is an element of the risk management process of an SMS that is used to assess safety concerns arising from, inter alia, deviations from standards and applicable regulations, identified changes at an aerodrome specified in 5.4, or when any other safety concerns arise.

Note. — Changes on an aerodrome can include changes to procedures, equipment, infrastructures, safety works, special operations, regulations, organization, etc.

5.5.3.2 When a safety concern, change or a deviation has an impact on several aerodrome stakeholders, consideration shall be given to the involvement of all stakeholders affected in the safety assessment process. In some cases, the stakeholders impacted by the change will need to conduct a separate safety assessment themselves in order to fulfil the requirements of their SMSs and coordinate with other relevant stakeholders. When a change has an impact on multiple stakeholders, a collaborative safety assessment should be conducted to ensure compatibility of the final solutions.

5.5.3.3 A safety assessment considers the impact of the safety concern on all relevant factors determined to be safety-significant. The list below provides a number of items that may need to be considered when conducting a safety assessment. The items in this list are not exhaustive and in no particular order:

a) Aerodrome layout, including runway configurations; runway length; taxiway, taxi lane and apron configurations; gates; jet bridges; visual aids; and the RFF services infrastructure and capabilities;

b) Types of aircraft, and their dimensions and performance characteristics, intended to operate at the aerodrome;

c) Traffic density and distribution;

d) Aerodrome ground services;

e) Air-ground communications and time parameters for voice and data link communications;

f) Type and capabilities of surveillance systems and the availability of systems providing controller support and alert functions;

g) Flight instrument procedures and related aerodrome equipment;

h) Complex operational procedures, such as collaborative decision-making (CDM);

i) Aerodrome technical installations, such as advanced surface movement guidance and control systems (A-SMGCS) or other air navigation aids;

j) Obstacles or hazardous activities at or in the vicinity of the aerodrome;

k) Planned construction or maintenance works at or in the vicinity of the aerodrome;

l) Any local or regional hazardous meteorological conditions (such as wind shear); and

m) Airspace complexity, ATS route structure and classification of the airspace, which may change the pattern of operations or the capacity of the same airspace.

Note. — Section 6.0 outlines the methodology and procedures to assess the adequacy between aeroplane operations and aerodrome infrastructure and operations.

5.5.3.4. Subsequent to the completion of the safety assessment, the aerodrome operator is responsible for implementing and periodically monitoring the effectiveness of the identified mitigation measures.

5.5.3.5. The NCAA reviews the safety assessment provided by the aerodrome operator and its identified mitigation measures, operational procedures and operating restrictions, as required in section 5.5.4, and is responsible for the subsequent regulatory oversight of their application.

Note.— A list of references to existing studies that may assist aerodrome operators in developing their safety assessments is available in Appendix B to Circular 305 — Operation of New Larger Aeroplanes at Existing Aerodromes. New and updated references will be included in other appropriate documents as they become available. However, it is to be noted that each study is specific to a particular deviation or change; hence, caution should be exercised in considering applicability to other situations and locations. Inclusion of these references does not imply ICAO endorsement or recognition of the outcome of the studies, which remains *the ultimate responsibility of the State in accordance with the Convention on International Civil Aviation.*

5.5.4 Safety Assessment Process

5.5.4.1 Introduction

Note. — Guidance on continuous improvement of the SMS as part of the safety assurance component of the SMS framework is available in Doc 9859.

5.5.4.1.1. The primary objective of a safety assessment is to assess the impact of a safety concern such as a design change or deviation in operational procedures at an existing aerodrome.

5.5.4.1.2 Such a safety concern can often impact multiple stakeholders; therefore, safety assessments often need to be carried out in a cross-organizational manner, involving experts from all the involved stakeholders. Prior to the assessment, a preliminary identification of the required tasks and the organizations to be involved in the process is conducted.

5.5.4.1.3 A safety assessment is initially composed of four basic steps:

a) Definition of a safety concern and identification of the regulatory compliance;

b) Hazard identification and analysis;

c) Risk assessment and development of mitigation measures; and

d) Development of an implementation plan for the mitigation measures and conclusion of the assessment.

Note 1.— A safety assessment process flow chart applicable for aerodrome operations is provided in Attachment A to this Advisory Circular; a generic safety risk management process can be found in Doc 9859.

Note 2.— Certain safety assessments may involve other stakeholders such as ground handlers, aeroplane operators, air navigation service providers (ANSPs), flight procedure designers and providers of radio navigation signals, including signals from satellites.

5.5.4.2 Definition of a safety concern and identification of the regulatory compliance

5.5.4.2.1 Any perceived safety concerns are to be described in detail, including timescales, projected phases, location, stakeholders involved or affected as well as their potential influence on specific processes, procedures, systems and operations.

5.5.4.2.2 The perceived safety concern is first analyzed to determine whether it is retained or rejected. If rejected, the justification for rejecting the safety concern is to be provided and documented.

5.5.4.2.3. An initial evaluation of compliance with the appropriate provisions in the regulations applicable to the aerodrome is conducted and documented.

5.5.4.2.4. The corresponding areas of concern are identified before proceeding with the remaining steps of the safety assessment, with all relevant stakeholders.

Note. — It may be useful to review the historical background of some regulatory provisions to gain a better understanding of the safety objective of those provisions.

5.5.4.2.5 If a safety assessment was conducted previously for similar cases in the same context at an aerodrome where similar characteristics and procedures exist, the aerodrome operator may use some elements from that assessment as a basis for the assessment to be conducted. Nevertheless, as each assessment is specific to a particular safety concern at a given aerodrome the suitability for re-using specific elements of an existing assessment is to be carefully evaluated.

5.5.4.3 Hazard identification

5.5.4.3.1. Hazards related to infrastructure, systems or operational procedures are initially identified using methods such as brain-storming sessions, expert opinions, industry knowledge, experience and operational judgement. The identification of hazards is conducted by considering:

a) Accident causal factors and critical events based on a simple causal analysis of available accident and incident databases;

b) Events that may have occurred in similar circumstances or that are subsequent to the resolution of a similar safety concern; and

c) Potential new hazards that may emerge during or after implementation of the planned changes.

5.5.4.3.2 Following the previous steps, all potential outcomes or consequences for each identified hazard are identified.

Note. — Further guidance on the definition of risk can be found in Doc 9859.

5.5.4.3.3 The appropriate safety objective for each type of hazard should be defined and detailed. This can be done through:

a) Reference to recognized standards and/or codes of practices;

b) Reference to the safety performance of the existing system;

c) Reference to the acceptance of a similar system elsewhere; and

d) Application of explicit safety risk levels.

5.5.4.3.4. Safety objectives are specified in either quantitative terms (e.g. identification of a numerical probability) or qualitative terms (e.g. comparison with an existing situation). The selection of the safety objective is made according to the aerodrome operator's policy with respect to safety improvement and is justified for the specific hazard.

5.5.4.4. Risk assessment and development of mitigation measures

5.5.4.4.1 The level of risk of each identified potential consequence is estimated by conducting a risk assessment. This risk assessment will determine the severity of a consequence (effect on the safety of the considered operations) and the probability of the consequence occurring and will be based on experience as well as on any available data (e.g. accident database, occurrence reports).

5.5.4.4.2 Understanding the risks is the basis for the development of mitigation measures, operational procedures and operating restrictions that might be needed to ensure safe aerodrome operations.

5.5.4.4.3 The method for risk evaluation is strongly dependent on the nature of the hazards. The risk itself is evaluated by combining the two values for severity of its consequences and probability of occurrence.

Note. — A risk categorization tool in the form of a safety risk (index) assessment matrix is available in Doc 9859.

5.5.4.4.4. Once each hazard has been identified and analysed in terms of causes, and assessed for severity and probability of its occurrence, it must be ascertained that all associated risks are appropriately managed. An initial identification of existing mitigation measures must be conducted prior to the development of any additional measures.

5.5.4.4.5. All-risk mitigation measures, whether currently being applied or still under development, are evaluated for the effectiveness of their risk management capabilities.

Note. — The exposure to a given risk (e.g. duration of a change, time before implementation of corrective actions, traffic density) is taken into account in order to decide on its acceptability.

5.5.4.4.6. In some cases, a quantitative approach may be possible, and numerical safety objectives can be used. In other instances such as changes to the operational environment or procedures, a qualitative analysis may be more relevant.

Note 1. — An example of a qualitative approach is the objective of providing at least the same protection as the one offered by the infrastructure corresponding to the appropriate reference code for a specific aeroplane.

Note 2. — Section 6.0 provides a list of typical challenges related to each part of the aerodrome infrastructure and the potential solutions proposed.

5.5.4.4.7 There is no standard methodology to conduct a safety assessment and it is up to the aerodrome operator to determine the appropriate methodology for each aeronautical study, depending on the size, complexity of the situation and the severity of the safety implications. However, the methodology adopted should be consistent with that established in the aerodrome operator's SMS.

Note 1. — Risk assessment models are commonly built on the principle that there should be an inverse relationship between the severity of an incident and its probability.

Note 2. — Methodologies for risk management can be found in section 5.6.

5.5.4.4.8 In some cases, the result of the risk assessment may be that the safety objectives will be met without any additional specific mitigation measures.

5.5.4.5 Development of an implementation plan and conclusion of the assessment

5.5.4.5.1 The last phase of the safety assessment process is the development of a plan for the implementation of the identified mitigation measures.

5.5.4.5.2 The implementation plan includes time frames, responsibilities for mitigation measures as well as control measures that may be defined and implemented to monitor the effectiveness of the mitigation measures.

5.5.5 Approval Or Acceptance Of A Safety Assessment

Note. — The safety assessment conducted by the aerodrome operator is a core SMS function. Management approval and implementation of the safety assessment, including future updates and maintenance, are the responsibility of the aerodrome operator. The NCAA may, for specific reasons, require the submission of the specific safety assessment for approval/acceptance.

5.5.5.1 NCAA has established the type of safety assessments that are subject to approval or acceptance and determines the process used for that approval/acceptance as provided in 5.5.1.1

5.5.5.2. Where required in **5.5.5.1**, a safety assessment subject to approval or acceptance by the Authority shall be submitted by the aerodrome operator prior to implementation.

