Brunei Department of Civil Aviation

Negara Brunei Darussalam

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Brunei Aviation Requirements

BAR 14 Volume I - Aerodromes

Table of Contents

Abbreviations and Symbols

Abbreviations

ACN†	Aircraft classification number
ACR††	Aircraft classification rating
ADP	Airside driver permit
AIP	Aeronautical information publication
APAPI	Abbreviated precision approach path indicator
aprx	Approximately
ARIWS	Autonomous runway incursion warning system
ASDA	Accelerate-stop distance available
ATS	Air traffic services
AT-VASIS	Abbreviated T visual approach slope indicator system
C	Degree Celsius
CBR	California bearing ratio
cd	Candela
CIE	Commission Internationale de l'Éclairage
cm	Centimetre
CRC	Cyclic redundancy check
DME	Distance measuring equipment
E	Modulus of elasticity
FOD	Foreign object debris
ft	Foot
ILS	Instrument landing system
IMC	Instrument meteorological conditions
K	Degree Kelvin
kg	Kilogram
km	Kilometre
km/h	Kilometre per hour
kt	Knot
L	Litre
LCFZ	Laser-beam critical flight zone
LDA	Landing distance available
LFFZ	Laser-beam free flight zone
LSFZ	Laser-beam sensitive flight zone
m	Metre
max	Maximum
MLS	Microwave landing system

Abbreviations

mm	Millimetre
mnm	Minimum
MN	Meganewton
MPa	Megapascal
MSL	Mean sea level
NFZ	Normal flight zone
NM	Nautical mile
NU	Not usable
OCA/H	Obstacle clearance altitude/height
OFZ	Obstacle free zone
OLS	Obstacle limitation surface
OMGWS	Outer main gear wheel span
PAPI	Precision approach path indicator
PCN†	Pavement classification number
PCR††	Pavement classification rating
RESA	Runway end safety area
RFF	Rescue and firefighting
RVR	Runway visual range
SMS	Safety management system
TODA	Take-off distance available
TORA	Take-off run available
T-VASIS	T visual approach slope indicator system
VMC	Visual meteorological conditions
VOR	Very high frequency omnidirectional radio range
WHMP	Wildlife hazard management programme
WIP	Work in progress

Symbols

°	Degree
=	Equals
′	Minute of arc
μ	Friction coefficient
>	Greater than
<	Less than
%	Percentage
±	Plus or minus

† Applicable until 27 November 2024.
†† Applicable as of 28 November 2024.

Amendment Records

The amendments listed below have been incorporated into this BAR 14 Volume I

Amendment no.	Version no.	Subject	Source	Section affected	Entered by (Date)	Approved by (Date)	Effective Date
-	01	Original version	ICAO Annex 14 Vol.I 7th Edition	All	UKCAAi (2017)	(2017)	(1 Feb 2017)
1	02	Table of Contents; Amendment Records; Control of This Document; General Definition; Applicability; Purpose; ICAO Annex 14 Compliance; a consequential amendment, as a result of the restructuring of Annex 15 and the introduction of PANS-AIM (Doc 10066); relating to change of references; safeguarding; data quality requirements and performance-based data error detection requirements;	ICAO Annex 14 Vol.I 8th Edition (Arising from Amendment 14 to ICAO Annex 14; include provisions applicable after Nov 2018)	DC.1.1; DC.1.2; 1.1; 1.2; 1.3; 1.4.1; 1.4.2; 1.6.3 Table 1; 1.7.1 l); 1.7.1 r); 1.9; 1.10; 1.11; 1.12; 1.13; 1.14; 1.15; 2.1.1; 2.1.2; 2.1.4; 2.3.3; 2.3.5; 2.3.8; 2.3.8 b); 2.3.8 c); 3.1.10; 3.2.1; 3.2.2; 3.2.4; 3.2.5; 3.2.6; 3.3.6 Table; 3.4.3; 3.4.4; 3.9.3 Table; 3.9.4; 3.9.9 Table; 3.10; 3.10.1; 3.10.2; 3.11.4; Chapter 4 Table 8; 9.4.1; 9.12; 10.2.8; 10.3.4; 13.3; Appendix I (3); Appendix II (3); Appendix XII	Pg Rasman bin Pg Sulaiman 30 Jan 2019	13 March 2019 (Aviation Safety Circular 1/2019)	13 March 2019

Amendment no.	Version no.	Subject	Source	Section affected	Entered by (Date)	Approved by (Date)	Effective Date
2	2.1	Table of Content Page Numbers; Added 'Recommendation' for Recommended Practices; Chapter 1 General Standard and Recommended Practices; Exemption; Chapter 2 Aerodrome Certification; Chapter 3 Physical Characteristics; Chapter 5 Obstacle Restriction and Removal; Visual Aids for Navigation, Denoting Obstacles and Restricted Areas; Chapter 9 Aerodrome Operational Services, Equipment & Installation; Chapter 10 Aerodrome Maintenance; Chapter 11 Aviation Fuel; Chapter 13 Safeguarding; Birdstrike Report Form	ICAO Annex 14 Vol.I 8th Edition (July 2018) (Arising from Amendment 14 to ICAO Annex 14: include provisions applicable after Nov 2018; include further information of aerodrome certification process)	1.4.1, 1.4.2, 1.4.3;1.6.4; 1.6.5; 2.1; 2.1.1; 2.1.2 (a) (b) (c); 2.1.3; 2.1.3 (d); 2.1.4 (a) (b) (c); 2.1.12 (a) (b); 3.1.18; 3.1.19; 3.2.3; 3.4.15; 3.5.7; 3.6.6; 3.9.11; 3.9.18; 3.11.5; 4.2.6; 5.1.3.3; 5.2.1.4; 5.2.1.7; 5.2.4.10; 5.2.13.11; 5.2.13.12; 5.2.17; 5.3.1.2; 5.3.4.8; 5.3.4.9; 5.4.4.4; 9.1.16; 9.4.1; 9.4.2; 9.4.4; 9.6.1; 9.6.2; 9.7; 9.8.3; 9.9.6; 9.11; 9.12; 10.5.13; 13.1; 13.2; Appendix I; Appendix III (1) (2) & (5); Appendix IV;	Pg Rasman bin Pg Sulaiman 1 Dec 2019	26 Dec 2019 (Aviation Safety Circular 4/2019)	01 Dec 2019
3	3.0	Revised definition of precision approach runway category III; airport master plan; aeroplanes equipped with folding wing tips; reporting of pavement strength ACR/PCR; reporting of works in progress on movement areas; width of clearways;	ICAO Annex 14 Vol.I 9th Edition (July 2022) (Arising from Amendment 15, 16 & 17 to ICAO Annex 14 Vol I)	DC.1.2; Revised Reference Document; 1.1; 1.2.2; 1.2.3;1.2.5;1.3.1; 1.3.2;1.7;1.8; 1.9; 1.9.4 (Table 1 & Table 2); 1.10;1.11;1.12;1.13;1.14;1.15;1.16;1.17;1.18;1.19; 1.20;1.21;1.22;1.23;1.24;1.25;1.2	Pg Rasman bin Pg Sulaiman (Q2 2025)	Subject to associated Aviation Safety Circular	30 Sept 2025

		standardized taxiway nomenclature; runway guard lights; no-entry bars; runway status lights; minimum sizes of signs; autonomous aircraft detection system; visual aids for denoting closed runways and taxiways or part thereof; training of aerodrome personnel; procedures on management of wildlife, apron safety and establishment of airside driver permit; Rescue and fire fighting for general aviation; revised of aerodrome certification process; add references to DOC 9981 PANS-Aerodromes; Amendment concerning the use of an enhanced global reporting format for assessing and reporting runway surface conditions; Global Reporting Format applicability Date; RST establishment requirements from DOC 9981 PANS-Aerodromes Ch 8; Coordination between Air Traffic Service Provider and Aerodrome Authorities; Added notes for clarity. Amended national aviation act.	(CAO 2006 has been amended as Civil Aviation Act)	6;2.1;2.1.1;2.1.2; 2.1.5;2.1.8;2.1.1 2;2.2;2.2.1;2.2.3; 2.2.5;3.1.10;3.1. 23;3.4.6;3.6.3;3. 9;3.9.1;3.12.3;3. 12.6;3.12.8;3.12. 9;5.3.1.1;5.3.20; 5.3.20.1;5.3.23;5 .3.23.1;5.3.23.4; 5.3.23.5;5.3.23.6 ;5.3.23.10;5.3.29 ;5.3.29.3;5.3.29. 9;5.3.30;Table 16;5.4.3.35;5.4.3 .36;5.4.3.37;5.4. 3.38;5.4.3.39; Chapter 6 added Introduction Note 1 & Note 2 for clarity; 7.1.4;7.4.1;9.1;9. 1.2;9.1.3;9.1.6;9. 2.1;9.2.3;9.2.6;9. 2.12;9.2.32;9.2.3 3;9.4 Note;9.4.2; 9.4.3;9.5.2;9.5.7; 9.7;9.9.5;10.1.2; 10.2.1;10.2.2;10. 2.3;10.2.4;10.2.5 ;10.2.6;10.2.8;10 .2.9;10.2.10;10.3 .1;10.3.4;10.3.5; Chapter 11; Most Appendices are removed and adopted into ADR Guidance Material; Revised Appendix IX.			
4	4.0	Amendent 18 includes runway strip width for code number 3 non-instrument runway; runway distance remaining signs (RDRS); harmonization of aerodrome lighting requirements for CAT II operations; main beam average intensity of lights; threshold marking; closed runway lighting; unserviceability signs; apron management	ICAO Annex 14 Vol.I 9th Edition (July 2022) (Arising from Amendment 18 to ICAO Annex 14 Vol I)	DC.1.1;DC.1.2; Cross Reference between BAR Vol I and ICAO and other provisions;Definit ion revised; deleted de-icing related definition; added ground handling;1.2.1; 1.2.2;1.2.4;1.3.2; 1.5.1;1.5.2;1.5.4; 1.5.5;1.5.6;1.5.7; 1.6.1;1.6.2;1.6.3; 1.6.4;1.15.1 s);1.16.4;1.16.6; 1.19.2;1.19.5; 1.19.10; 1.22 d) & e);1.23.1	Pg Rasman bin Pg Sulaiman (Q3 2026)	Subject to associated Aviation Safety Circular	01 June 2026

		service; ground handling as of 26 November 2026; and; obstacle limitation surfaces as of 21 November 2030; New Chapters added; added compliance and enforcement section under Chapter 2.		a);1.25.2 j);1.26; 2.1 c);2.1.1; 2.1.2; 2.1.3;2.1.4;2.1.5; 2.1.6;2.1.7;2.1.8; 2.1.10;2.1.14;2.1 .16; 2.2.1;2.2.2;2.2.3; 2.2.4;2.2.5;2.3.1; 2.3.4;2.3.9;2.3.1 0;2.3.11;3.1.23;3 .3.1; 3.3.2;3.4.5;3.4.9; 3.4.18;3.7.1;Tabl e 3-1;3.12.9;Table 3-2; 3.13.2;3.13.3;3.1 3.5; 3.15 deleted all de-icing provisions; 4.2.21;4.2.23;4.2 .24;4.2.25;5.1.1. 3;5.1.4.1;5.1.4.3; 5.2.1.6;5.2.8.1;5. 2.11.1; 5.2.4.1;5.2.4.2 (deleted); 5.2.11.4;5.2.13.2 ;5.2.16.3;5.2.16. 4;5.2.16.9;5.3.1. 2;5.3.1.8;5.3.4.1 7 (deleted); 5.3.4.18 (deleted);5.3.4.3 4;5.3.4.35;5.3.5. 2;5.3.5.3;5.3.5.4(deleted);5.3.5.7 – 5.3.5..23 (deleted discontinued T-VASIS and AT-VASIS);5.3.12.4(deleted);5.3.22.1 -5.3.22.3 (deleted non-applicable de-icing);5.4.1.3;5.4 .1.4;5.4.8;5.5.4.1 – 5.5.4.3 (deleted non applicable snow);6.2.4.3 (e);7.1;7.4.1;7.4. 2;7.4.3;7.4.4;8.1. 10 (d);8.2.4;9.1.3;9. 2.33 (deleted);9.4;9.5; 9.6;9.7;9.11;9.12 .2;10.3.5 (deleted);10.5.1; Chapter 11, Chapter 12;Chapter 13; added new Chapter 15			

Control of this Document

DC.1 Introduction

DC.1.1 Pursuant to Civil Aviation Act and the Civil Aviation Regulations (CAP 290) and their subsequent amendments, the following requirements are hereby established for compliance by all persons concerned, the Director of Civil Aviation is empowered to adopt and amend Brunei Aviation Requirements. In accordance herewith, the following requirement is hereby established for compliance by all persons concerned. This requirement shall be known as BAR 14 Volume I - Aerodromes and any reference to this title shall mean referring to the requirements to be met for civil aviation in Brunei Darussalam.