5.5.5.3 The Authority analyses the safety assessment and verifies that:

a) Appropriate coordination has been performed between the concerned stakeholders;

b) The risks have been properly identified and assessed, based on documented arguments (e.g. physical or Human Factors studies, analysis of previous accidents and incidents);

c) The proposed mitigation measures adequately address the risk; and

d) The time frames for planned implementation are acceptable.

Note. — It is preferable to work with a team of the Authority's operational experts in the areas considered in the safety assessment.

5.5.5.4 On completion of the analysis of the safety assessment, the Authority may:

a) Either gives formal approval or acceptance of the safety assessment to the aerodrome operator as required in section

5.5.5.1; or

b) If some risks have been underestimated or have not been identified, coordinates with the aerodrome operator to reach an agreement on safety acceptance; or

c) If no agreement can be reached, rejects the proposal for possible resubmission by the aerodrome operator; or

d) May choose to impose conditional measures to ensure safety.

5.5.5.5. The Authority should ensure that the mitigation or conditional measures are properly implemented and that they fulfil their purpose.

5.5.6 Promulgation Of Safety Information

5.5.6.1. The aerodrome operator determines the most appropriate method for communicating safety information to the stakeholders and ensures that all safety-relevant conclusions of the safety assessment are adequately communicated.

5.5.6.2. In order to ensure adequate dissemination of information to interested parties, information that affects the current integrated aeronautical information package (IAIP) or other relevant safety information is:

a) Promulgated in the relevant section of the IAIP; and

b) Published in the relevant information communication through appropriate means.

5.6 Risk assessment method

a. The risk assessment takes into account the probability of occurrence of a hazard and the severity of its consequences; the risk is evaluated by combining the two values for severity and probability of occurrence. Risk management is the identification, analysis and elimination, and/or mitigation of such risk identified to an acceptable level.

b. Each identified hazard must be classified by probability of occurrence and severity of impact. This process of risk classification will allow the aerodrome to determine the level of risk posed by a particular hazard. The classification of probability and severity refers to potential events. An example would be “Operation of Code 4F aircraft in a Code 4E airport” and “Wingtip collision in parking bays”. The former is a hazard whereas the latter is one of its consequences. The associated risk and control/mitigation measures should also be recorded in the hazard log when information is available. This log should be constantly updated throughout the aeronautical study life-cycle.

c. The severity classification includes five classes ranging from “catastrophic” (class A) to “not significant” (class E). The examples in Appendix C, table 1 adapted from Doc 9859 with aerodrome-specific examples, serve as a guide to better understand the definition.

d. The classification of the severity of an event should be based on a “credible case” but not on a “worst case” scenario. A credible case is expected to be possible under reasonable conditions (probable course of events). A worst case may be expected under extreme conditions and combinations of additional and improbable hazards. If worst cases are to be introduced implicitly, it is necessary to estimate appropriate low frequencies.

Appendix B of this AC contains a sample hazard log. The aerodrome operator may use this to formulate its own hazard log to suit the aeronautical study.

e. The probability and severity of the consequence identified can be qualitative or quantitative. The aerodrome operator is free to use any method appropriate to the aeronautical study, but in accordance with the risk management methodology established in the aerodrome operator’s SMS. Some examples to assess the probability and severity of a consequence occurring are provided in Appendix C to this AC.

f. A risk assessment matrix should be developed. This matrix provides a relationship between the probability and severity of a consequence of a hazard occurring. The risk indexes (combinations of the risk probability values and the risk severity values) should be placed in a risk tolerability table. Appendix C also gives an example of risk assessment matrix and risk tolerability.

Risk control/mitigation measures should be developed to address the potential hazard or to reduce the risk probability or severity of the consequence when the risk is classified to be tolerable to a level acceptable by the aerodrome operator. There are three broad categories for risk control/mitigation and they are as follows:

(1) Avoidance - the operation or activity is cancelled as the risks exceed the benefits of continuing the operation or activity;
An example to illustrate this would be as follows: "To prohibit Code 4F aircraft to land or take-off from (name of airport), which is a Code 4E airport with some Code 4F capability."

(2) Reduction - the frequency of the operation or activity is reduced, action is taken to reduce the magnitude of the consequences of the accepted risk; and
An example to illustrate this would be as follows: "To reduce the number of Code 4F Aircraft to land or take-off from (name of airport)."

(3) Segregation of exposure - action is taken to isolate the effects of the consequences of the hazard or build-in redundancy to protect against it.
An example to illustrate this would be as follows:
"To ensure (name of airport) staff liaise with the Aeronautical Information Services (AIS) on the promulgation of aerodrome circulars with the necessary aerodrome information to (names of aircraft operators) and (names of other airports) within (fixed period of time) stated in their new process and/or new procedures."

5.7 Recommendations

a. To allow the aerodrome operator and the Authority to be convinced and assured that the proposed deviation will not pose a drop in the level of safety, the aerodrome operator should recommend operating procedures/restrictions or other measures that will address any safety concerns. In addition, the aerodrome operator should estimate the effectiveness (through trials, surveys, simulations etc.) Of each recommendation listed so as to identify the best means to address the proposed deviation.

b. The aerodrome operator should also ensure that the affected parties are well informed of such changes. The notification procedure including process flow, time frame and different means of notification such as the Aeronautical Information Publication (AIP) and Notice to Airmen (NOTAM) should be included in the study.

c. An example to illustrate this would be as follows:
"The following are some of the operating procedures/restrictions or other measures as well as their measured effectiveness, which could be adopted to ensure safe aircraft operations in (name of airport): (Name of the operating procedures/restrictions or other measures and their corresponding measured effectiveness)

The notification procedure to the affected parties is as follows: (Description of the notification procedure including process flow, time frame and different means of notification)

5.8 Conclusion

a. The aerodrome operator, after taking into account all the necessary considerations listed above, should be able to summarize and conclude the results of the aeronautical study, and come to a decision on any safety measures that should be adopted. The aerodrome operator should also specify a date to put in place all the necessary safety measures and show they maintain the same level of safety with the recommended safety measures mentioned in the aeronautical study.

b. An example to illustrate this would be as follow:
"The results of this aeronautical study have concluded that (name proposed deviation) will indeed pose a drop in the level of safety. However, by adopting (type of safety measures), this drop in the level of safety can be safely addressed… These safety measures will be put in place on (proposed date) to address the proposed deviation. With these safety measures put in place, (to explain how to maintain the same level of safety)…"

5.9 Monitoring of the Deviation

a. After the completion of the aeronautical study, the aerodrome operator should monitor the status of the deviation and ensure that the implemented recommendations have been effectively carried out, and that the level of safety is not compromised at any time. This assessment is to allow feedback into the safety assessment process, if required.

b. An example would be as follows:
"(Name of the aerodrome operator) will monitor the deviation's status (fixed period of time) and ensure the safety measures has been effectively carried out and the level of safety is not compromised at any time. (Name of the aerodrome operator) will review the safety assessment process, if required…"

c. For temporary deviations, the aerodrome operator should also notify the Authority after the deviation has been corrected.

6. AERODROME COMPATIBILITY

6.1 Introduction

6.1.1 This section outlines a methodology and procedure to assess the compatibility between aeroplane operations and aerodrome infrastructure and operations when an aerodrome accommodates an aeroplane that exceeds the certificated characteristics of the aerodrome.

6.1.2 A compatibility study should be performed collaboratively between affected stakeholders which includes the aerodrome operator, the aeroplane operator, ground handling agencies as well as the various air navigation service providers (ANSPs).

6.1.3 The following steps describe the arrangement, to be appropriately documented, between the aeroplane operator and aerodrome operator for the introduction of an aeroplane type/subtype new to the aerodrome:

a) The aeroplane operator submits a request to the aerodrome operator to operate an aeroplane type/subtype new to the aerodrome;

b) The aerodrome operator identifies possible means of accommodating the aeroplane type/subtype including access to movement areas and, if necessary, considers the feasibility and economic viability of upgrading the aerodrome infrastructure; and

c) The aerodrome operator and aircraft operator discuss the aerodrome operator's assessment, and whether operations of the aeroplane type/subtype can be accommodated and, if permitted, under what conditions.

6.1.4 The following procedures should be included in the aerodrome compatibility study:

a) Identify the aeroplane's physical and operational characteristics (see Attachments A, B of this AC and D to chapter 4 of ICAO DOC 9981);

b) Identify the applicable regulatory requirements;

c) Establish the adequacy of the aerodrome infrastructure and facilities vis-à-vis the requirements of the new aeroplane (see the appendix to this section);

d) Identify the changes required to the aerodrome;

e) Document the compatibility study; and

f) Perform the required safety assessments identified during the compatibility study (see section5.5 on safety assessment).

Note 1. — A compatibility study may require a review of the obstacle limitation surfaces at an aerodrome as specified in Chapter 8, Aerodrome Standards Manual. Further guidance on the function of these surfaces is given in Doc 9137, Part 6 — Control of Obstacles. Where required, reporting of obstacles is prescribed in Annex 4 — Aeronautical Charts and Annex 15 — Aeronautical Information Services.

Note 2. — For aerodrome operations in low visibility conditions, additional procedures may be implemented in order to safeguard the operation of aeroplanes. Further guidance on operations in low visibility conditions are available in Doc 9137 — Airport Services Manual, Part 8 — Airport Operational Services, Doc 9476 — Manual of Surface Movement Guidance and Control Systems (SMGCS); and Doc 9830 — Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual.

Note 3. — Additional processes that ensure suitable measures are in place to protect the signal produced by the ground-based radio navigation equipment may be necessary at aerodromes with precision instrument approaches.

6.1.5 The result of the compatibility study should enable decisions to be made and should provide:

a) The aerodrome operator with the necessary information in order to make a decision on allowing the operation of the specific aeroplane at the given aerodrome;

b) The aerodrome operator with the necessary information in order to make a decision on the changes required to the aerodrome infrastructure and facilities to ensure safe operations at the aerodrome with due consideration to the harmonious future development of the aerodrome; and

c) The Authority with the information which is necessary for its safety oversight and the continued monitoring of the conditions specified in the aerodrome certification.

Note 1. — Each compatibility study is specific to a particular operational context and to a particular type of aeroplane.

Note 2. — See Annex 6 — Operation of Aircraft, Part I — International Commercial Air Transport — Aeroplanes, Section 4, regarding the obligation of the aeroplane operator.

Note 3. — Information resulting from the compatibility study that is considered to be of operational significance is published in accordance with Aerodrome Standards Manual, 6.2.13.1, and Annex 15.

6.2 Impact Of Aeroplane Characteristics On The Aerodrome Infrastructure

6.2.1 General

6.2.1.1 Introducing new types of Aeroplanes into existing aerodromes may have an impact on the aerodrome facilities and services, in particular, when the aeroplane characteristics exceed the parameters that were used for planning the aerodrome.

6.2.1.2 The parameters used in aerodrome planning are defined in Aerodrome Standards Manual, which specifies the use of the aerodrome reference code determined in accordance with the characteristics of the aeroplane for which an aerodrome facility is intended. The aerodrome reference code provides a starting point for the compatibility study and may not be the sole means used to conduct the analysis and to substantiate the aerodrome operator's decisions and the State's safety oversight actions.

Note. — The individual facilities required at an aerodrome are interrelated by the aerodrome reference code. The design of these facilities, including a description of the aerodrome reference code, can be found in Aerodrome Standards Manual.

6.2.2 Consideration of the aeroplane's physical characteristics

The aeroplane's physical characteristics may influence the aerodrome dimensions, facilities and services in the movement area. These characteristics are detailed in Attachment A.

6.2.3 Consideration of the aeroplane's operational characteristics

In order to adequately assess aerodrome compatibility, aeroplane operational characteristics should be included in the evaluation process. The operational characteristics can include the infrastructure requirements of the aeroplane as well as ground servicing requirements. These characteristics are detailed in Attachment B.

6.3 Physical Characteristics Of Aerodromes

In order to adequately assess the aeroplane's compatibility, aerodrome physical characteristics should be included in the evaluation process. These characteristics are detailed in the Appendix D.

7. Submission And Approval Of Aeronautical Study To Nigerian Civil Aviation Authority.

The aerodrome operator should note the guidance provided in this AC and use the suggested checklist provided in Appendix A to ensure that any aeronautical study submitted to the Authority meets the requirements for approval/acceptance.

Appendix C,

Table 1:Severity classification scheme with examples

(Adapted from Doc 9859 with aerodrome-specific examples)

Severity	Meaning	Value	Example
Catastrophic	– Equipment destroyed – Multiple deaths	A	– collision between aircraft and/or other object during take-off or landing
Hazardous	– 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	B	– runway incursion, significant potential for an accident, extreme action to avoid collision – attempted take-off or landing on a closed or engaged runway – take-off/landing

Major	– 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	– runway incursion, ample time and distance (no potential for a collision) – collision with obstacle on apron/ parking position (hard collision) – person falling down from height – missed approach with ground contact of the wing ends during the touchdown – large fuel puddle near the aircraft while passengers are on-board

Minor	– Nuisance – Operating limitations – Use of emergency procedures – Minor incident	D	– hard braking during landing or taxiing – damage due to jet blast (objects) – expendables are laying around the stands – collision between maintenance vehicles on service road – breakage of drawbar during pushback (damage to the aircraft) – slight excess of maximum take-off weight without safety consequences – aircraft rolling into passenger bridge with no damage to the aircraft needing immediate repair

Severity	Meaning	Value	Example
			– forklift that is tilting – complex taxiing instructions/procedures
Negligible	– Few consequences	E	– slight increase in braking distance – temporary fencing collapsing because of strong winds – cart losing baggage

6. The probability classification includes five classes ranging from "extremely improbable" (class 1) to "frequent" (class 5) as shown in Appendix C, table 2.

7. The probability classes presented in Appendix C, table 3 are defined with quantitative limits. It is not the intention to assess frequencies quantitatively; the numerical value serves only to clarify the qualitative description and support a consistent expert judgement.

Appendix C, Table 2: Probability classification scheme

Probability class	Meaning
5 Frequent	Likely to occur many times (has occurred frequently)
4 Reasonably probable	Likely to occur sometimes (has occurred infrequently)
3 Remote	Unlikely to occur (has occurred rarely)
2 Extremely remote	Very unlikely to occur (not known to have occurred)
1 Extremely improbable	Almost inconceivable that the event will occur

8. The classification refers to the probability of events per a period of time. This is reasoned through the following:

a) Many hazards at aerodromes are not directly related to aircraft movements; and

b) The assessment of hazards occurrence probabilities can be based on expert judgement without any calculations.

9. The aim of the matrix is to provide a means of obtaining a safety risk index. The index can be used to determine tolerability of the risk and to enable the prioritization of relevant actions in order to decide about risk acceptance.

10. Given that the prioritization is dependent on both probability and severity of the events, the prioritization criteria will be two-dimensional. Three main classes of hazard mitigation priority are defined in Appendix C, table 3:

a) Hazards with high priority — intolerable;

b) Hazards with mean priority — tolerable; and

c) Hazards with low priority — acceptable.

11. The risk assessment matrix has no fixed limits for tolerability but points to a floating assessment where risks are given risk priority for their risk contribution to aircraft operations. For this reason, the priority classes are intentionally not edged along the probability and severity classes in order to take into account the imprecise assessment.

Appendix C, Table 3: Risk assessment matrix with prioritization classes

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

Appendix C, Table 4: Safety risk tolerability matrix

Tolerability description	Assessed risk index	Suggested criteria
Intolerable region	**5A,5B,5C, 4A,4B,3A**	**STOP: Unacceptable under the existing circumstances. Do not permit any operation until sufficient control measures have been implemented to reduce risk to an acceptable level.**
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**

Appendix D:

1. Physical Characteristics Of Aerodromes

Each paragraph within this section is structured as follows:

Introduction

This section provides the rationale, including the basis and objectives for the various elements of the physical infrastructure required in Aerodrome Standards Manual, Chapter 7. References are made, where necessary, to other ICAO documents.

Challenges

This section identifies possible challenges based on experience, operational judgement and analysis of hazards linked to an infrastructure item in relation to ICAO provisions. Each compatibility study should determine the challenges relevant for the accommodation of the planned aeroplane at the existing aerodrome.

Potential solutions

This section presents possible solutions related to the identified problems. Where it is impracticable to adapt the existing aerodrome infrastructure or operations in accordance with the applicable regulation, the compatibility study or, where necessary, safety assessment, determines the appropriate solutions or possible risk mitigation measures to be implemented.

Note 1. — Where possible solutions have been developed, these should be reviewed periodically to assess their continued validity. These possible solutions do not substitute or circumvent the provisions contained in Aerodrome Standards Manual.

Note 2. — Procedures on the conduct of a safety assessment can be found in Section 5.5.

2. Runways

2.1 Runway length

Note 1. — Runway length is a limiting factor on aeroplane operations and should be assessed in collaboration with the aeroplane operator. Information *on aeroplane reference field length can be found in Attachment D to Chapter 4 of ICAO DOC 9981*

Note 2. — Longitudinal slopes can have an effect on aeroplane performance.

2.2 Runway width

Introduction

2.2.1 For a given runway width, factors affecting aeroplane operations include the characteristics, handling qualities and performance demonstrated by the aeroplane. It may be advisable to consider other factors of operational significance in order to have a safety margin for factors such as wet or contaminated runway pavement, crosswind conditions, crab angle approaches to landing, aeroplane controllability during aborted take-off, and engine failure procedures.

Note. — Guidance is given in Doc 9157, Part 1 — Runways.

Challenges

2.2.2 The main issue associated with available runway width is the risk of aeroplane damage and fatalities associated with an aeroplane veering off the runway during take-off, rejected take-off or during the landing.

2.2.3 The main causes and accident factors are:

a) For take-off/rejected take-off:

1) Aeroplane (asymmetric spin-up and/or reverse thrust, malfunctioning of control surfaces, hydraulic system, tires, brakes, nose-gear steering, centre of gravity and power plant (engine failure, foreign object ingestion));

2) Temporary surface conditions (standing water, snow, dust, residuals (rubber), FOD, damage to the pavement and runway friction coefficient);

3) Permanent surface conditions (horizontal and vertical slopes and runway friction characteristics);

4) Meteorological conditions (e.g. heavy rain, crosswind, strong/gusty winds, reduced visibility, snow); and

5) Human Factors (crew, maintenance, balance, payload security);

b) For landing:

1) Aeroplane/airframe (malfunction of the landing gear, control surfaces, hydraulic system, brakes, tires, nose- gear steering and power plant (reverse and thrust lever linkage));

2) Temporary surface conditions (standing water, snow, dust, residuals (e.g. rubber), FOD, damage to the pavement and applying runway friction coefficient);

3) Permanent surface conditions (horizontal and vertical slopes and runway friction characteristics);

4) Prevailing meteorological conditions (heavy rain, crosswind, strong/gusty winds, thunderstorms/wind shear, reduced visibility);

5) Human Factors (i.e. hard landings, crew, maintenance);

6) ILS localizer signal quality/interference, where auto land procedures are used;

7) Any other localizer signal quality/interference of approach aid equipment;

8) Lack of approach path guidance such as VASIS or PAPI; and

9) Approach type and speed.

Note. — An analysis of lateral runway excursion reports shows that the causal factor in aeroplane accidents/incidents is not the same for take-off and landing. Mechanical failure is, for instance, a frequent accident factor for runway excursions during take-off, while hazardous meteorological conditions such as thunderstorms are more often associated with landing accidents/incidents. Engine reverse thrust system malfunction and/or contaminated runway surfaces have also been a factor in a significant number of veer-offs during landing (other subjects are relevant to the aeroplane such as brake failures and high crosswinds).

Potential solutions

2.2.4 The lateral runway excursion is linked to specific aeroplane characteristics, performance/handling qualities, controllability in response to such events as aeroplane mechanical failures, pavement contamination and crosswind conditions. Runway width is not a required specific certification limitation. However, indirectly related is the determination of minimum control speed on the ground (Vmcg) and the maximum demonstrated crosswind. These additional factors should be considered as key factors in order to ensure that this kind of hazard is adequately addressed.