DC.1.2 This document is primarily based on ICAO Annex 14 Volume 1 – Aerodromes Design and Operations, ICAO Doc 9981 – PANS Aerodromes, ICAO Doc 9774 - Manual on Certification of Aerodromes and other related and relevant document. A comprehensive cross reference is provided in Page 10 of this bar describing the BAR 14 material and their source document, as well as a list of differences between BAR 14 and ICAO provisions.

DC.2 Authority for this Requirement

DC.2.1 This BAR 14 Volume I – Aerodromes, is issued on the authority of the Director of Civil Aviation.

DC.3 Applicability

DC.3.1 This BAR 14 Volume I - Aerodromes is applicable to the aviation industry of Brunei Darussalam.

DC.4 Scope

DC.4.1 BAR 14 Volume I Aerodromes contains the basic requirements to be met for civil aviation in Brunei Darussalam, and shows compliance with ICAO Annexes. The requirements are separated into the following civil aviation safety requirements with cross references where applicable.

BAR 1 – Personnel Licensing

BAR 2 – Rules of the Air

BAR 3 – Meteorological Service for International Air Navigation

BAR 4 – Aeronautical Charts

BAR 5 – Units of Measurement

BAR 6 – Operation of Aircraft

BAR 7 – Aircraft Registration and Cancellation

BAR 8 – Airworthiness of Aircraft and Continuous Airworthiness

BAR 9 – Facilitation

BAR 10 – Aeronautical Telecommunications

BAR 11 – Air Traffic Services

BAR 12 – Search and Rescue

BAR 13 – Aircraft Accident and Incident Investigation

BAR 14 – Volume I – Aerodromes

BAR 14 – Volume II - Heliports

BAR 15 – Aeronautical Information Services

BAR 16 – Environmental Protection

BAR 17 – Aviation Security

BAR 18 – The Safe Transport of Dangerous Goods by Air

BAR 19 – Safety Management

DC.5 Definitions

DC.5.1 Terms not defined within this document shall have the meaning given to them in the relevant legal instruments or international legal instruments in which they appear, especially as they appear in the Convention and its Annexes.

Cross Reference between BAR 14 Vol I and ICAO and other provisions

This part serves two purposes. Firstly, it records the source of all the provisions in BAR 14 Volume 1. This is important when potential amendments are evaluated. Secondly, it records any differences between the provisions of BAR 14 Volume 1 and to those of the latest amendment ICAO Annex 14 Volume 1. The identification of differences is required under Article 38 of the Chicago Convention.

As a general policy, the Brunei DCA has adopted ICAO Standards and Recommended Practices without change. However, in a few cases listed below, some Recommended Practices have been upgraded to Standards.

Where there is no difference, this is listed as 'No'. However, where provisions exist in BAR 14 and there is no equivalent ICAO provision in ICAO Annex 14 (such as the provisions for Exemption) this is listed as 'n/a'. In some cases, material has been added for which there is no ICAO SARP. In these cases, the source of the material has been listed but this material does not constitute a 'Difference' that has to be notified by Brunei DCA to ICAO under its obligations under Article 38 of the Chicago Convention, and has been marked as 'n/a'.

BAR 14 Ref.	Source	Title	Difference
Chapter 1		**General**	
1.1	Annex 14 Vol. 1	Definitions	No
1.2	Annex 14 Vol. 1	Applicability	No
1.3	CAAi	Purpose	n/a
1.4	Annex 14 Vol. 1	Standards and Recommended Practices	No
1.5	CAAi	ICAO Annex 14 Compliance	n/a
1.6	CAAi	Exemptions	n/a
1.7	Annex 14 Vol. I	Common Reference Systems	No
1.8	Annex 14 Vol. I	Airport Design and Master Plan	No
1.9	Annex 14 Vol. I	Aerodrome Reference Code	No
1.10	Annex 14 Vol. I	Specific Procedures for Aerodrome Operations	No
1.11	Annex 14 Vol. I	Aeronautical Data	No
1.12	Annex 14 Vol. I	Aerodrome Reference Point	No
1.13	Annex 14 Vol. I	Aerodrome and Runway	No

		Elevations	
1.14	Annex 14 Vol. I	Aerodrome Reference Temperature	No
1.15	Annex 14 Vol. I	Aerodrome Dimensions and related information	No
1.16	Annex 14 Vol. I	Strength of Pavements (Applicable as of 28 November 2024)	No
1.17	Annex 14 Vol. I	Pre-flight Altimeter Check Location	No
1.18	Annex 14 Vol. I	Declared Distances	No
1.19	Annex 14 Vol. I	Condition of the Movement Area and Related Facillities	No (Except Snow and Ice related terms are removed and not applicable)
1.20	Annex 14 Vol. I	Disabled Aircraft Removal	No
1.21	Annex 14 Vol. I	Rescue and Firefighting	No
1.22	Annex 14 Vol. I	Visual Approach Slope Indicator Systems	No (Except T-VASIS and AT-VASIS related terms.are removed and not applicable)
1.23	Annex 14 Vol. I	Coordination between Aeronautical Information Services and Aerodrome Authorities	No
1.24	PANS-Aerodrome (Doc 9981)	Runway Safety	No
1.25	PANS-Aerodrome (Doc 9981)	Coordination between Air Traffic Service Provider and Aerodrome Authorities	No
1.26	PANS-Aerodrome (Doc 9981)	Aerodrome Safety Coordination	No
Chapter 2		**Aerodrome Certification**	
2.1 – 2.3	CAAi, PANS-Aerodrome (Doc	Aerodrome Certification Process, Aerodrome Manual, obligations of the Aerodrome	No

	9981), Doc9774	Operator	
Chapter 3		**Physical Characteristics**	
3.1 – 3.15	Annex 14 Vol. 1		No (Except De-icing/anti-icing facilities related provisions are removed and not applicable)
Chapter 4		**Obstacle Restriction & removal**	
4.1 – 4.4	Annex 14 Vol. 1		No
Chapter 5		**Visual Aids for Navigation**	
5.1 – 5.5	Annex 14 Vol. 1		No (Except both T-VASIS and AT-VASIS related provisions and De-icing/anti-icing facilities related provisions are removed and not applicable)
Chapter 6		**Visual Aids for Denoting Obstacles**	
6.1 – 6.2	Annex 14 Vol. 1		No
Chapter 7		**Visual Aids for Denoting Restricted Areas**	
7.1 – 7.4	Annex 14 Vol. 1		No
Chapter 8		**Electrical Systems**	
8.1 – 8.3	Annex 14 Vol. 1		No
Chapter 9		**Aerodrome Operational Services, Equipment & Installation**	
9.1 – 9.11	Annex 14 Vol. 1		No
Chapter 10		**Aerodrome Maintenance**	
10.1 – 10.5	Annex 14 Vol. 1		No

Chapter 11		**Aeronautical Study**	
11.1	ICAO Doc.9774, Appendix 3	Information	No
Chapter 12		**Contracted Activities**	
12.1	EU Commission Reg 139/2014	ADR.OR.D.010 Contracted Activities	n/a
Chapter 13		**Obstacle Control**	
13.1	Annex 14 Vol. 1, 4.3.2 ICAO Doc 9981 2.4.5 ICAO Doc 9137 Part 6 - Control of Obstacles	Information	No
Chapter 14		**Appendices**	
Appendix 1		**Colours for Aeronautical Ground Lights, Markings, Signs and Panels**	
	Annex 14 Vol. 1 - App 1,		No
Appendix 2		**Aeronautical Ground Light Characteristics**	
	Annex 14 Vol. 1 - App 2,		No
Appendix 3		**Mandatory Instruction Markings and Information Markings**	
	Annex 14 Vol. 1 - App 3		No
Appendix 4		**Requirements Concerning Design of Taxiing Guidance Signs**	
	Annex 14 Vol. 1 - App 4		No
Appendix 5		**Location of Lights on Obstacles**	
	Annex 14 Vol 1. -		No

	App 5		
Chapter 15		**Attachments**	
15.1	Annex 14 Vol 1. – Att A	**Attachment A - Guidance Material Supplementary to BAR 14 Volume 1**	No
15.2	Annex 14 Vol. 1 – Att B	**Attachment B – Obstacle Limitation Surfaces**	No

Reference Documents

The reference documents listed below are applicable:

BAR 14 Volume II - Heliports

BAR 19 – Safety Management.

ICAO Annex 14, Aerodromes - Volume I, Aerodrome Design and Operation;

ICAO Annex 14, Aerodromes – Volume II, Heliports;

ICAO Annexes (relevant parts) 2, 3, 4, 6, 10, 11, 14, 15, 16, 17 and 19;

ICAO Doc 4444, Procedures for Air Navigation Services - Air Traffic Management (PANS-ATM);

ICAO Doc 8071, Manual on Testing of Radio Navigation Aids;

ICAO Doc 8126, Aeronautical Information Services Manual;

ICAO Doc 8168, Procedures for Air Navigation Services - Aircraft Operations Volumes I and II (PANS-OPS);

ICAO Doc 8643, Aircraft Type Designators;

ICAO Doc 9137, Airport Services Manual, Parts 1 to 9;

ICAO Doc 9150, Stolport Manual;

ICAO Doc 9157, Aerodrome Design Manual, Part 1 to 6;

ICAO Doc 9184, Airport Planning Manual, Parts 1 to 3;

ICAO Doc 9261, Heliport Manual;

ICAO Doc 9332, Manual on the ICAO Bird Strike Information System (IBIS);

ICAO Doc 9365, Manual of All-Weather Operations;

ICAO Doc 9426, Air Traffic Services Planning Manual;

ICAO Doc 9476, Manual of Surface Movement Guidance and Control Systems (SMGCS);

ICAO Doc 9643, Manual on Simultaneous Operations on Parallel or near-Parallel Instrument Runways;

ICAO Doc 9674, World Geodetic System — 1984 (WGS-84) Manual;

ICAO Doc 9683, Human Factors Training Manual;

ICAO Doc 9734, Establishment and Management of a State's Safety Oversight System;

ICAO Doc 9760, Airworthiness Manual, Volumes I and II;

ICAO Doc 9774, Manual on Certification of Aerodromes;

ICAO Doc 9815, Manual on Laser Emitters and Flight Safety;

ICAO Doc 9829, Guidance on the Balanced Approach to Aircraft Noise Management;

ICAO Doc 9830, Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual;

ICAO Doc 9859, Safety Management Manual (SMM);

ICAO Doc 9870, Manual on the Prevention of Runway Incursions;

ICAO Doc 9981 Procedures for Air Navigation Services — Aerodromes (PANS-AERODROMES);

ICAO Doc 10066 Procedures for Air Navigation Services – Aeronautical Information Management (PANS-AIM);

ICAO Circular 305 AN/177 Operation of New Larger Aeroplanes at Existing Aerodromes, June 2004

ICAO Circular 329 AN/191 Assessment, Measurement and Reporting of Runway Surface Condition, 2012

ICAO Circular 355 Assessment, Measurement and Reporting of Runway Surface Condition

ICAO Doc 10121, Manual of Ground Handling

European Action Plan for the Prevention of Runway Incursions (EAPPRI);

Chapter 1. General and Aerodrome Data

1.1. Definitions

Acceptable Means of Compliance (AMC): Provisions adopted by the Brunei DCA to indicate the normal means of compliance to establish compliance with the BARs. An entity or a person not wishing to comply with an AMC must show compliance using an Alternative Means of Compliance procedure accepted by the Brunei DCA.

Accuracy: A degree of conformance between the estimated or measured value and the true value.

Note.- For measured positional data, the accuracy is normally expressed in terms of a distance from a stated position within which there is a defined confidence of the true position falling.

Advanced Surface Movement Guidance and Control System (A-SMGCS): A system providing routing, guidance and surveillance for the control of aircraft and vehicles in order to maintain the declared surface movement rate under all weather conditions within the aerodrome visibility operational level (AVOL) while maintaining the required safety.

Aerodrome: A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.

Aerodrome Beacon: Aeronautical beacon used to indicate the location of an aerodrome from the air.

Aerodrome Certificate: A certificate issued by the Brunei DCA under BAR 14 Volume I - Aerodromes and any other applicable requirements, subsequent to the acceptance/approval of the Aerodrome Manual, for the operation of an aerodrome.

Aerodrome Elevation: The elevation of the highest point of the landing area.

Aerodrome facilities and equipment: Facilities and equipment, inside or outside the boundaries of an aerodrome, that are constructed or installed and maintained for the arrival, departure and surface movement of aircraft.

Aerodrome for International or Public Use: The context of international or public use shall be in accordance with the requirements of Article 15 and Article 68 of the Convention (ICAO Doc 7300).

Aerodrome Identification Sign: A sign placed on an aerodrome to aid in identifying the aerodrome from the air.

Aerodrome Manual: The manual that forms the aerodrome exposition and is part of the application for an Aerodrome Certificate pursuant to the applicable BARs, including any amendments thereto accepted by the Brunei DCA.

Aerodrome Mapping Data (AMD): Data collected for the purpose of compiling aerodrome mapping information for aeronautical uses.

Note.— Aerodrome mapping data are collected for purposes that include the improvement of the user's situational awareness, surface navigation operations, training, charting and planning.

Aerodrome Mapping Database (AMDB): A collection of aerodrome mapping data organized and arranged as a structured data set.

Aerodrome Operator: In relation to a certified aerodrome, the Aerodrome Certificate holder.

Aerodrome Post Holder: Those positions identified in BAR 14 Volume I - Aerodromes who are subject to acceptance by the Brunei DCA.

Aerodrome Reference Point: The designated geographical location of an aerodrome.

Aerodrome Traffic Density:

Light: Where the number of movements in the mean busy hour is not greater than 15 per runway or typically less than 20 total aerodrome movements.

Medium: Where the number of movements in the mean busy hour is of the order of 16 to 25 per runway or typically between 20 to 35 total aerodrome movements.

Heavy: Where the number of movements in the mean busy hour is 26 or more per runway or typically more than 35 total aerodrome movements.

Note 1.- The number of movements in the mean busy hour is the arithmetic mean over the year of the number of movements in the daily busiest hour.

Note 2.- Either a take-off or a landing constitutes a movement.

Aeronautical Beacon: An aeronautical ground light visible at all azimuths, either continuously or intermittently, to designate a particular point on the surface of the earth.

Aeronautical Ground Light: Any light specially provided as an aid to air navigation, other than a light displayed on an aircraft.

Aeronautical Study: A study of an aeronautical problem by aerodrome operator to identify possible solutions and select a solution that is acceptable to the Brunei DCA without degrading safety.

Aeroplane Reference Field Length: The minimum field length required for take- off at maximum certificated take-off mass, sea level, standard atmospheric conditions, still air and zero runway slope, as shown in the appropriate aeroplane flight manual prescribed by the certificating authority or equivalent data from the aeroplane manufacturer. Field length means balanced field length for aeroplanes, if applicable, or take-off distance in other cases.

Note.- ICAO Annex 14, Volume 1, Attachment A, Section 2 provides information on the concept of balanced field length and the ICAO Airworthiness Manual (Doc 9760) contains detailed guidance on matters related to take-off distance.

Aircraft Classification Number (ACN): A number expressing the relative effect of an aircraft on a pavement for a specified standard subgrade category. **(applicable until 27 November 2024).**

Note.- The aircraft classification number is calculated with respect to the centre of gravity (CG) position which yields the critical loading on the critical gear. Normally the aftmost CG position appropriate to the maximum gross apron mass is used to calculate the ACN. In exceptional cases the forward most CG position may result in the nose gear loading being more critical.

Aircraft Classification Rating (ACR): A number expressing the relative effect of an aircraft on a pavement for a specified standard subgrade category. **(applicable as of 28 November 2024).**

Note.— The aircraft classification rating is calculated with respect to the centre of gravity (CG) position which yields the critical loading on the critical gear. Normally the aftmost CG position appropriate to the maximum gross apron (ramp) mass is used to calculate the ACR. In exceptional cases the forwardmost CG position may result in the nose gear loading being more critical.

Aircraft Stand: A designated area on an apron intended to be used for parking an aircraft.

Alternative Means of Compliance (ALMC): Alternative means of compliance are those that propose an alternative to an existing Acceptable Means of Compliance (AMC) or those that propose new means to establish compliance with the BAR for which no associated AMC have been adopted by the Brunei DCA.

Apron: A defined area, on a land aerodrome, intended to accommodate aircraft for purposes of loading or unloading passengers, mail or cargo, fuelling, parking or maintenance, including any apron taxiways and aircraft stand taxilanes.

Apron Management Service: A service provided to regulate the activities and the movement of aircraft and vehicles on an apron.

Arresting System: A system designed to decelerate an aeroplane overrunning the runway.

Autonomous Runway Incursion Warning System (ARIWS): A system which provides autonomous detection of a potential incursion or of the occupancy of an active runway and a direct warning to a flight crew or a vehicle operator.

Balked Landing: A landing manoeuvre that is unexpectedly discontinued at any point below the obstacle clearance altitude/height (OCA/H).

Barrette: Three or more aeronautical ground lights closely spaced in a transverse line so that from a distance they appear as a short bar of light.

Calendar: Discrete temporal reference system that provides the basis for defining temporal position to a resolution of one day (ISO 19108, Geographic information - Temporal schema).

Capacitor Discharge Light: A lamp in which high-intensity flashes of extremely short duration are produced by the discharge of electricity at high voltage through a gas enclosed in a tube.

Certified Aerodrome: An aerodrome whose operator has been granted an Aerodrome Certificate.

Clearway: A defined rectangular area on the ground or water selected or prepared as a suitable area over which an aeroplane may make a portion of its initial climb to a specified height.

Competence: The ability to apply knowledge, understanding and skills in performing to the standards required in employment. This includes problems and meeting changing demands.

Competence in Application: The ability of individuals to demonstrate consistently that the performance outcomes defined for their role can be achieved to the standard expected in the workplace.

Competent in Acquisition: The ability of individuals to demonstrate that they can apply the learning acquired in the workplace to the standards defined in the performance criteria for their role.

Contaminated Runway: A runway is contaminated when more than 25 per cent of the runway surface area (whether in isolated areas or not) within the required length and width being used is covered by water more than 3 mm (0.125 in) deep;

Cyclic Redundancy Check (CRC): A mathematical algorithm applied to the digital expression of data that provides a level of assurance against loss or alteration of data.

Data accuracy: A degree of conformance between the estimated or measured value and the true value.

Data integrity (assurance level): A degree of assurance that an aeronautical data and its value has not been lost or altered since the origination or authorized amendment.

Data quality: A degree or level of confidence that the data provided meet the requirements of the data user in terms of accuracy, resolution, integrity (or equivalent assurance level), traceability, timeliness, completeness and format.

Datum: Any quantity or set of quantities that may serve as a reference or basis for the calculation of other quantities (ref. ISO 19104, Geographic information - Terminology).

Declared Distances:

Take-off Run Available (TORA). The length of runway declared available and suitable for the ground run of an aeroplane taking off.

Take-off Distance Available (TODA). The length of the Take-off Run Available plus the length of the clearway, if provided.

Accelerate-Stop Distance Available (ASDA). The length of the Take-off Run Available plus the length of the stopway, if provided.

Landing Distance Available (LDA). The length of runway which is declared available and suitable for the ground run of an aeroplane landing.

Dependent Parallel Approaches: Simultaneous approaches to parallel or near- parallel Instrument Runways where radar separation minima between aircraft on adjacent extended runway centre lines are prescribed.

Displaced Threshold: A threshold not located at the extremity of a runway.

Effective Intensity: The effective intensity of a flashing light is equal to the intensity of a fixed light of the same colour which will produce the same visual range under identical conditions of observation.

Ellipsoid Height (Geodetic height): The height related to the reference ellipsoid, measured along the ellipsoidal outer normal through the point in question.

Fixed Light: A light having constant luminous intensity when observed from a fixed point.

Foreign object debris (FOD): An inanimate object within the movement area which has no operational or aeronautical function and which has the potential to be a hazard to aircraft operations.

Frangible Object: An object of low mass designed to break, distort or yield on impact so as to present the minimum hazard to aircraft.

Note.- Guidance on design for frangibility is contained in the ICAO Aerodrome Design Manual (Doc 9157) Part 6.

Geodetic Datum: A minimum set of parameters required to define location and orientation of the local reference system with respect to the global reference system/frame.

Geoid: The equipotential surface in the gravity field of the Earth which coincides with the undisturbed Mean Sea Level (MSL) extended continuously through the continents.

Note.- The geoid is irregular in shape because of local gravitational disturbances (wind tides, salinity, current, etc.) and the direction of gravity is perpendicular to the geoid at every point.

Geoid Undulation: The distance of the geoid above (positive) or below (negative) the mathematical reference ellipsoid.

Note.- In respect to the World Geodetic System — 1984 (WGS-84) defined ellipsoid, the difference between the WGS-84 ellipsoidal height and orthometric height represents WGS-84 geoid undulation.

Gregorian Calendar: Calendar in general use; first introduced in 1582 to define a year that more closely approximates the tropical year than the Julian calendar (ISO 19108 - Geographic information — Temporal schema).

Note.- In the Gregorian calendar, common years have 365 days and leap years 366 days divided into twelve sequential months.

Ground Handling: Services necessary for an aircraft's arrival at, and departure from, an airport, other than air traffic services.

Hazard Beacon: An aeronautical beacon used to designate a danger to air navigation.

Heliport: An aerodrome or a defined area on a structure intended to be used wholly or in part for the arrival, departure and surface movement of helicopters.