2.2.5 For a specific aeroplane, it may be permissible to operate on a runway with a narrower width if approved by the appropriate authorities for such operations.

Note. — The maximum demonstrated crosswind is included in the aircraft flight manual.

2.2.6 Potential solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

a) Paved inner shoulders of adequate bearing strength to provide an overall width of the runway and its (inner) shoulders of the recommended runway width according to the reference code;

b) Paved/unpaved outer shoulders with adequate bearing strength to provide an overall width of the runway and its shoulder according to the reference code;

c) Additional runway centre line guidance and runway edge markings; and

d) Increased full runway length FOD inspection, when required or requested.

2.2.7 Aerodrome operators should also take into account the possibility that certain aeroplanes are not able to make a 180-degree turn on narrower runways. When there is no proper taxiway at the end of the runway, providing a suitable runway turn pad is recommended.

Note. — Particular care should be given while maneuvering on runways having a width less than recommended to prevent the wheels of the aeroplane from leaving the pavement, while avoiding the use of large amounts of thrust that could damage runway lights and signs and cause erosion of the runway strip. For affected runways a close inspection, as appropriate, is generally considered to detect the presence of debris that may be deposited during 180-degree turns on the runway after landing.

Note. — Guidance is given in Doc 9137, Part 2 — Pavement Surface Conditions.

2.2.8 Aerodromes which use embedded (inset) runway edge lights should take into account additional consequences such as:

a) More frequent cleaning intervals for the embedded lights, as dirt will affect the function more quickly compared to elevated runway edge lights; and

b) In addition, bi-directional inset lights can facilitate snow removal procedures on a wider range.

2.2.9 Location and specifications for runway signs should be considered due to the increased size of the aeroplane's wingspan (engine location) as well as the increased thrust rating from the aeroplane's engines.

2.3 Runway shoulders

Introduction

2.3.1 The shoulders of a runway should be capable of minimizing any damage to an aeroplane veering off the runway. In some cases, the bearing strength of the natural ground may be sufficient without additional preparation to meet the requirements for shoulders. The prevention of ingestion of objects from jet engines should always be taken into account particularly for the design and construction of the shoulders. In case of specific preparation of the shoulders, visual contrast, such as the use of runway side-stripe markings, between runway and runway shoulders, may be required.

Note. — Guidance is given in Doc 9157, Part 1.

Challenges

2.3.2 Runway shoulders have three main functions:

a) To minimize any damage to an aeroplane running off the runway;

b) To provide jet blast protection and to prevent engine FOD ingestion; and

c) To support ground vehicle traffic, RFF vehicles and maintenance vehicles.

Note. — Inadequate width of existing runway bridges is a special topic that needs careful evaluation.

2.3.3 Potential issues associated with runway shoulder characteristics (width, soil type, bearing strength) are:

a) Aeroplane damage that could occur after excursion onto the runway shoulder due to inadequate bearing capacity;

b) Shoulder erosion causing ingestion of foreign objects by jet engines due to unsealed surfaces; consideration should be given to the impact of FOD on aeroplane tires and engines as a potentially major hazard; and

c) Difficulties for RFF services to access a damaged aeroplane on the runway due to inadequate bearing strength.

2.3.4 Factors to be considered are:

a) Runway centre line deviations;

b) Power plant characteristics (engine height, location and power); and

c) Soil type and bearing strength (aeroplane mass, tire pressure, gear design).

Potential solutions

2.3.5 Possible solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

a) Excursion onto the runway shoulder. Provide the suitable shoulder as detailed in section 2.3;

b) Jet blast. Information about outer engine position, jet blast velocity contour and jet blast directions at take-off is needed to calculate the required width of shoulders that has to be enhanced for protection against jet blast. Lateral deviation from the runway centre line should also be taken into account;

Note 1. — Jet blast velocity data may be available from the aircraft manufacturers.

Note 2. — Relevant information is typically available in the aircraft characteristics for airport planning manual of aircraft manufacturers.

c) RFF vehicles. Operational experience with aeroplanes currently operated on existing runways suggests that an overall width of the runway and its shoulders, which is compliant with the requirements, is adequate to permit intervention on aeroplanes by occasional RFF vehicle traffic. However, longer upper-deck escape chutes may reduce the margin between the shoulder edge and the extension of escape slides and reduce the supporting surface available to rescue vehicles; and

d) Additional surface inspections. It may be necessary to adapt the inspection programme for FOD detection.

2.4 Runway turn pads

Introduction

2.4.1 Turn pads are generally provided when an exit taxiway is not available at the runway end. A turn pad allows an aeroplane to turn back after landing and before take-off and to position itself correctly on the runway.

Note. — Guidance on typical turn pads is given in Doc 9157, Part 1, and Appendix 4. In particular, the design of the total width of the turn pad should be such that the nose-wheel steering angle of the aeroplane for which the turn pad is intended will not exceed 45 degrees.

Challenges

2.4.2 For minimizing the risk of a turn pad excursion, the turn pad should be designed sufficiently wide to permit the 180-degree turn of the most demanding aeroplane that will be operated. The design of the turn pad generally assumes a maximum nose landing gear steering angle of 45 degrees, which should be used unless some other condition applies for the particular type of aeroplane, and considers clearances between the gears and the turn pad edge, as for a taxiway.

2.4.3 The main causes and accident factors of the aeroplane veering off the turn pad pavement are:

a) Aeroplane characteristics that are not adequate and aeroplane failure (ground maneuvering capabilities, especially long aeroplanes, malfunctioning of nose-gear steering, engine, brakes);

b) Adverse surface conditions (standing water, friction coefficient);

c) Loss of the turn pad visual guidance (markings and lights inadequately maintained); and

d) Human Factors, including incorrect application of the 180-degree procedure (nose-wheel steering, asymmetric thrust, differential breaking).

Note. — No turn pad excursions with passenger injuries have so far been reported. Nevertheless, an aeroplane disabled on a turn pad can have an impact on runway closure.

Potential solutions

2.4.4 The ground maneuvering capabilities available from aircraft manufacturers are one of the key factors to be considered in order to determine whether an existing turn pad is suitable for a particular aeroplane. The speed of the maneuvering aeroplane is also a factor.

Note. — Relevant information is typically available in the aircraft characteristics for airport planning manual of aircraft manufacturers.

2.4.5 For a specific aeroplane, it may be permissible to operate on a runway turn pad not provided in accordance with Aerodrome Standards Manual specifications, considering:

a) The specific ground maneuvering capability of the specific aeroplane (notably the maximum effective steering angle of the nose landing gear);

b) The provision for adequate clearances;

c) The provision for appropriate marking and lighting;

d) The provision of shoulders;

e) The protection from jet blast; and

f) If relevant, protection of the ILS.

In this case, the turn pad can have a different shape. The objective is to enable the aeroplane to align on the runway while losing the least runway length as possible. The aeroplane is supposed to taxi at slow speed.

Note. — Further advisory material on turn pads may be available from the aircraft manufacturers.

2.5 Runway Strips

2.5.1 Runway strip dimensions

Introduction

2.5.1.1 A runway strip is an area enclosing a runway and any associated stop way. Its purpose is to:

a) Reduce the risk of damage to an aeroplane running off the runway by providing a cleared and graded area which meets specific longitudinal and transverse slopes, and bearing strength requirements; and

b) Protect an aeroplane flying over it during landing, balked landing or take-off by providing an area which is cleared of obstacles, except for permitted aids to air navigation.

2.5.1.2 Particularly, the graded portion of the runway strip is provided to minimize the damage to an aeroplane in the event of a veer-off during a landing or take-off operation. It is for this reason that objects should be located away from this portion of the runway strip unless they are needed for air navigation purposes and are frangibly mounted.

Note. — The dimensions and characteristics of the runway strip are detailed in Aerodrome Standards Manual, Section 7.2.3.4, and Attachment A.

Challenges

2.5.1.3 Where the requirements on runway strips cannot be achieved, the available distances, the nature and location of any hazard beyond the available runway strip, the type of aeroplane and the level of traffic at the aerodrome should be reviewed. Operational restrictions may be applied to the type of approach and low visibility operations that fit the available ground dimensions, while also taking into account:

a) Runway excursion history;

b) Friction and drainage characteristics of the runway;

c) Runway width, length and transverse slopes;

d) Navigation and visual aids available;

e) Relevance in respect of take-off or aborted take-off and landing;

f) Scope for procedural mitigation measures; and

g) Accident report.

2.5.1.4 An analysis of lateral runway excursion reports shows that the causal factor in aeroplane accidents/incidents is not the same for take-off and for landing. Therefore, take-off and landing events may need to be considered separately.

Note.— Mechanical failure is a frequent accident factor in runway excursions during take-off, while hazardous meteorological conditions such as thunderstorms are more often present with landing accident/incidents. Brake failures or engine reverse thrust system malfunctions have also been factors in a significant number of landing veer- offs.

2.5.1.5 Lateral deviation from the runway centre line during a balked landing with the use of the digital autopilot as well as manual flight with a flight director for guidance have shown that the risk associated with the deviation of specific aeroplanes is contained within the OFZ.

Note.— Provisions on OFZ are given in Aerodrome Standards Manual, and in Circular 301, New Larger Aeroplanes — Infringement of the Obstacle Free Zone: Operational Measures and Aeronautical Study.

2.5.1.6 The lateral runway excursion hazard is clearly linked to specific aeroplane characteristics, performance/ handling qualities and controllability in response to such events as aeroplane mechanical failures, pavement contamination and crosswind conditions. This type of hazard comes under the category for which risk assessment is mainly based on flight crew/aeroplane performance and handling qualities. Certified limitations of the specific aeroplane is one of the key factors to be considered in order to ensure that this hazard is under control.

Potential solutions

2.5.1.7 Potential solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

a) Improving runway surface conditions and/or the means of recording and indicating rectification action, particularly for contaminated runways, having knowledge of runways and their condition and characteristics in precipitation;

b) Ensuring that accurate and up-to-date meteorological information is available and that information on runway conditions and characteristics is passed to flight crews in a timely manner, particularly when flight crews need to make operational adjustments;

c) Improving the aerodrome operator's knowledge of recording, prediction and dissemination of wind data, including wind shear, and any other relevant meteorological information, particularly when it is a significant feature of an aerodrome's climatology;

d) Upgrading the visual and instrument landing aids to improve the accuracy of aeroplane delivery at the correct landing position on runways; and

e) In consultation with aeroplane operators, formulating any other relevant aerodrome operating procedures or restrictions and promulgating such information appropriately.