Holding Bay: A defined area where aircraft can be held, or bypassed, to facilitate efficient surface movement of aircraft.

Hot spot: A location on an aerodrome movement area with a history or potential risk of collision or runway incursion, and where heightened attention by pilots/drivers is necessary.

Human Factors principles: Principles which apply to aeronautical design, certification, training, operations and maintenance and which seek safe interface between the human and other system components by proper consideration to human performance.

Human performance: Human capabilities and limitations which have an impact on the safety and efficiency of aeronautical operations.

Identification Beacon: An aeronautical beacon emitting a coded signal by means of which a particular point of reference can be identified.

Independent Parallel Approaches: Simultaneous approaches to parallel or near- parallel Instrument Runways where radar separation minima between aircraft on adjacent extended runway centre lines are not prescribed.

Independent Parallel Departures: Simultaneous departures from parallel or near-parallel Instrument Runways.

Instrument Runway: One of the following types of runways intended for the operation of aircraft using instrument approach procedures:

a) *Non-precision Approach Runway*. A runway served by visual aids and non-visual aid(s) intended for landing operations following an instrument approach operation type A and a visibility not less than 1 000 m.

b) *Precision Approach Runway, Category I*. A runway served by visual aids and non-visual aid(s) intended for landing operations following an instrument approach operation type B with a decision height (DH) not lower than 60 m (200 ft) and either a visibility not less than 800 m or a runway visual range not less than 550 m.

c) *Precision Approach Runway, Category II*. A runway served by visual aids and non-visual aid(s) intended for landing operations following an instrument approach operation type B with a decision height (DH) lower than 60 m (200 ft)but not lower than 30 m (100 ft) and a runway visual range not less than 300 m.

d) *Precision Approach Runway, Category III*. A runway served by visual aids and non-visual aid(s) intended for landing operations following an instrument approach operation type B with a decision height (DH) lower than 30 m (100 ft), or no decision height and a Runway Visual Range less than 300 m or no Runway Visual Range limitations

Note 1.- Visual aids need not necessarily be matched to the scale of non-visual aids provided. The criterion for the selection of visual aids is the conditions in which operations are intended to be conducted.

Note 2. - Refers to Annex 6 – Operation of Aircraft for instrument approach operation types.

Integrity Classification (Aeronautical Data): Classification based upon the potential risk resulting from the use of corrupted data. Aeronautical data is classified as:

Routine data: there is a very low probability when using corrupted routine data that the continued safe flight and landing of an aircraft would be severely at risk with the potential for catastrophe;

Essential data: there is a low probability when using corrupted essential data that the continued safe flight and landing of an aircraft would be severely at risk with the potential for catastrophe; and

Critical data: there is a high probability when using corrupted critical data that the continued safe flight and landing of an aircraft would be severely at risk with the potential for catastrophe.

Intermediate Holding Position: A designated position intended for traffic control at which taxiing aircraft and vehicles shall stop and hold until further cleared to proceed, when so instructed by the aerodrome control tower.

Landing Area: That part of a movement area intended for the landing or take-off of aircraft.

Landing Direction Indicator: A device to indicate visually the direction currently designated for landing and for take-off.

Laser-beam Critical Flight Zone (LCFZ): Airspace in the proximity of an aerodrome but beyond the LFFZ where the irradiance is restricted to a level unlikely to cause glare effects.

Laser-beam Free Flight Zone (LFFZ): Airspace in the immediate proximity to the aerodrome where the irradiance is restricted to a level unlikely to cause any visual disruption.

Laser-beam Sensitive Flight Zone (LSFZ): Airspace outside, and not necessarily contiguous with, the LFFZ and LCFZ where the irradiance is restricted to a level unlikely to cause flash-blindness or after-image effects.

Lighting System Reliability: The probability that the complete installation operates within the specified tolerances and that the system is operationally usable.

Low Visibility Conditions (LVC): The meteorological conditions requiring approaches and landings in Category II and Category III, take offs in RVR less than 550 metres or for surface movements in meteorological conditions not permitting ATC to be carried out with visual reference.

Low Visibility Procedures (LVP): The measures required to support safe operations at an aerodrome in Low Visibility Conditions (LVC).

Manoeuvring Area: That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, excluding aprons and any other part of the aerodrome provided for the maintenance of aircraft.

Marker: An object displayed above ground level in order to indicate an obstacle or delineate a boundary.

Marking: A symbol or group of symbols displayed on the surface of the Movement Area in order to convey aeronautical information.

Maximum carrying capacity: In relation to an aircraft, means the maximum passenger-seating capacity, or the maximum payload, permitted under the aircraft's certificate of type approval.

Maximum passenger-seating capacity: In relation to an aircraft, means the maximum number of seats for passengers permitted under the aircraft's certificate of type approval.

Minister: The Minister of Transport and Infocommunications and where applicable includes the Director of Civil Aviation, or the Head or officers of the Regulatory Division, or any authorised person to whom the Minister has delegated his powers.

Movement Area: That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, consisting of the Manoeuvring Area and the apron(s).

Near-parallel Runways: Non-intersecting runways whose extended centre lines have an angle of convergence/divergence of 15 degrees or less.

Non-Instrument Runway: A runway intended for the operation of aircraft using visual approach procedures.

Note.— Visual meteorological conditions (VMC) are described in Chapter 3 of Annex 2 — Rules of the Air.

Normal Flight Zone (NFZ): Airspace not defined as LFFZ, LCFZ or LSFZ but which must be protected from laser radiation capable of causing biological damage to the eye.

Obstacle: All fixed (whether temporary or permanent) and mobile objects, or parts thereof, that:

a) are located on an area intended for the surface movement of aircraft or

b) that extend above a defined surface intended to protect aircraft in flight,

c) or that stand outside those defined surfaces and that have been assessed as being a hazard to air navigation.

Obstacle Free Zone (OFZ): The airspace above the Inner Approach Surface, Inner Transitional Surfaces, and Balked Landing Surface and that portion of the strip bounded by these surfaces, which is not penetrated by any fixed obstacle other than a low-mass and frangibly mounted one required for air navigation purposes.

Obstacle limitation surfaces (OLS): A series of surfaces that define the volume of airspace at and around an aerodrome to be kept free of obstacles in order to permit the intended aeroplane operations to be conducted safely and to prevent the aerodrome from becoming unusable by the growth of obstacles around the aerodrome.

Orthometric height. Height of a point related to the geoid, generally presented as an MSL elevation.

Outer main gear wheel span (OMGWS): The distance between the outside edges of the main gear wheels.

Orthometric Height: Height of a point related to the geoid, generally presented as an mean sea level (MSL) elevation.

Pavement Classification Number (PCN): A number expressing the bearing strength of a pavement **(applicable until 27 November 2024).**

Pavement Classification Rating (PCR): A number expressing the bearing strength of a pavement **(applicable as of 28 November 2024).**

Precision Approach Runway: See Instrument Runway.

Primary Runway(s): Runway(s) used in preference to others whenever conditions permit.

Protected Flight Zones: Airspace specifically designated to mitigate the hazardous effects of laser radiation.

Road: An established surface route on the Movement Area meant for the exclusive use of vehicles.

Road-holding Position: A designated position at which vehicles may be required to hold.

Runway: A defined rectangular area on a land aerodrome prepared for the landing and take-off of aircraft.

Runway condition assessment matrix (RCAM): A matrix allowing the assessment of the runway condition code, using associated procedures, from a set of observed runway surface condition(s) and pilot report of braking action.

Runway condition code (RWYCC): A number describing the runway surface condition to be used in the runway condition report.

Note.— The purpose of the runway condition code is to permit an operational aeroplane performance calculation by the flight crew. Procedures for the determination of the runway condition code are described in the PANS-Aerodromes (Doc 9981).

Runway condition report (RCR): A comprehensive standardized report relating to runway surface condition(s) and its effect on the aeroplane landing and take-off performance.

Runway End Safety Area (RESA): An area symmetrical about the extended runway centre line and adjacent to the end of the strip primarily intended to reduce the risk of damage to an aeroplane undershooting or overrunning the runway.

Runway Guard Lights: A light system intended to caution pilots or vehicle drivers that they are about to enter an active runway.

Runway-Holding Position: A designated position intended to protect a runway, an obstacle limitation surface or an ILS/MLS critical/sensitive area at which taxiing aircraft and vehicles shall stop and hold, unless otherwise authorized by the aerodrome control tower.

Note.- In radiotelephony phraseologies, the expression “holding point” is used to designate the runway-holding position.

Runway Strip: A defined area including the runway and stopway, if provided, intended:

a) To reduce the risk of damage to aircraft running off a runway; and

b) To protect aircraft flying over it during take-off or landing operations.

Runway Surface Condition(s): A description of the condition(s) of the runway surface used in the runway condition report which establishes the basis for the determination of the runway condition code for aeroplane performance purposes.

Note 1.— The runway surface conditions used in the runway condition report establish the performance requirements between the aerodrome operator, aeroplane manufacturer and aeroplane operator.

Note 2.— Other contaminants are also reported but are not included in the list of runway surface condition descriptors because their effect on runway surface friction characteristics and the runway condition code cannot be evaluated in a standardized manner.

Note 3.— Procedures on determining runway surface conditions are available in the PANS-Aerodromes (Doc 9981).

a) *Dry runway*. A runway is considered dry if its surface is free of visible moisture and not contaminated within the area intended to be used.

b) *Wet runway*. The runway surface is covered by any visible dampness or water up to and including 3 mm deep within the intended area of use.

c) *Slippery wet runway*. A wet runway where the surface friction characteristics of a significant portion of the runway have been determined to be degraded.

d) *Contaminated runway*. A runway is contaminated when a significant portion of the runway surface area (whether in isolated areas or not) within the length and width being used is covered by one or more of the substances listed in the runway surface condition descriptors.

Note.— Procedures on determination of contaminant coverage on runway are available in the PANS-Aerodromes (Doc 9981).

e) *Runway surface condition descriptors*. One of the following elements on the surface of the runway:

Note.— The descriptions for e) is used solely in the context of the runway condition report and are not intended to supersede or replace any existing WMO definitions.

i) *Standing water*. Water of depth greater than 3 mm.

Note.— Running water of depth greater than 3 mm is reported as standing water by convention.

Runway Turn Pad: A defined area on a land aerodrome adjacent to a runway for the purpose of completing a 180-degree turn on a runway.

Runway Visual Range (RVR): The range over which the pilot of an aircraft on the centre line of a runway can see the runway surface markings or the lights delineating the runway or identifying its centre line.

Safety Management System (SMS): A systematic approach to managing safety including the necessary organizational structure, accountabilities, policies and procedures.

Segregated Parallel Operations: Simultaneous operations on parallel or near- parallel Instrument Runways in which one runway is used exclusively for approaches and the other runway is used exclusively for departures.

Shoulder: An area adjacent to the edge of a pavement so prepared as to provide a transition between the pavement and the adjacent surface.

Sign:

a) *Fixed message sign*. A sign presenting only one message.

b) *Variable message sign*. A sign capable of presenting several pre-determined messages or no message, as applicable.

Signal area: An area on an aerodrome used for the display of ground signals.

State Safety Programme (SSP): An integrated set of requirements and activities for the management of aviation safety by the State.

Station Declination: An alignment variation between the zero degree radial of a VOR and true north, determined at the time the VOR station is calibrated.

Stopway: A defined rectangular area on the ground at the end of take-off run available prepared as a suitable area in which an aircraft can be stopped in the case of an abandoned take-off.

Surface Movement Guidance and Control System (SMGCS): A system for the provision of guidance to and control of, all aircraft, ground vehicles and personnel on the Movement Area of an aerodrome for the prevention of collisions and to ensure that traffic flows smoothly and freely.

Note. - Reference to SMGCS also includes A-SMGCS.

Switch-over Time (light): The time required for the actual intensity of a light measured in a given direction to fall from 50 per cent and recover to 50 per cent during a power supply changeover, when the light is being operated at intensities of 25 per cent or above.

Take-off Runway: A runway intended for take-off only.

Taxiway: A defined path on a land aerodrome established for the taxiing of aircraft and intended to provide a link between one part of the aerodrome and another, including:

a) *Aircraft Stand Taxilane*. A portion of an apron designated as a taxiway and intended to provide access to aircraft stands only.

b) *Apron Taxiway*. A portion of a taxiway system located on an apron and intended to provide a through taxi route across the apron.

c) *Rapid Exit Taxiway*. A taxiway connected to a runway at an acute angle and designed to allow landing aeroplanes to turn off at higher speeds than are achieved on other exit taxiways thereby minimizing runway occupancy times.

Taxiway Intersection: A junction of two or more taxiways.

Taxiway Strip: An area including a taxiway intended to protect an aircraft operating on the taxiway and to reduce the risk of damage to an aircraft accidentally running off the taxiway.

Threshold: The beginning of that portion of the runway usable for landing.

Touchdown Zone: The portion of a runway, beyond the threshold, where it is intended landing aeroplane first contact the runway.

Unmanned Aircraft Systems (UAS): An aircraft and its associated elements which are operated with no pilot on board.

Unserviceable area: A part of the movement area that is unfit and unavailable for use by aircraft.

Usability Factor: The percentage of time during which the use of a runway or system of runways is not restricted because of the cross-wind component.

Note.- Crosswind component means the surface wind component at right angles to the runway centre line.

Work area: A part of an aerodrome in which maintenance or construction works are in progress.

1.2. Applicability

1.2.1. BAR 14 Volume I - Aerodromes applies to all aerodromes that are certificated within Brunei Darussalam. Any aerodrome within Brunei Darussalam open for international use may apply for an Aerodrome Certificate under these requirements.

1.2.2. These requirements represent the minimum requirements to achieve an acceptable level of safety performance, and where appropriate, shall apply to heliports with runway(s) but shall not apply to stolports.

Note.— Although there are at present no specifications relating to stolports, it is intended that specifications for these aerodromes will be included as they are developed. In the interim, guidance material on stolports is given in the Stolport Manual (Doc 9150).

1.2.3. Wherever a colour is referred to in this document, the specifications for that colour given in Appendix 1 of Annex 14 Volume I shall apply.

1.2.4. A cross reference between the SARPs requirements of BAR 14 Volume 1 and latest edition of ICAO Annex 14 Volume I and other provisions is shown in Page 10. If differences are identified, ICAO shall be notified of these differences. Where a difference is deemed to be significant, it shall be published in the Brunei Aeronautical Information Publication (AIP) in accordance with the requirements of BAR 15, Annex 15 and PANS-AIM (Doc 10066).

1.3. Purpose

1.3.1. This BAR 14 Volume I – Aerodromes provides requirements that are primarily based upon the Standards and Recommended Practices (SARPs) of ICAO Annex 14 Volume I, as well as those of Annex 15, PANS-Aerodromes (Doc 9981) and PANS-AIM (Doc 10066) to the Convention on International Civil Aviation (Chicago Convention) and other related ICAO documents.

1.3.2. The issue of a certificate indicates only that the holder is considered competent to secure the safe operation of an aerodrome in accordance with the Aerodrome Manual. It signifies the holder that, at the time of certification, the aerodrome meets the specifications regarding the facility and its operation, and that it has, according to the certifying authority, the capability to maintain these specifications for the period of validity of the certificate. The possession of such a certificate or Aerodrome Manual does not relieve the aerodrome certificate holder from the responsibility for compliance with BAR 14 Volume I - Aerodromes and any other legislation in force. Neither does it relieve the aerodrome of its responsibility for oversight of any service provider contracted by the aerodrome to meet the requirements imposed upon service providers.

1.3.3. In addition, BAR 14 Volume I - Aerodromes includes material and specifications to support the safety oversight activities by the Brunei DCA [RASS] and to provide guidance to aerodrome operators on the physical characteristics of an aerodrome, the operational requirements and the infrastructure that is required to be provided. Where appropriate, reference is made to other documents in support of BAR 14 Volume I - Aerodromes. This material can be used to establish minimum acceptable standards or Acceptable Means of Compliance (AMC) under the discretion of the Brunei DCA.

1.4. Standards and Recommended Practices

1.4.1. Standards and Recommended Practices in the context of this BAR 14 Volume I – Aerodromes are defined as follows:

Standard. Any specification for physical characteristics, configuration, material, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which aerodrome operators shall conform in accordance with the provisions of the BAR 14 Volume I - Aerodromes. In the event of non-compliance with any standard, an application for exemption and justification (through appropriate risk assessment and/ or aeronautical studies) to the Brunei DCA is compulsory.

Recommended Practices. Any specification for physical characteristics, configuration, material, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency of international air navigation and to which aerodrome operators should endeavour to conform in accordance with the provisions of the BAR 14 Volume I – Aerodromes. In the event of non-compliance with any recommended practice, notification to the Brunei DCA is compulsory.

1.4.2. In this BAR 14 Volume I - Aerodromes, ***standards*** are identified by the words 'must' or 'shall'. Unless otherwise exempted pursuant to paragraph 1.6, they shall be complied with at all times.

1.4.3. In this BAR 14 Volume I – Aerodromes, ***recommended practices*** are identified by the words 'should' or 'may'. Aerodrome operators should endeavour to comply with recommended practices.

1.5. ICAO Annex 14 compliance

1.5.1. Except as provided in this paragraph, the operator of a certificated aerodrome shall comply with the Standard requirements contained in BAR 14 Volume I - Aerodromes.

1.5.2. Where there is a missing provision between BAR 14 Volume I - Aerodromes and ICAO SARPs, the aerodrome certificate holder shall comply with the more stringent provisions from ICAO.

1.5.3. The RFFS level of protection to be available shall not be less than that needed for the highest category of aeroplane planned to use the aerodrome.

1.5.4. The additional requirements in paragraph 9.1 shall apply to emergency planning and emergency exercises.

1.5.5. An alternative means of compliance to that specified in paragraph 1.3.3 may be proposed through the submission to the Brunei DCA [RASS] of an aeronautical study. An aeronautical study is a study of an aeronautical problem to identify possible solutions and select a solution that is acceptable without degrading safety. An aeronautical study shall:

(a) assess the impact of a proposed deviation from the requirements;

(b) present alternative means of ensuring the safety of aircraft operations; and

(c) estimate the effectiveness of each alternative and to recommend procedures to compensate for the deviation.

Detailed of an aeronautical study can be found in Chapter 11.

1.5.6. Any agreement or contract between an aerodrome operator and any service provider or sub-contractor providing services to the certificate holder shall include the specific requirement for compliance with BAR 14 Volume I - Aerodromes as appropriate. See Chapter 12 for contracted activities requirements.

1.5.7. Where differences are identified, ICAO shall be notified of these differences. Where a difference is deemed to be significant, it shall be published in the Brunei Aeronautical Information Publication (AIP) in accordance with the requirements of BAR 15, Annex 15 and PANS-AIM (Doc 10066).

1.6. Exemptions

Note: More information and guidance on exemption process is given in ADR 025 - Procedures for accepting non-compliance in aerodromes (Exemption).

1.6.1. The Brunei DCA [RASS] may accept a non-compliance in aerodrome or exempt, in writing, an aerodrome operator from complying with standard provisions in BAR 14 Volume I. However, before the Brunei DCA [RASS] decides to exempt the aerodrome operator, the Brunei DCA [RASS] must take into account all safety-related aspects.

1.6.2. An acceptance of non-compliance in aerodrome or exemption is subject to the aerodrome operator complying with the conditions and procedures specified by the Brunei DCA [RASS] in the ADR 025 - Procedures for Accepting Non-compliance in aerodromes (Exemption) and in the aerodrome certificate as being necessary in the interest of safety.

1.6.3. When an aerodrome does not meet the requirement of a standard specified in a requirement, the Brunei DCA [RASS] may determine, after reviewing the submitted aeronautical study or safety risk assessment, only if and where permitted by the standards, the alternative conditions and procedures that are necessary to ensure a level of safety equivalent to that established by the relevant standard or practice. See Chapter 11 Aeronautical Study for more information.

1.6.4. Any accepted deviation or acceptance of non-compliance (exemption) from a standard referred to shall be set out in an endorsement on the aerodrome certificate and shall notify for ICAO differences.

1.6.5. Exemptions granted to an aerodrome operator must also be recorded in the Aerodrome Manual. The Aerodrome Manual must contain details of exemption, reasons that the exemption was requested for, any resultant limitations, conditions or procedures imposed, and other related safety information.

1.7. Common Reference Systems

1.7.1. Horizontal reference system

World Geodetic System — 1984 (WGS-84) shall be used as the horizontal (geodetic) reference system. Reported aeronautical geographical coordinates (indicating latitude and longitude) shall be expressed in terms of the WGS-84 geodetic reference datum.

Note.— Comprehensive guidance material concerning WGS-84 is contained in the World Geodetic System — 1984 (WGS-84) Manual (Doc 9674).

1.7.2. Vertical reference system

Mean sea level (MSL) datum, which gives the relationship of gravity-related height (elevation) to a surface known as the geoid, shall be used as the vertical reference system.

Note 1.— The geoid globally most closely approximates MSL. It is defined as the equipotential surface in the gravityfield of the Earth which coincides with the undisturbed MSL extended continuously through the continents.

Note 2.— Gravity-related heights (elevations) are also referred to as orthometric heights while distances of points above the ellipsoid are referred to as ellipsoidal heights.

1.7.3. Temporal reference system

1.7.3.1. The Gregorian calendar and Coordinated Universal Time (UTC) shall be used as the temporal reference system.

1.7.3.2. When a different temporal reference system is used, this shall be indicated in GEN 2.1.2 of the Aeronautical Information Publication (AIP).

Note.— See PANS-AIM (Doc 10066), Appendix 2.

1.8. Airport Design and Master Plan

Introductory Note.— A master plan for the long-term development of an aerodrome conveys the ultimate development in a phased manner and reports the data and logic upon which the plan is based. Master plans are prepared to support modernization of existing aerodromes and creation of new aerodromes, regardless of size, complexity or role. It is important to note that a master plan does not constitute a confirmed implementation programme. It provides information on the types of improvements to be undertaken in a phased manner. Guidance on all aspects of the planning of aerodromes is contained in the Airport Planning Manual (Doc 9184), Part 1.

1.8.1. **Recommendation -** A master plan containing detailed plans for the development of aerodrome infrastructure should be established for aerodromes deemed relevant by States.

Note 1 - A master plan represents the development plan of a specific aerodrome . It is developed by the aerodrome operator based on economic feasibility, traffic forecasts, and current and future requirements provided by, among others, aircraft operators (see 1.8.3).

Note 2.— A master plan may be required when the lack of capacity at an airport, due to conditions such as, but not limited to expected traffic growth, changing weather and climatic conditions or major works to address safety or environmental concerns, would put the connectivity of a geographical area at risk or cause severe disruption to the air transport network

1.8.2. **Recommendation -** The master plan should:

a) contain a schedule of priorities including a phased implementation plan; and

b) be reviewed periodically to take into account current and future aerodrome traffic.