2.5.2 Obstacles on runway strips

Introduction

2.5.2.1 An object located on a runway strip which may endanger aeroplanes is regarded as an obstacle, according to the definition of "obstacle" and should be removed, as far as practicable. Obstacles may be either naturally occurring or deliberately provided for the purpose of air navigation.

Challenges

2.5.2.2 An obstacle on the runway strip may represent either:

a) A collision risk for an aeroplane in flight or for an aeroplane on the ground that has veered off the runway; and

b) A source of interference to navigation aids.

Note 1.— Mobile objects that are beyond the OFZ (inner transitional surface) but still within the runway strip, such as vehicles and holding aeroplanes at runway-holding positions, or wing tips of aeroplanes taxiing on a parallel taxiway to the runway, should be considered.

Note 2. — Provisions on OFZ are given in Aerodrome Standards Manual, and in Circular 301.

Potential solutions

2.5.2.3 Potential solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

a) A natural obstacle should be removed or reduced in size wherever possible; alternatively, grading of the area allows reduction of the severity of damage to the aeroplane;

b) Other fixed obstacles should be removed unless they are necessary for air navigation, in which case they should be frangible and should be so constructed as to minimize the severity of damage to the aeroplane;

c) An aeroplane considered to be a moving obstacle within the runway strip should respect the requirement on the sensitive areas installed to protect the integrity of the ILS and should be subject to a separate safety assessment; and

Note.— Provisions on ILS critical and sensitive areas are given in Annex 10 — Aeronautical Telecommunications, Volume I — Radio Navigation Aids.

d) Visual and instrument landing aids may be upgraded to improve the accuracy of aeroplane delivery at the correct landing position on runways, and in consultation with aeroplane operators, any other relevant aerodrome operating procedures or restrictions may be formulated and such information promulgated appropriately.

3. Runway End Safety Area (RESA)

Introduction

3.1 A RESA is primarily intended to reduce the risk of damage to an aeroplane undershooting or overrunning the runway. Consequently, a RESA will enable an aeroplane overrunning to decelerate, and an aeroplane undershooting to continue its landing.

Challenges

3.2 Identification of specific issues related to runway overruns and undershoots is complex. There are a number of variables that have to be taken into account, such as prevailing meteorological conditions, the type of aeroplane, the load factor, the available landing aids, runway characteristics, the overall environment, as well as Human Factors.

3.3 When reviewing the RESA, the following aspects have to be taken into account:

a) The nature and location of any hazard beyond the runway end;

b) The topography and obstruction environment beyond the RESA;

c) The type of aeroplanes and level of traffic at the aerodrome and actual or proposed changes to either;

d) Overrun/undershoot causal factors;

e) Friction and drainage characteristics of the runway which have an impact on runway susceptibility to surface contamination and aeroplane braking action;

f) Navigation and visual aids available;

g) Type of approach;

h) Runway length and slope, in particular, the general operating length required for take-off and landing versus the runway distances available, including the excess of available length over that required;

I) The location of the taxiways and runways;

i) Aerodrome climatology, including predominant wind speed and direction and likelihood of wind shear; and

j) Aerodrome overrun/undershoot and veer-off history

Potential solutions

3.4 Potential solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

a) Restricting the operations during adverse hazardous meteorological conditions (such as thunderstorms);

b) Defining, in cooperation with aeroplane operators, hazardous meteorological conditions and other factors relevant to aerodrome operating procedures and publishing such information appropriately;

c) Improving an aerodrome's database of operational data, detection of wind data, including wind shear and other relevant meteorological information, particularly when it is a significant change from an aerodrome's climatology;

d) Ensuring that accurate and up-to-date meteorological information, current runway conditions and other characteristics are detected and notified to flight crews in time, particularly when flight crews need to make operational adjustments;

e) Improving runway surfaces in a timely manner and/or the means of recording and indicating necessary action for runway improvement and maintenance (e.g. friction measurement and drainage system), particularly when the runway is contaminated;

f) Removing rubber build-up on runways according to a scheduled time frame;

g) Repainting faded runway markings and replacing inoperative runway surface lighting identified during daily runway inspections;

h) Upgrading visual and instrument landing aids to improve the accuracy of aeroplane delivery at the correct landing position on runways (including the provision of ILSs);

i) Reducing declared runway distances in order to provide the necessary RESA;

j) Installing suitably positioned and designed arresting systems as a supplement or as an alternative to standard RESA dimensions when necessary (see Note 1);

k) Increasing the length of a RESA and/or minimizing the potential obstruction in the area beyond the RESA; and

Publishing provisions, including the provision of an arresting system, in the AIP.

Note 1. — Further guidance on arresting systems can be found in Aerodrome Standards Manual, Attachment A.

Note 2. — In addition to the AIP entry, information/instructions may be disseminated to local runway safety teams and others to promote awareness in the community.

4. Taxiways

4.1 General

Introduction

4.1.1 Taxiways are provided to permit the safe and expeditious surface movement of aeroplanes.

4.1.2 A sufficiently wide taxiway permits smooth traffic flow while facilitating aeroplane ground steering.

Note 1. — Guidance material is given in Doc 9157, Part 2 — Taxiways, Aprons and Holding Bays; Section 1.2 and Table 1-1 provide the formula for determining the width of a taxiway.

Note 2. — Particular care should be taken while maneuvering on taxiways having a width less than that specified in Aerodrome Standards Manual, to prevent the wheels of the aeroplane from leaving the pavement, while avoiding the use of large amounts of thrust that could damage taxiway lights and signs and cause erosion of the taxiway strip. Affected taxiways should be closely inspected, as appropriate, for the presence of debris that may be deposited while taxiing into position for take-off.

Challenges

4.1.3 The issue arises from a lateral taxiway excursion.

4.1.4 Causes and accident factors can include:

a) Mechanical failure (hydraulic system, brakes, nose-gear steering);

b) Adverse surface conditions (standing water and friction coefficient);

c) Loss of the taxiway centre line visual guidance (markings and light inadequately maintained);

d) Human Factors (including directional control, orientation error, pre-departure workload); and

e) Aeroplane taxi speed.

Note. — The consequences of a taxiway excursion are potentially disruptive. However, consideration should be given to the greater potential impact of deviation of a larger aeroplane in terms of blocked taxiways or disabled aeroplane removal.

4.1.5 Pilot precision and attention are key issues since they are heavily related to the margin between the outer main gear wheel and the taxiway edge.

4.1.6 Compatibility studies related to taxiway width and potential deviations can include:

a) The use of taxiway deviation statistics to calculate the taxiway excursion probability of an aeroplane depending on taxiway width. The impact of taxiway guidance systems and meteorological and surface conditions on taxiway excursion probability should be assessed whenever possible;

b) View of the taxiway from the cockpit, taking into account the visual reference cockpit cut-off angle and pilot eye height; and

c) The aeroplane outer main gear wheel span.

Potential solutions

4.1.7 Potential solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

a) The provision of taxiway centre line lights;

b) Conspicuous centre line marking;

c) The provision of on-board taxi camera systems to assist taxi guidance;

d) Reduced taxi speed;

e) The provision of taxi side-stripe markings;

f) Taxiway edge lights (inset or elevated);

g) Reduced wheel-to-edge clearance, using taxiway deviation data;

h) The use of alternative taxi routes; and

I) The use of marshaller services (follow-me guidance).

Note 1. — Taxi cameras are designed to ease the taxi and can assist the flight crew in preventing the wheels of the aeroplane from leaving the full-strength pavement during normal ground maneuvering.

Note 2. — Taxiways that are not provided with suitable shoulders may be restricted in operation.

4.1.8 Special attention should be given to the offset of centre line lights in relation to centre line markings, especially during winter conditions when distinguishing between markings and offset lights can be difficult.

4.1.9 Location and specifications for taxiway signs should be considered due to the engine location as well as the increased thrust in the aeroplane engines.

4.2 Taxiway curves

Introduction

4.2.1 Aerodrome Standards Manual, 7.2.9.6, contains provisions on taxiway curves. Additional guidance is included in Doc 9157, Part 2.

Challenges

4.2.2 Any hazard will be the result of a lateral taxiway excursion on a curved section.

4.2.3 The main causes and accident factors are the same as for a taxiway excursion on a straight taxiway section. The use of the cockpit-over-centerline steering technique on a curved taxiway will result in track-in of the main landing gear from the centre line. The amount of track-in depends on the radius of the curved taxiway and the distance from the cockpit to the main landing gear.

4.2.4 The consequences are the same as for lateral taxiway excursions on straight sections.

4.2.5 The required width of the curved portions of taxiways is related to the clearance between the outer main wheel and the taxiway edge on the inner curve. The hazard is related to the combination of the outer main gear wheel span and the distance between the nose gear/cockpit and the main gear. Consideration should be given to the effect on airfield signs and other objects nearby of jet blast from a turning aeroplane.

4.2.6 Certain aeroplanes may require wider fillets on curved sections or taxiway junctions.

Potential solutions

4.2.7 Potential solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

a) The widening of existing fillets or the provision of new fillets;

b) Reduced taxi speed;

c) The provision of taxiway centre line lights and taxi side-stripe markings (and inset taxiway edge lights);

d) Reduced wheel-to-edge clearance, using taxiway deviation data;

e) Pilot judgemental oversteering; and

f) Publication of provisions in the appropriate aeronautical documentation.

Note 1. — Taxi cameras are designed to ease the taxi and can assist the flight crew in preventing the wheels of the aeroplane from leaving the full-strength pavement during normal ground maneuvering.

Note 2. — Operations on taxiway curves that are not provided with suitable taxiway fillets should be restricted.

4.2.8 Special attention should be given to the offset of centre line lights in relation to centre line markings.

4.2.9 Location and specifications for taxiway signs should be considered due to the increase in the size of aeroplanes as well as the increased thrust in aeroplane engines.

5. Runway And Taxiway Minimum Separation Distances

Introduction

5.1 A minimum distance is provided between the centre line of a runway and the centre line of the associated parallel taxiway for instrument runways and non-instrument runways.

Note 1.— Doc 9157, Part 2, section 1.2, and Table 1-5, clarify that the runway/taxiway separation is based on the principle that the wing tip of an aeroplane taxiing on a parallel taxiway should be clear of the runway strip.

Note 2.— It is permissible to operate with lower separation distances at an existing aerodrome if a safety assessment indicates that such lower separation distances would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes. See Note 2 to Table 7-1, and Notes 2, 3 and 4 to 7.2.9.8 of Aerodrome Standards Manual

Note 3. — Doc 9157, Part 2, has related guidance in 1.2.46 to 1.2.49. Furthermore, attention is drawn to the need to provide adequate clearance at an existing aerodrome in order to operate an aeroplane with the minimum possible risk.

Challenges

5.2 The potential issues associated with runway/parallel taxiway separation distances are:

a) The possible collision between an aeroplane running off a taxiway and an object (fixed or mobile) on the aerodrome;

b) The possible collision between an aeroplane leaving the runway and an object (fixed or mobile) on the aerodrome or the risk of a collision of an aeroplane on the taxiway that infringes on the runway strip; and

c) Possible ILS signal interference due to a taxiing or stopped aeroplane.

5.3 Causes and accident factors can include:

a) Human Factors (crew, ATS);

b) Hazardous meteorological conditions (such as thunderstorms and wind shear);

c) Aeroplane mechanical failure (such as engine, hydraulic system, flight instruments, control surfaces and autopilot);

d) Surface conditions (standing water and friction coefficient);

e) Lateral veer-off distance;

f) Aeroplane position relative to navigation aids, especially ILS; and

g) Aeroplane size and characteristics (especially wingspan).

Note. — Common accident/incident databases deal with lateral runway excursions but do not include accident reports relative to in-flight collisions and ILS signal interference. Therefore, the causes and accident factors specific to the local environment and identified above for runway separation issues are mainly supported by local aerodrome experience. The huge variety and complexity of accident factors for collision risk should be emphasized.

5.4 Potential solutions

Potential solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

a) Place a restriction on the wingspan of aeroplanes using the parallel taxiway or on the runway, if continued unrestricted taxiway or runway operation is desired;

b) Consider the most demanding length of aeroplane that can have an impact on runway/taxiway separation and the location of holding positions (ILS);

c) Change taxiway routing so that the required runway airspace is free of taxiing aeroplanes; and

d) Employ tactical control of aerodrome movements.

Note. — When A-SMGCS is available, it can be utilized as a supporting means to the proposed solutions especially in low visibility conditions.

6. Taxiway And Taxilane Minimum Separation Distances

Introduction

6.1 Taxiway to object separation

The taxiway minimum separation distances provide an area clear of objects that may endanger an aeroplane.

Note 1. — See Aerodrome Standards Manual, 7.2.9.

Note 2. — Additional guidance material on minimum separation distances is included in Doc 9157, Part 2.

6.2 Parallel taxiway separation

The minimum separation distance is equal to the wingspan plus maximum lateral deviation plus increment.

Note 1. — Information is given in Doc 9157, Part 2.

Note 2. — If the minimum required distance between the centre lines of two parallel taxiways is not provided, it is permissible to operate with lower separation distances at an existing aerodrome if a compatibility study, which may include a safety assessment, indicates that such lower separation distances would not adversely affect the safety or significantly affect the regularity of aeroplane operations.

Challenges

6.3 Taxiway to object separation

The separation distances during taxiing are intended to minimize the risk of a collision between an aeroplane and an object (taxiway/object separation, taxi lane/object separation).

Note. — Taxiway deviation statistics can be used to assess the risk of a collision between two aeroplanes or between an aeroplane and an object.

6.4 The causes and accident factors can include:

a) Mechanical failure (hydraulic system, brakes, nose-gear steering);

b) Conditions (standing water and friction coefficient);

c) Human Factors (directional control, temporary loss of orientation resulting in aeroplanes being incorrectly positioned, etc.).

6.5 Parallel taxiway separation

The potential issues associated with parallel taxiway separation distances are:

a) The probable collision between an aeroplane running off a taxiway and an object (aeroplane on parallel taxiway); and

b) An aeroplane running off the taxiway and infringing the opposite taxiway strip.

6.6 Causes and accident factors can include:

- **a)** Human Factors (crew, ATS);
- **b)** Hazardous meteorological conditions (such as reduced visibility);
- **c)** Aeroplane mechanical failure (such as engine, hydraulic system, flight instruments, control surfaces, autopilot);
- **d)** Surface conditions (standing water and friction coefficient);
- **e)** Lateral veer-off distance; and
- **f)** Aeroplane size and characteristics (especially wingspan).

Potential solutions

6.7 Taxiway to object separation

Potential solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

- **a)** The use of reduced taxiing speed;
- **b)** The provision of taxiway centre line lights;
- **c)** The provision of taxi side-stripe markings (and inset taxiway edge lights);
- **d)** The provision of special taxi routing for larger aeroplanes;
- **e)** Restrictions on aeroplanes (wingspan) allowed to use parallel taxiways during the operation of a specific aeroplane;
- **f)** Restrictions on vehicles using service roads adjacent to a designated aeroplane taxi route;
- **g)** The use of “follow-me” guidance;
- **h)** The provision of reduced spacing between taxiway centre line lights; and
- **I)** The provision of straightforward taxiway naming and ground routings with respect to the hazard of taxiway veer-offs.

Note. — Special attention should be given to the offset of centre line lights in relation to centre line markings. Especially during winter conditions, distinguishing between markings and offset lights can be difficult.

6.8 Parallel taxiway separation

Potential solutions can be developed by providing the following facilities, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

a) Place a restriction on the wingspan of aeroplanes using the parallel taxiway if continued unrestricted taxiway operation is desired;

b) Consider the most demanding length of aeroplane that can have an impact on a curved taxiway section;

c) Change taxiway routing;

d) Employ tactical control of aerodrome movements;

e) Use of reduced taxiing speed;

f) Provision of taxiway centre line lights;

g) Provision of taxi side-stripe markings (and inset taxiway edge lights);

h) Use of “follow-me” guidance;

I) Provision of reduced spacing between taxiway centre line lights; and

j) Provision of straightforward taxiway naming and ground routings with respect to the hazard of taxiway veer- offs.

7. Taxiways On Bridges

Introduction

7.1 The width of that portion of a taxiway bridge capable of supporting aeroplanes, as measured perpendicularly to the taxiway centre line, is normally not less than the width of the graded area of the strip provided for that taxiway, unless a proven method of lateral restraint is provided which is not hazardous for aeroplanes for which the taxiway is intended.

Note. — Aerodrome Standards Manual, section 7.2.9, and Doc 9157, Part 2, provide information on taxiways on bridges.

7.2 Access is to be provided for RFF vehicles to intervene, in both directions within the specified response time, with the largest aeroplane for which the taxiway is intended.

7.3 If aeroplane engines overhang the bridge structure, it may be necessary to protect the adjacent areas, below the bridge, from engine blast.

Challenges

7.4 The following hazards are related to the width of taxiway bridges:

a) Landing gear leaving the load-bearing surface;

b) Deployment of an escape slide beyond the bridge, in case of an emergency evacuation;

c) Lack of maneuvering space for RFF vehicles around the aeroplane;

d) Jet blast to vehicles, objects or personnel below the bridge;

e) Structural damage to the bridge due to the aeroplane mass exceeding the bridge design load; and

f) Damage to the aeroplane due to insufficient clearance of engines, wings or fuselage from bridge rails, lights or signs.

7.5 The causes and accident factors can include:

a) Mechanical failure (hydraulic system, brakes, nose-gear steering);

b) Surface conditions (standing water and friction coefficient);

c) Human Factors (directional control, disorientation, pilot’s workload);

d) The position of the extremity of the escape slides; and

e) Undercarriage design.

7.6 The main causes of and accident factors for jet blast effect below the bridge are:

a) Power plant characteristics (engine height, location and power);

b) Bridge blast protection width; and

c) Taxiway centre line deviation factors (see taxiway excursion hazard in 4.1.4).

7.7 In addition to the specifications of Section 5.5, Safety Assessments for Aerodromes, hazard prevention mechanisms should be based on the critical dimensions of the aeroplane in relation to the bridge width.

Potential solutions

7.8 Potential solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

a) Where feasible, strengthen existing bridges;

b) Provide a proven method of lateral restraint to prevent the aeroplane from veering off the full bearing strength of the taxiway bridge;

c) Provide an alternative path/bridge for RFF vehicles or implement emergency procedures to taxi the aeroplane away from such taxi bridges;

d) Implement jet blast procedures to reduce the effects of jet blast on the undercroft; and

e) Use the vertical clearance provided by high wings.

7.9 The RFF vehicles need to have access to both sides of the aeroplane to fight any fire from the best position, allowing for wind direction as necessary. In case the wingspan of the considered aeroplane exceeds the width of the bridge, another bridge nearby can be used for access to the “other” side of an aeroplane rather than an increased bridge width; in this case the surface of the bypass routes are at least stabilized where it is unpaved.

Note. — The use of another bridge as mentioned in 7.9 is practicable only where bridges are paired (parallel taxiways) or when there is a service road in the surrounding area. In any case, the bridge strength is to be checked, depending on the aeroplane planning to use it.

7.10 The protection from jet blast of vehicular traffic under/near the bridge is to be studied, consistent with the overall width of the taxiway and its shoulders.

7.11 The bridge width should be compatible with the deployment of escape slides. If this is not the case, a safe and quick escape route should be ensured.

Note. — Curved centre lines should be avoided leading up to, on and when leaving the bridge.

8. Taxiway Shoulders

Introduction

8.1 Taxiway shoulders are intended to protect an aeroplane operating on the taxiway from FOD ingestion and to reduce the risk of damage to an aeroplane running off the taxiway.