1.8.3. **Recommendation -** Aerodrome stakeholders, particularly aircraft operators, should be consulted in order to facilitate the master planning process using a consultative and collaborative approach.

Note 1.— Provision of advanced planning data to facilitate the planning process includes future aircraft types, characteristics and numbers of aircraft expected to be used,

anticipated growth of aircraft movements, and number of passengers and amount of cargo projected to be handled.

Note 2.— See Annex 9, Chapter 6 on the need for aircraft operators to inform aerodrome operators concerning the former's service, schedule and fleet plans to enable rational planning of facilities and services in relation to the traffic anticipated.

Note 3.— See ICAO's Policies on Charges for Airports and Air Navigation Services (Doc 9082), Section 1, regarding consultation with users concerning provision of advance planning data and protection of commercially sensitive data.

1.8.4. Architectural and infrastructure-related requirements for the optimum implementation of international civil aviation security measures shall be integrated into the design and construction of new facilities and alterations to existing facilities at an aerodrome.

1.8.5. **Recommendation -** The design of aerodromes should take into account, where_appropriate, land-use and environmental control measures.

Note.— Guidance on land-use planning and environmental control measures is contained in the Airport Planning Manual (Doc 9184), Part 2.

1.9. Aerodrome Reference Code

Introductory Note.— The intent of the reference code is to provide a simple method for interrelating the numerous specifications concerning the characteristics of aerodromes so as to provide a series of aerodrome facilities that are suitable for the aeroplanes that are intended to operate at the aerodrome. The code is not intended to be used for determining runway length or pavement strength requirements. The code is composed of two elements which are related to the aeroplane performance characteristics and dimensions. Element 1 is a number based on the aeroplane reference field length and element 2 is a letter based on the aeroplane wingspan. The code letter or number within an element selected for design purposes is related to the critical aeroplane characteristics for which the facility is provided. When applying BAR14 Volume I, first identify the aeroplanes which the aerodrome is intended to serve and then determine the two elements of the code.

1.9.1. An aerodrome reference code - code number and letter – which is selected for aerodrome planning purposes shall be determined in accordance with the characteristics of the aeroplane for which an aerodrome facility is intended.

1.9.2. The aerodrome reference code numbers and letters shall have the meanings assigned to them as shown in Tables 1-1 and Table 1-2 below. The code shall take into account the characteristics of the largest aeroplane regularly using the aerodrome facility.

1.9.3. The code number for element 1 shall be determined from Table 1-1 selecting the code number corresponding to the highest value of the aeroplane reference field lengths of the aeroplanes for which the runway is intended.

Note 1.— The determination of the aeroplane reference field length is solely for the selection of a code number and is not intended to influence the actual runway length provided.

Note 2.— Guidance on determining the runway length is given in the Aerodrome Design Manual (Doc 9157), Part 1.

1.9.4. The code letter for element 2 shall be determined from Table 1-2 by selecting the code letter which corresponds to the greatest wingspan of the aeroplanes for which the facility is intended.

Note.— Guidance on determining the aerodrome reference code is given in the Aerodrome Design Manual (Doc 9157), Parts 1 and 2.

Table 1-1. Aerodrome reference code, Code element 1

Code element 1	
Code number (1)	**Aeroplane reference field length**
1	Less than 800m
2	800m up to but not including 1200m
3	1200m up to but not including 1800m
4	1800m and over

Note. Further guidance on determining the runway length is given in the Aerodrome Design Manual, (Doc 9157), Part 1 - Runways

Table 1-2. Aerodrome reference code, Code element 2

Code element 2	
Code letter (3)	**Wingspan (4)**
A	Up to but not including 15m
B	15m up to but not Including 24m
C	24m up to but not Including 36m
D	36m up to but not Including 52m
E	52m up to but not Including 65m
F	65m up to but not Including 80m

Note 1.- This table are used to determine the aerodrome reference code. Further guidance on planning for aeroplanes with wingspans greater than 80 m is given in Aerodrome Design Manual ICAO Doc 9157 Parts 1 and 2.

Note 2.— Procedures on conducting aerodrome compatibility study to accommodate aeroplanes with folding wing tips spanning two code letters are given in the Procedures for Air Navigation Services Aerodromes (PANS-Aerodromes, Doc 9981). Further guidance can be found in the manufacturer's aircraft characteristics for airport planning manual.

1.10. Specific Procedures for Aerodrome Operations

Introductory Note.— This section introduces PANS-Aerodromes (Doc 9981) for use by an aerodrome undertaking an assessment of its compatibility with the type of traffic or

operation it is intending to accommodate. The material in the PANS-Aerodromes addresses operational issues faced by existing aerodromes and provides the necessary procedures to ensure the continued safety of operations. Where alternative measures, operational procedures and operating restrictions have been developed, these are detailed in the aerodrome manual and reviewed periodically to assess their continued validity. The PANS-Aerodromes does not substitute nor circumvent the provisions contained in this Annex. It is expected that infrastructure on an existing aerodrome or a new aerodrome will fully comply with the requirements in this Annex. See Annex 15, 5.2.2 c) on a State's responsibilities for the listing of its differences to the related ICAO Procedures in its Aeronautical Information Publication.

1.10.1. When the aerodrome accommodates an aeroplane that exceeds the certificated characteristics of the aerodrome, the compatibility between the operation of the aeroplane and aerodrome infrastructure and operations shall be assessed and appropriate measures developed and implemented in order to maintain an acceptable level of safety during operations.

Note.— Procedures to assess the compatibility of the operation of a new aeroplane with an existing aerodrome can be found in the PANS-Aerodromes (Doc 9981).

1.10.2. Information concerning alternative measures, operational procedures and operating restrictions implemented at an aerodrome arising from 1.10.1 shall be promulgated.

Note 1.— See PANS-AIM (Doc 10066), Appendix 2, AD 2.20, on the provision of a detailed description of local traffic regulations.

Note 2.— See PANS-Aerodromes (Doc 9981), Chapter 3, section 3.6, on promulgation of safety information.

1.11. Aeronautical Data

1.11.1. Determination and reporting of aerodrome-related aeronautical data shall be in accordance with the accuracy and integrity classification required to meet the needs of the end-users of aeronautical data.

Note.— Specifications concerning the accuracy and integrity classification related to aerodrome-related aeronautical data are contained in PANS-AIM (Doc 10066), Appendix 1.

1.11.2. **Recommendation -** Aerodrome mapping data should be made available to the aeronautical information services for aerodromes deemed relevant by States where safety and/or performance-based operations suggest possible benefits.

Note 1.— Aerodrome mapping databases related provisions are contained in Annex 15, Chapter 5 and PANS-AIM (Doc 10066), Chapter 5.

Note 2.— Guidance material concerning the application of aerodrome mapping databases is provided in 15.1 Attachment A, Section 22.

1.11.3. Where made available in accordance with 1.11.2, the selection of the aerodrome mapping data features to be collected shall be made with consideration of the intended applications.

Note 1.— It is intended that the selection of the features to be collected match a defined operational need.

Note 2.— Aerodrome mapping databases can be provided at one of two levels of quality — fine or medium. These levels and the corresponding numerical requirements are defined in RTCA Document DO-272B and European Organization for Civil Aviation Equipment

(EUROCAE) Document ED-99C — User Requirements for Aerodrome Mapping Information.

1.11.4. Digital data error detection techniques shall be used during the transmission and/or storage of aeronautical data and digital data sets.

Note.— Detailed specifications concerning digital data error detection techniques are contained in PANS-AIM (Doc 10066).

1.12. Aerodrome Reference Point

1.12.1. An aerodrome reference point shall be established for an aerodrome.

1.12.2. The aerodrome reference point shall be located near the initial or planned geometric centre of the aerodrome and shall normally remain where first established.

1.12.3. The position of the aerodrome reference point shall be measured and reported to the aeronautical information services authority in degrees, minutes and seconds.

1.13. Aerodrome and Runway Elevations

1.13.1. The aerodrome elevation and geoid undulation at the aerodrome elevation position shall be measured to the accuracy of one-half metre or foot and reported to the aeronautical information services authority.

1.13.2. For an aerodrome used by international civil aviation for non-precision approaches, the elevation and geoid undulation of each threshold, the elevation of the runway end and any significant high and low intermediate points along the runway shall be measured to the accuracy of one-half metre or foot and reported to the aeronautical information services authority.

1.13.3. For precision approach runway, the elevation and geoid undulation of the threshold, the elevation of the runway end and the highest elevation of the touchdown zone shall be measured to the accuracy of one-quarter metre or foot and reported to the aeronautical information services authority.

Note.— Geoid undulation must be measured in accordance with the appropriate system of coordinates.

1.14. Aerodrome Reference Temperature

1.14.1. An aerodrome reference temperature shall be determined for an aerodrome in degree Celcius.

1.14.2. **Recommendation -** The aerodrome reference temperature should be the monthly mean of the daily maximum temperatures for the hottest month of the year (the hottest month being that which has the highest monthly mean temperature). This temperature should be averaged over a period of years.

1.15. Aerodrome Dimensions and Related Information.

1.15.1. General information, including the following shall be made available in the AIP:

a) runway — true bearing to one-hundredth of a degree, designation number, length, width, displaced threshold location to the nearest metre or foot, slope,

surface type, type of runway and, for a precision approach runway category I, the existence of an obstacle free zone when provided;

b) strip, runway end safety areas type; stop ways and arresting system - length, width to nearest metre or foot, and surface system type; and location (which runway end) and description;

c) taxiway - designation, width and surface type;

d) apron - surface type and aircraft stands;

e) the boundaries of the air traffic control service;

f) clearway - length to the nearest metre of foot, and ground profile;

g) visual aids for approach procedures; marking and lighting of runways, taxiways and aprons; other visual guidance and control aids on taxiways and aprons, including runway holding positions, taxi-holding positions and stop bars, and location and type of visual docking guidance system; availability of standby power of lighting;

h) location and radio frequency of VOR aerodrome check-point;

i) location and designation of standard taxi-routes;

j) distances to the nearest metre or foot of localizer and glide path elements comprising an instrument landing system (ILS) or azimuth and elevation antenna of a microwave landing system (MLS) in relation to the associated runway extremities.

k) the geographical coordinates of each threshold shall be measured and reported to the aeronautical information services authority in degrees, minutes, seconds and hundredths of seconds.

l) the geographical coordinates of appropriate taxiway center line points shall be measured and reported to the aeronautical information services authority in degrees, minutes, seconds and hundredths of seconds.

m) the geographical coordinates of each aircraft stand shall be measured and reported to the aeronautical information services authority in degrees, minutes, seconds and hundredths of seconds.

n) The geographical coordinates of obstacles in Area 2 (the part within the aerodrome boundary) and in Area 3 shall be measured and reported to the aeronautical information services authority in degrees, minutes, seconds and tenths of seconds. In addition, the top elevation, type, marking and lighting (if any) of significant obstacles in the approach and take-off areas, in the circling area and in the vicinity of the aerodrome shall be reported to the aeronautical information services authority. This information may best be shown in the form of charts such as those required for the preparation of aeronautical information publications as specified in BAR 4 and BAR 15, Annex 4 and Annex 15 and PANS-AIM (Doc 10066);

Note.— PANS-AIM (Doc 10066), Appendix 8, provides requirements for obstacle data determination in Areas 2 and 3.

o) pavement surface type and bearing strength using Aircraft Classification Rating - Pavement Classification Rating (ACR - PCR) method;

p) one or more pre-flight altimeter check locations shall be established on an apron and their elevation;

q) declared distances; take-off run available (TORA); take-off distance available (TODA); accelerate-stop distance available (ASDA); landing distance available (LDA);
Note.— Guidance on calculation of declared distances is given in 15.1 Attachment A, Section 3.

r) disabled aircraft removal plan: the telephone/telex/facsimile numbers; e-mail address of the aerodrome coordinator for the removal of an aircraft disabled on or adjacent to the movement area; information on the capability to remove a disabled aircraft - expressed in terms of the aircraft which the aerodrome is equipped to remove; and

s) rescue and fire fighting: level of protection provided shall be expressed terms of the category of the rescue and fire fighting services which shall be in accordance with the longest aeroplane normally using the aerodrome and the type and amounts of extinguishing agents normally available at the aerodrome.

t) Information on the condition of the movement area and the operational status of related facilities shall be provided to the appropriate aeronautical information services units, and similar information of operational significance to the air traffic services units, to enable those units to provide the necessary information to arriving and departing aircraft. The information shall be kept up to date and changes in conditions reported without delay.