8.2 The taxiway shoulder dimensions are based on current information regarding the width of the outer engine exhaust plume for breakaway thrust. Furthermore, the surface of taxiway shoulders is prepared so as to resist erosion and ingestion of the surface material by aeroplane engines.

Note. — Guidance material is contained in Doc 9157, Part 2.

Challenges

8.3 The factors leading to reported issues are:

a) Power plant characteristics (engine height, location and power);

b) Taxiway shoulder width, the nature of the surface and its treatment; and

c) Taxiway centre line deviation factors, both from the expected minor wander from tracking error and the effect of main gear track-in in the turn area while using the cockpit-over-centre line-steering technique.

Potential solutions

8.4 Potential solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

a) Excursion on the taxiway shoulder. The thickness and composition of shoulder pavements should be such as to withstand the occasional passage of the aeroplane operating at the aerodrome that has the most demanding impact on pavement loading, as well as the full load of the most demanding aerodrome emergency vehicle. The impact of an aeroplane on pavements should be assessed and, if required, existing taxiway shoulders (if allowed to be used by these heavier aeroplanes) may need to be strengthened by providing a suitable overlay.

Note. — Surface materials of an asphalt paved shoulder of 10 to 12.5 cm thick (the higher thickness where wide bodied aircraft jet blast exposure is likely) and firmly adhering to the underlying pavement layers (by way of a tack coat or other means that assures a well-bonded interface between the surface layer and the underlying strata) is generally a suitable solution.

b) Jet blast. Information on engine position and jet blast velocity contour at breakaway thrust mode is used to assess jet blast protection requirements during taxiing operations. A lateral deviation from the taxiway centre line should be taken into account, particularly in the case of a curved taxiway and the use of the cockpit-over- centre-line steering technique. The effect of jet blast can also be managed by the use of thrust management of the engines (in particular for four-engine aircraft).

Note. — Further information concerning aeroplane characteristics including the margins between the outer engine axis and the edge of the shoulder, and the distance from the outer engine to the ground can be found in the manufacturer's aircraft characteristics for airport planning manual.

c) RFF vehicles. Operational experience with current aeroplanes on existing taxiways suggests that a compliant overall width of the taxiway and its shoulders permits the intervention of aeroplanes by occasional RFF vehicle traffic.

Note 1.— For NLA, the longer upper-deck escape chutes may reduce the margin between the shoulder edge and the extremity of these escape slides and reduce the supporting surface available to rescue vehicles.

Note 2. — In some cases, the bearing strength of the natural ground may be sufficient, without special preparation, to meet the requirements for shoulders. (Doc 9157, Part 1, provides further design criteria).

9. Clearance Distance On Aircraft Stands

Introduction

9.1 Aerodrome Standards Manual section 7.2.13.6, recommends the minimum distance between an aeroplane using the stand and an obstacle.

Note. — Doc 9157, Part 2, provides additional guidance on this subject.

Challenges

9.2 The possible reasons for collision between an aeroplane and an obstacle on the apron or holding bay can be listed as:

a) Mechanical failure (e.g. hydraulic system, brakes, nose-gear steering);

b) Surface conditions (e.g. standing water, ice-covered surfaces, friction coefficient);

c) Loss of the visual taxi guidance system (docking system out of service); and

d) Human Factors (directional control, orientation error).

9.3 The probability of a collision during taxiing depends more on Human Factors than on aeroplane performance. Unless technical failure occurs, aeroplanes will respond reliably to directional inputs from the pilot when taxiing at the usual ground speed. Nevertheless, caution should be exercised with regard to the impact of aeroplanes with larger wingspans.

Potential solutions

9.4 Potential solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

a) Appropriate condition of marking and signage;

b) Apron stand lead-in lights;

c) Azimuth guidance as a visual docking system;

d) Appropriate training of operating and ground personnel should be ensured by an aerodrome operator;

e) Operational restrictions (e.g. adequate clearances before and behind parked or holding aeroplanes due to the increased length of aeroplanes);

f) Temporarily downgraded adjacent aircraft stands;

g) Towing the aeroplane on/from the stand;

h) Use of remote/cargo stands or "roll-through" parking positions for handling the aeroplane;

I) Publication of procedures in the appropriate aeronautical documentation (i.e. closing or rerouting of taxilanes behind parked aeroplanes);

J) Advanced visual guidance system;

k) Marshaller guidance;

l) Enhancing apron lighting levels in low visibility conditions; and

m) Use of the vertical clearances provided by high wings.

10. Pavement Design

Introduction

10.1 To facilitate flight planning, various aerodrome data are required to be published, such as data concerning the strength of pavements, which is one of the factors required to assess whether the aerodrome can be used by an aeroplane of a specific all-up mass.

Note.— The aircraft classification number/pavement classification number (ACN/PCN) method is used for reporting pavement strength. Requirements are given in Aerodrome Standards Manual, section 6.2.6, and Attachment A, section 20. Doc 9157, Part 3 — Pavements, contains guidance on reporting pavement strength using the ACN/PCN method.

10.2 The increased mass and/or gear load of the aeroplanes may require additional pavement support. Existing pavements and their maintenance will need to be evaluated for adequacy due to differences in wheel loading, tire pressure, and undercarriage design. Bridge, tunnel and culvert load-bearing capacities are a limiting factor, requiring some operational procedures.

Potential solutions

10.3 Potential solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

a) Restrictions on aeroplanes with higher ACNs on specific taxiways, runway bridges or aprons; or

b) Adoption of adequate pavement maintenance programmes.

APPENDIX F

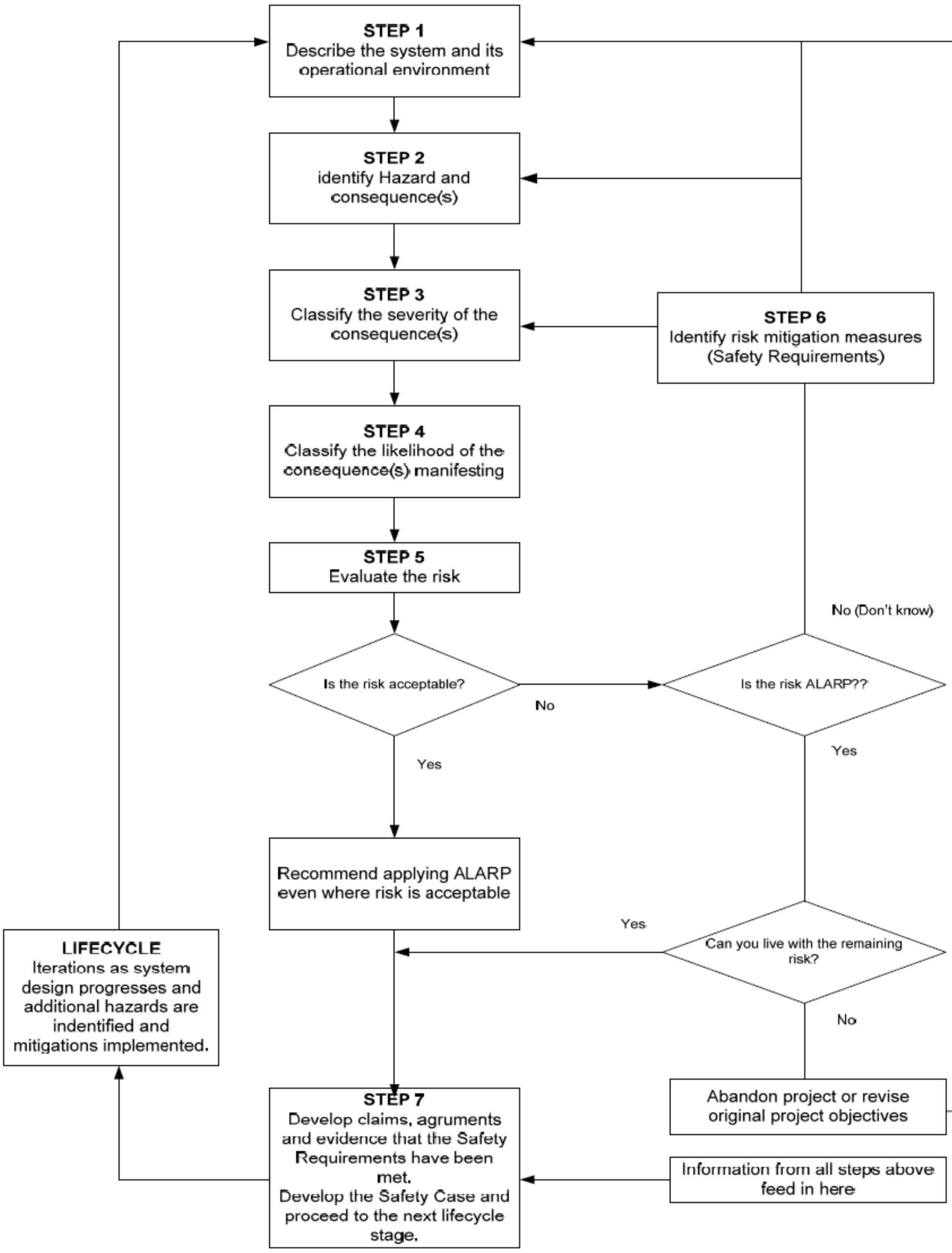
CHECKSHEET FOR AERONAUTICAL STUDY

Note: The purpose of this Appendix A is to provide aerodrome operators with a suggested check sheet for reviewing of an aeronautical study. Aerodrome operators may use this check sheet as a guide for development of an Aeronautical study tailored to his individual situation.