Note.1 — The Nature, format and conditions of the information to be provided are specified in the PANS-AIM (Doc 10066) and the PANS-ATM (Doc 4444).

Note. 2 – The accuracy of the information provided under paragraph 1.15.1 is critical to aircraft safety. Information requiring engineering survey and assessment should be gathered or verified by qualified technical persons.

1.16. Strength of Pavement (Applicable as of 28 November 2024)

1.16.1. The bearing strength of a pavement shall be determined.

1.16.2. The bearing strength of a pavement intended for aircraft of apron (ramp) mass greater than 5 700 kg shall be made available using the aircraft classification rating-pavement classification rating (ACR-PCR) method by reporting all of the following information:

a) pavement classification rating (PCR) and numerical value;

b) pavement type for ACR-PCR determination;

c) subgrade strength category;

d) maximum allowable tire pressure category or maximum allowable tire pressure value; and

e) evaluation method.

Note.— Guidance on reporting and publishing of PCRs is contained in the Aerodrome Design Manual (Doc 9157, Part 3).

1.16.3. The PCR reported shall indicate that aircraft with an aircraft classification rating (ACR) equal to or less than the reported PCR may operate on the pavement

subject to any limitation on the tire pressure or aircraft all-up mass for specified aircraft type(s).

Note.— Different PCRs may be reported if the strength of the pavement is subject to significant seasonal variation.

1.16.4. The ACR of an aircraft shall be determined in accordance with the standard procedures associated with the ACR-PCR method.

Note.— The standard procedures for determining the ACR of an aircraft are given in the Aerodrome Design Manual (Doc 9157), Part 3. For convenience, dedicated software is available on the ICAO website for computing any aircraft ACR at any mass on rigid and flexible pavements for the four standard subgrade strength categories detailed as in 1.16.6 (b) below

1.16.5. For the purposes of determining the ACR, the behaviour of a pavement shall be classified as equivalent to a rigid or flexible construction.

1.16.6. Information on pavement type for ACR-PCR determination, subgrade strength category, maximum allowable tire pressure category and evaluation method codes shall be reported using the following codes:

a) Pavement type for ACR-PCR determination:

	Code
Rigid pavement	R
Flexible pavement	F

Note.— If the actual construction is composite or non-standard, include a note to that effect (see example 2 below).

b) Subgrade strength category:

	Code
High strength: characterized by E = 200 MPa and representing all E values equal to or above 150 MPa, for rigid and flexible pavements.	A
Medium strength: characterized by E = 120 MPa and representing a range in E values equal to or above 100 MPa and strictly less than 150 MPa, for rigid and flexible pavements.	B
Low strength: characterized by E = 80 MPa and representing a range in E values equal to or above 60 MPa and strictly less than 100 MPa, for rigid and flexible pavements.	C
Ultra-low strength: characterized by E = 50 MPa and representing all E values strictly less than 60 MPa, for rigid and flexible pavements.	D

c) Maximum allowable tire pressure category:

	Code
Unlimited: no pressure limit	W
High: pressure limited to 1.75 MPa	X
Medium: pressure limited to 1.25 MPa	Y
Low: pressure limited to 0.50 Mpa	Z

Note.— See Note 5 to 10.2.1 where the pavement is used by aircraft with tire pressures in the upper categories.

d) Evaluation method:

	Code
Technical evaluation: representing a specific study of the pavement characteristics and the types of aircraft which the pavement is intended to serve.	T
Using aircraft experience: representing a knowledge of the specific type and mass of aircraft satisfactorily being supported under regular use.	U

Note.— The following examples illustrate how pavement strength data are reported under the ACR-PCR method. Further guidance on this topic is contained in the Aerodrome Design Manual (Doc 9157), Part 3.

Example 1.— If the bearing strength of a rigid pavement, resting on a medium-strength subgrade, has been assessed by technical evaluation to be PCR 760 and there is no tire pressure limitation, then the reported information would be:

PCR 760 / R / B / W / T

Example 2.— If the bearing strength of a composite pavement, behaving like a flexible pavement and resting on a highstrength subgrade, has been assessed by using aircraft experience to be PCR 550 and the maximum allowable tire pressure is 1.25 MPa, then the reported information would be:

PCR 550 / F / A / Y / U

Note.— Composite construction.

1.16.7. **Recommendation -** Criteria should be established to regulate the use of a pavement by an aircraft with an ACR higher than the PCR reported for that pavement in accordance with 1.16.2 and 1.16.3.

Note.— Chapter 15.1 Attachment A, Section 19, details a simple method for regulating overload operations while the Aerodrome Design Manual (Doc 9157), Part 3, includes the descriptions of more detailed procedures for evaluation of pavements and their suitability for restricted overload operations.

1.16.8. The bearing strength of a pavement intended for aircraft of apron (ramp) mass equal to or less than 5 700 kg shall be made available by reporting the following information:

a) maximum allowable aircraft mass; and

b) maximum allowable tire pressure.

Example: 4 800 kg/0.60 MPa.

1.17. Pre-flight Altimeter Check Location

1.17.1. One or more pre-flight altimeter check locations shall be established for an aerodrome.

1.17.2. **Recommendation -** A pre-flight check location should be located on an apron.

Note 1.— Locating a pre-flight altimeter check location on an apron enables an altimeter check to be made prior to obtaining taxi clearance and eliminates the need for stopping for that purpose after leaving the apron.

Note 2.— Normally an entire apron can serve as a satisfactory altimeter check location.

1.17.3. The elevation of a pre-flight altimeter check location shall be given as the average elevation, rounded to the nearest metre or foot, of the area on which it is located. The elevation of any portion of a pre-flight altimeter check location shall be within 3 m (10 ft) of the average elevation for that location.

1.18. Declared Distances

1.18.1. The following distances shall be calculated to the nearest metre or foot for a runway intended for use by international commercial air transport:

a) take-off run available;

b) take-off distance available;

c) accelerate-stop distance available; and

d) landing distance available.

Note.— Guidance on calculation of declared distances is given in Chapter 15, Attachment A, Section 3.

1.19. Condition of the Movement Area and Related Facilities

1.19.1. Information on the condition of the movement area and the operational status of related facilities shall be provided to the appropriate aeronautical information services units, and similar information of operational significance to the air traffic services units, to enable those units to provide the necessary information to arriving and departing aircraft. The information shall be kept up to date and changes in conditions reported without delay.

Note.— The nature, format and conditions of the information to be provided are specified in the PANS-AIM (Doc 10066) and the PANS-ATM (Doc 4444). Specific procedures pertaining to works in progress on the movement area and to the reporting of such works are included in the PANS-Aerodromes (Doc 9981).

1.19.2. The condition of the movement area and the operational status of related facilities shall be monitored, and reports on matters of operational significance affecting aircraft and aerodrome operations shall be provided in order to take appropriate action, particularly in respect of the following:

a) construction or maintenance work;

b) rough or broken surfaces on a runway, a taxiway or an apron;

c) water on a runway, a taxiway or an apron;

d) contaminants on a runway, taxiway or apron;

e) other temporary hazards, including parked aircraft;

f) failure or irregular operation of part or all of the aerodrome visual aids; and

g) failure of the normal or secondary power supply.

Note 1.— Other contaminants may include mud, dust, sand, volcanic ash, oil and rubber. Procedures for monitoring and reporting including for the issuance of NOTAMs in relation to the the conditions of the movement area are included in the PANS-Aerodromes (Doc 9981).

Note 2.— The Aeroplane Performance Manual (Doc 10064) provides guidance on aircraft performance calculation requirements regarding the description of runway surface conditions in 2.9.2 c), d) and e).

Note 3.— Origin and evolution of data, assessment process and the procedures are prescribed in the PANS-Aerodromes (Doc 9981). These procedures are intended to fulfil the requirements to achieve the desired level of safety for aeroplane operations prescribed by Annex 6 and Annex 8 and to provide the information fulfilling the syntax requirements for dissemination specified in Annex 15, PANS-AIM (Doc 10066) and the PANS-ATM (Doc 4444).

1.19.3. To facilitate compliance with 1.19.1 and 1.19.2, the following inspections shall be carried out each day:

a) for the movement area, at least once where the aerodrome reference code number is 1 or 2 and at least twice where the aerodrome reference code number is 3 or 4; and

b) for the runway(s), inspections in addition to a) whenever the runway surface conditions may have changed significantly due to meteorological conditions.

Note 1.— Procedures on carrying out daily inspections of the movement area are given in the PANS-Aerodromes (Doc 9981). Further guidance is available in the Airport Services Manual (Doc 9137), Part 8, in the Manual of Surface Movement Guidance and Control Systems (SMGCS) (Doc 9476) and in the Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual (Doc 9830).

Note 2.— The PANS-Aerodromes (Doc 9981) contains clarifications on the scope of a significant change in the runway surface conditions.

1.19.4. Personnel assessing and reporting runway surface conditions required in 1.19.2 and 1.19.5 shall be trained and competent to perform their duties.

Note 1.— Guidance on training of personnel is given in Chapter 15 Attachment A, Section 6

Note 2.— Information on training for personnel assessing and reporting runway surface conditions is available in the PANS-Aerodromes (Doc 9981).

Runway surface condition(s) for use in the runway condition report

Introductory Note.— The philosophy of the runway condition report is that the aerodrome operator assesses the runway surface conditions whenever water are present on an operational runway. From this assessment, a runway condition code (RWYCC) and a description of the runway surface are reported which can be used by the flight crew for aeroplane performance calculations. This report, based on the type, depth and coverage of contaminants, is the best assessment of the runway surface condition by the aerodrome operator; however, all other pertinent information may be taken into consideration. See 15.1 Attachment A, Section 6, for further details. The ADR 024 Global Reporting Format GRF contains procedures on the use of the runway condition report and assignment of the RWYCC in accordance with the runway condition assessment matrix (RCAM). Further GRF procedures are given in PANS-Aerodromes (Doc 9981).

1.19.5. The runway surface condition shall be assessed and reported through a runway condition code (RWYCC) and a description using the following terms:

DRY
STANDING WATER
WET
LOOSE SAND

Note 1.— The runway surface conditions are those conditions for which, by means of the methods described in the PANS-Aerodromes (Doc 9981), the flight crew can derive appropriate aeroplane performance.

Note 2.— The conditions, either singly or in combination with other observations, are criteria for which the effect on aeroplane performance is sufficiently deterministic to allow assignment of a specific runway condition code.

Note 3.— The terms LOOSE SAND do not appear in the aeroplane performance section but are used in the situational awareness section of the runway condition report.