The suggested check sheet for reviewing of an aeronautical study is as shown below:

CHECKSHEET FOR AERONAUTICAL STUDY	YES	NO	REMARKS
1. Aim of the study including Address, safety concerns, identify safety measures, and make reference to specific SARPs in ASM;	☐	☐	
2. Consultation with stakeholders, senior management team and divisions/departments affected	☐	☐	
3. The study is approved by a senior executive of the organization	☐	☐	
4. Background information on the current situation;	☐	☐	
5. Proposed date for complying with SARPs, if the deviation is due to development of the aerodrome;	☐	☐	
6. Safety assessment including (a) identification of hazards and consequences, and (b) risk management;	☐	☐	
7. The safety assessment used in the study (e.g. hazard log, risk probability and severity, risk assessment matrix, risk tolerability and risk control/mitigation;	☐	☐	

8. Recommendation (including operating procedures/restrictions or other measures to address safety concerns) of the aeronautical study and how the proposed deviation will not degrade the level of safety;	☐	☐	
9. Estimation of the effectiveness of each recommendation listed in the aeronautical study;	☐	☐	
10. Notification procedure including process flow, time frame and the publication used to promulgate the deviation;	☐	☐	
11. Conclusion of the study;	☐	☐	
12. Monitoring of the deviation; and	☐	☐	
13. Notification to the Authority once the temporary deviation has been corrected.	☐	☐	


STEP 1
Describe the system and its operational environment
STEP 2
identify Hazard and consequence(s)
STEP 3
Classify the severity of the consequence(s)
STEP 4
Classify the likelihood of the consequence(s) manifesting
STEP 5
Evaluate the risk
STEP 6
Identify risk mitigation measures (Safety Requirements)
Is the risk acceptable?
No
Yes
Is the risk ALARP??
No (Don't know)
Yes
Recommend applying ALARP even where risk is acceptable
Can you live with the remaining risk?
Yes
No
Abandon project or revise original project objectives
LIFECYCLE
Iterations as system design progresses and additional hazards are indentified and mitigations implemented.
STEP 7
Develop claims, agruments and evidence that the Safety Requirements have been met.
Develop the Safety Case and proceed to the next lifecycle stage.
Information from all steps above feed in here

APPENDIX G

HAZARD LOG

***Note**: The purpose of this Appendix B is to provide aerodrome operator with suggested hazard log safety assessment of an aeronautical study. Aerodrome operators may use this log as a guide to formulate his hazard log. This log should be constantly updated throughout the aeronautical study life-cycle.*

A sample hazard log for safety assessment of an aeronautical study is as shown below:

S/N	Type of Hazard and operation	Hazard & Description	Consequences Identified	Risk Index	Risk Tolerability	Risk Control/ Mitigation	Residual Risk Index	Residual Risk Tolerability	Action, If any to further reduce risk(s) and the resulting risk index and residual risk tolerability
1	Aircraft Operation	Operation of code 4F aircraft in (name of airport) code 4E airport using runway for landing and take-off	- wing tip collision at (parking bay number) - loss of control of aircraft during pushback/ towing operations	3C	Tolerable	- Use of wing walkers - Aircraft to taxi at (speed value) - Training of staff for pushback towing operations -Restrictions on other aircraft movements within (parking bay number)	2D	Acceptable	- Conduct trials to study the effectiveness of the implementation - Resulting risk index 2E - Residual risk tolerability: Acceptable

ATTACHMENT A

AEROPLANE PHYSICAL CHARACTERISTICS

This attachment lists aeroplane characteristics that may have an impact on the relevant aerodrome characteristics, facilities and services in the movement area.

1. FUSELAGE LENGTH

The fuselage length may have an impact on:

a) The dimensions of the movement area (taxiway, holding bays and aprons), passenger gates and terminal areas;

b) The aerodrome category for RFF;

c) Ground movement and control (e.g. reduced clearance behind a longer aeroplane holding at an apron or a runway/intermediate holding position to permit the passing of another aeroplane);

d) De-icing facilities; and

e) Clearances at the aircraft stand.

2. FUSELAGE WIDTH

The fuselage width is used to determine the aerodrome category for RFF.

3. DOOR SILL HEIGHT

The door sill height may have an impact on:

a) The operational limits of the air bridges;

b) Mobile steps;

c) Catering trucks;

d) Persons with reduced mobility; and

e) Dimensions of the apron.

4. **AEROPLANE NOSE CHARACTERISTICS**

The aeroplane nose characteristics may have an impact on the location of the runway-holding position of the aeroplane which should not infringe the OFZ.

5. TAIL HEIGHT

The tail height may have an impact on:

a) The location of the runway-holding position;

b) ILS critical and sensitive areas: In addition to the tail height of the critical aeroplane, tail composition, tail position, fuselage height and length can have an effect on ILS critical and sensitive areas;

c) The dimensions of aeroplane maintenance services;

d) Aeroplane parking position (in relation to aerodrome OLS);

e) Runway/parallel taxiway separation distances; and

f) The clearance of any aerodrome infrastructure or facilities built over stationary or moving aeroplanes.

6. WINGSPAN

The wingspan may have an impact on:

a) Taxiway/taxilane separation distances (including runway/taxiway separation distances);

b) The dimensions of the OFZ;

c) The location of the runway-holding position (due to the impact of the wingspan on OFZ dimensions);

d) The dimensions of aprons and holding bays;

e) Wake turbulence;

f) Gate selection;

g) Aerodrome maintenance services around the aeroplane; and

h) Equipment for disabled aeroplane removal.

7. WING TIP VERTICAL CLEARANCE

The wing tip vertical clearance may have an impact on:

a) Taxiway separation distances with height-limited objects;

b) Apron and holding bay clearances with height-limited objects;

c) Aerodrome maintenance services (e.g. snow removal);

d) Airfield signage clearances; and

e) Service road locations.

8. COCKPIT VIEW

The relevant geometric parameters to assess the cockpit view are cockpit height, cockpit cut-off angle and the corresponding obscured segment. The cockpit view may have an impact on:

a) Runway visual references (aiming point);

b) Runway sight distance;

c) Taxiing operations on straight and curved sections;

d) Markings and signs on runways, turn pads, taxiways, aprons and holding bays;

e) Lights: in low visibility conditions, the number and spacing of visible lights when taxiing may depend on the cockpit view; and

f) Calibration of PAPI/VASIS (pilot eye height above wheel height on approach).

Note. — Cockpit view with reference to the obscured segment is also affected by the attitude of the aeroplane on approach.

9. DISTANCE FROM THE PILOT'S EYE POSITION TO THE NOSELANDING GEAR

The design of taxiway curves is based on the cockpit-over-centre-line concept. The distance from the pilot's eye position to the nose landing gear is relevant for:

a) Taxiway fillets (wheel track);

b) The dimensions of aprons and holding bays; and

c) The dimensions of turn pads.

10. LANDING GEAR DESIGN

The aeroplane landing gear design is such that the overall mass of the aeroplane is distributed so that the stresses transferred to the soil through a well-designed pavement are within the bearing capacity of the soil. The landing gear layout also has an effect on the maneuverability of the aeroplane and the aerodrome pavement system.

11. OUTER MAIN GEAR WHEEL SPAN

The outer main gear wheel span may have an impact on:

a) Runway width;

b) The dimensions of turn pads;

c) Taxiway width;

d) Taxiway fillets;

e) The dimensions of aprons and holding bays; and

f) The dimension of the OFZ.

12. WHEELBASE

The wheelbase may have an impact on:

a) The dimensions of turn pads;

b) Taxiway fillets;

c) The dimensions of aprons and holding bays; and

d) Terminal areas and aeroplane stands.

13. GEAR STEERING SYSTEM

The gear steering system may have an impact on the dimensions of turn pads and the dimensions of aprons and holding bays.

14. MAXIMUM AEROPLANE MASS

The maximum mass may have an impact on:

a) The mass limitation on existing bridges, tunnels, culverts and other structures under runways and taxiways;

b) Disabled aeroplane removal;

c) Wake turbulence; and

d) Arresting systems when provided as an element of kinetic energy.

15. LANDING GEAR GEOMETRY, TIRE PRESSURE AND AIRCRAFT CLASSIFICATION NUMBER (ACN) VALUES

Landing gear geometry, tire pressure and ACN values may have an impact on the airfield pavement and associated shoulders.

16. ENGINE CHARACTERISTICS

16.1 The engine characteristics include engine geometry and engine airflow characteristics, which may affect aerodrome infrastructure as well as ground handling of the aeroplane and operations in adjacent areas which are likely to become affected by jet blast.

16.2 The engine geometry aspects are:

a) The number of engines;

b) The location of engines (span and length);

c) The vertical clearance of engines; and

d) The vertical and horizontal extent of possible jet blast or propeller wash.

16.3 The engine airflow characteristics are:

a) Idle, breakaway and take-off thrust exhaust velocities;

b) Thrust reverser fitment and flow patterns; and

c) Inlet suction effects at ground level.

16.4 The engine characteristics may be relevant for the following aerodrome infrastructure and operational aspects:

a) Runway shoulder width and composition (jet blast and ingestion issues during take-off and landing);

b) Shoulder width and composition of runway turn pads;

c) Taxiway shoulder width and composition (jet blast and ingestion issues during taxiing);

d) Bridge width (jet blast under the bridge);

e) The dimensions and location of blast protection fences;

f) The location and structural strength of signs;

g) The characteristics of runway and taxiway edge lights;

h) The separation between aeroplanes and adjacent ground service personnel, vehicles or passengers;

I) The design of engine run-up areas and holding bays;

j) The design and use of functional areas adjacent to the maneuvering area;

k) The design of air bridges; and

l) The location of refueling pits on the aircraft stand.

17. MAXIMUM PASSENGER- AND FUEL-CARRYING CAPACITY

Maximum passenger- and fuel-carrying capacity may have an impact on:

a) Terminal facilities;

b) Fuel storage and distribution;

c) Aerodrome emergency planning;

d) Aerodrome rescue and firefighting; and

e) Air bridge loading configuration.

18. FLIGHT PERFORMANCE

Flight performance may have an impact on:

a) Runway width;

b) Runway length;

c) The OFZ;

d) Runway/taxiway separation;

e) Wake turbulence;

f) Noise; and

g) Aiming point marking.

ATTACHMENT B:

AEROPLANE GROUND SERVICING REQUIREMENTS

The following list of aeroplane ground servicing characteristics and requirements may affect the available aerodrome infrastructure. This list is not exhaustive; additional items may be identified by the stakeholders involved in the compatibility assessment process:

a) Ground power;

b) Passengers embarking and disembarking;

c) Cargo loading and unloading;

d) Fueling;

e) Pushback and towing;

f) Taxiing and marshalling;

g) Aeroplane maintenance;

h) RFF;

i) Equipment areas;

j) Stand allocation; and

k) Disabled aircraft removal.