1.19.6. Whenever an operational runway is contaminated, an assessment of the contaminant depth and coverage over each third of the runway shall be made and reported.

Note.— Procedures on depth and coverage reporting are found in the PANS-Aerodromes (Doc 9981)

1.19.7. Reserved

1.19.8. Reserved

1.19.9. Information that a runway or portion thereof is slippery wet shall be made available.

Note 1.— The surface friction characteristics of a runway or a portion thereof can be degraded due to rubber deposits, surface polishing, poor drainage or other factors. The determination that a runway or portion thereof is slippery wet stems from various methods used solely or in combination. These methods may be functional friction measurements, using a continuous friction measuring device, that fall below a minimum standard as defined by the State, observations by aerodrome maintenance personnel, repeated reports by pilots and aircraft operators based on flight crew experience, or through analysis of aeroplane stopping performance that indicates a substandard surface. Supplementary tools to undertake this assessment are described in the PANS-Aerodromes (Doc 9981).

Note 2.— See 1.19.1 and 1.23 concerning the provision of information to, and coordination between, appropriate authorities.

1.19.10. Notification shall be given to relevant aerodrome users when the friction level of a paved runway or portion thereof is less than the minimum friction level specified by the Brunei DCA in accordance with 10.2.3.

Note 1.— Additional guidance on determining and expressing the minimum friction level is provided in Assessment, Measurement and Reporting of Runway Surface Conditions (Cir 355).

Note 2.— Procedures on conducting a runway surface friction characteristics evaluation programme are provided in the PANS-Aerodromes (Doc 9981).

Note 3.— Information to be promulgated in a NOTAM includes specifying which portion of the runway is below the minimum friction level and its location on the runway.

1.20. Disabled Aircraft Removal

Note.— See 9.3 for information on disabled aircraft removal services.

1.20.1. **Recommendation** - The telephone/telex number(s) of the office of the aerodrome coordinator of operations for the removal of an aircraft disabled on or adjacent to the movement area should be made available, on request, to aircraft operators.

1.20.2. **Recommendation** - Information concerning the capability to remove an aircraft disabled on or adjacent to the movement area should be made available.

Note.— The capability to remove a disabled aircraft may be expressed in terms of the largest type of aircraft which the aerodrome is equipped to remove.

1.21. Rescue and Firefighting

Note.— See 9.2 for information on rescue and firefighting services.

1.21.1. Information concerning the level of protection provided at an aerodrome for aircraft rescue and firefighting purposes shall be made available in the AIP.

1.21.2. **Recommendation** - The level of protection normally available at an aerodrome should be expressed in terms of the category of the rescue and firefighting services as described in 9.2 and in accordance with the types and amounts of extinguishing agents normally available at the aerodrome.

1.21.3. Changes in the level of protection normally available at an aerodrome for rescue and firefighting shall be notified to the appropriate air traffic services units and aeronautical information services units to enable those units to provide the necessary information to arriving and departing aircraft. When such a change has been corrected, the above units shall be advised accordingly.

Note.— Changes in the level of protection from that normally available at the aerodrome could result from a change in the availability of extinguishing agents, equipment to deliver the agents or personnel to operate the equipment, etc.

1.21.4. **Recommendation** - A change should be expressed in terms of the new category of the rescue and firefighting service available at the aerodrome.

1.22. Visual Approach Slope Indicator Systems

The following information concerning a visual approach slope indicator system installation shall be made available:

a) associated runway designation number;

b) type of system according to 5.3.5.2. For a PAPI or APAPI installation, the side of the runway on which the lights are installed, i.e. left or right, shall be given;

c) where the axis of the system is not parallel to the runway centre line, the angle of displacement and the direction of displacement, i.e. left or right, shall be indicated;

d) nominal approach slope angle(s). For a PAPI and an APAPI this shall be angle (B + C) ÷ 2 and (A + B) ÷ 2, respectively as in Figure 5-20; and

e) minimum eye height(s) over the threshold of the on-slope signal(s). For a PAPI this shall be the setting angle of the third unit from the runway minus 2', i.e. angle B minus 2', and for an APAPI this shall be the setting angle of the unit farther from the runway minus 2', i.e. angle A minus 2'.

1.23. Coordination Between Aeronautical Information Services and Aerodrome Authorities

1.23.1. To ensure that aeronautical information services units obtain information to enable them to provide up-to-date pre-flight information and to meet the need for in-flight information, arrangements shall be made between aeronautical information services and aerodrome authorities responsible for aerodrome services to report to the responsible aeronautical information services unit, with a minimum of delay:

a) information on the status of certification of aerodromes and aerodrome conditions (ref. 2.11, 1.19, 1.20, 1.21, 1.22);

b) the operational status of associated facilities, services and navigation aids within their area of responsibility;

c) any other information considered to be of operational significance.

1.23.2. Before introducing changes to the air navigation system, due account shall be taken by the services responsible for such changes of the time needed by aeronautical information services for the preparation, production and issue of relevant material for promulgation. To ensure timely provision of the information to aeronautical information services, close coordination between those services concerned is therefore required.

1.23.3. Of a particular importance are changes to aeronautical information that affect charts and/or computer-based navigation systems which qualify to be notified by the aeronautical information regulation and control (AIRAC) system, as specified in Annex 15, Chapter 6. The predetermined, internationally agreed AIRAC effective dates shall be observed by the responsible aerodrome services when submitting the raw information/data to aeronautical information services.

Note.— Detailed specifications concerning the AIRAC system are contained in PANS-AIM (Doc 10066), Chapter 6.

1.23.4. The aerodrome services responsible for the provision of raw aeronautical information/data to the aeronautical information services shall do that while taking into account accuracy and integrity requirements necessary to meet the needs of the end-user of aeronautical data.

Note 1.— Specifications concerning the accuracy and integrity classification of aerodrome-related aeronautical data are contained in PANS-AIM (Doc 10066), Appendix 1.

Note 2.— Specifications for the issue of NOTAM and SNOWTAM are contained in Annex 15, Chapter 6 and PANS-AIM (Doc 10066), Appendices 3 and 4, respectively.

Note 3.— AIRAC information is distributed by the AIS at least 42 days in advance of the AIRAC effective dates with the objective of reaching recipients at least 28 days in advance of the effective date.

Note 4.— The schedule of the predetermined internationally agreed AIRAC common effective dates at intervals of 28 days and guidance for the AIRAC use are contained in the Aeronautical Information Services Manual (Doc 8126, Chapter 2).

1.24. Runway Safety

Introductory Note.— This section covers the establishment requirements of a runway safety team at an aerodrome, the identification of hazards related to runway safety, the development and implementation of action plans, collection of data and the promulgation of safety information.

Note.— See PANS-Aerodromes (Doc 9981), Chapter 8, on Runway Safety for more details information.

1.24.1. Objectives

1.24.1.1. An aerodrome operator shall establish a runway safety team comprised of relevant organizations operating or providing services on the aerodrome.

1.24.1.2. The runway safety team shall identify runway related hazards. These may include aerodrome design, markings, signs and lights, as well as relevant aerodrome operations and procedures.

1.24.1.3. Within the context of the runway safety team, measures shall be taken to mitigate any hazards identified in accordance with the above paragraph and, as appropriate, reduce the safety risk of issues related to runway safety, including but not limited to the following:

a) runway incursion;

b) runway excursion;

c) runway confusion; and

d) suspension or closure of runway operations.

1.24.1.4. The runway safety team shall identify hazards and develop mitigation strategies and procedures to maintain runway safety during abnormal operations, including the suspension of runway operations. These strategies and procedures shall be implemented under the responsibility of the aerodrome operator.

1.24.1.5. Procedures to collect, monitor, analyse and protect safety data and safety information shall be established to understand and improve runway safety performance.

1.24.1.6. Information that could enhance runway safety, including identified hot spots and specific local procedures shall be communicated to the relevant users.

1.24.2. Operational Practices of Runway Safety Teams (RST)

1.24.2.1. The terms of reference and composition of the runway safety team (RST) shall be established and included in the aerodrome manual. Activities to be included in the terms of reference as well as the proposed composition of an RST are included in the Appendix found in the PANS-Aerodromes (Doc 9981) Chapter 8.

1.24.2.2. All organizations involved in the RST shall participate in a collaborative process of hazard identification and safety risk assessment, as well as in the development of a robust runway safety action plan.

1.24.2.3. The primary role of the RST shall be to develop a runway safety action plan. This action plan shall, as a minimum, facilitate the identification of runway safety hazards and the conduct of runway safety risk assessments and recommend measures for hazard removal and mitigation of the residual risk. These measures may be developed based on local occurrences or combined with information collected from external databases.

Note 1.— The runway safety action plan may be supported by a safety risk management process under the aerodrome safety management system, in accordance with the Safety Management Manual (SMM) (Doc 9859).

Note 2.— For more details on the establishment of a runway safety team, see the ICAO Runway Safety Team Handbook.

Note 3.— A list of causal factors to runway safety events is included in Attachment B to PANS-Aerodromes (Doc 9981) Chapter 8.

1.24.2.4. The aerodrome operator shall have ownership of the runway safety action plan_and ensure that it forms an effective element of the aerodrome safetymanagement system, as appropriate.

Note.— More information covers under the establishment of a runway safety team at an aerodrome; Runway incursion prevention, Runway excursion prevention, Runway confusion, and Suspension or closure of runway operations can be found in the PANS-Aerodromes (Doc 9981) Chapter 8 Runway Safety.

1.25. Coordination Between Air Traffic Service (ATS) Provider and Aerodrome Operator

1.25.1. The Aerodrome Operator and ATS Provider shall coordinate their activities regarding issues related to both the safety of aerodrome and aircraft operations.

1.25.2. The coordination between Aerodrome Operator and ATS Provider shall consists but not limited of the following:

a. Aerodrome Works;
b. Construction of buildings and structures in the vicinity of the airport;
c. Construction of helipads in the vicinity of the airport;
d. Bird and Wildlife Strike Reporting;
e. Incidents on Runway/Apron/Taxiway;
f. Disruption/Change of Aerodrome Facilities and Services;
g. New Aerodrome Facilities;
h. Obstacles on Strip/RESA/Aerodrome;

i. Aerodrome Data;

j. Feedback on status of ground aids, when required;

k. Lighting Facilities;

l. Rescue and Fire Fighting (RFF); and

m. Runway Excursion / Incursion.

Note. - see ADR 012 Aerodrome Certification Procedure Para 3.6.1 and PANS-Aerodrome (Doc 9981) for further information.

1.26. Aerodrome Safety Coordination

1.26.1. Introduction

This section specifies the role of the Brunei DCA Regulatory in the coordination process and the interaction between the aerodrome operator and other stakeholders which is necessary for the safety of operations at the aerodrome.

1.26.2. Coordination affecting aerodrome safety

1.26.2.1. The Brunei DCA Regulatory shall verifies that coordination exists between the aerodrome operator, aeroplane operators, air navigation service providers and all other relevant stakeholders to ensure the safety of operations.

1.26.2.2. The aerodrome operator shall ensure that all users of the aerodrome, including ground-handling agencies and other organizations that perform activities independently at the aerodrome in relation to flight or aircraft handling, comply with the safety requirements of the aerodrome operator. The aerodrome operator monitors such compliance.

1.26.3. State's feedback on occurrences

1.26.3.1. The aerodrome operator shall report safety occurrences at their aerodromes to Brunei DCA in accordance with the applicable regulation in BAR 13 – Accident Prevention & Occurrence Reporting.

1.26.3.2. Aerodrome operators shall report accidents and serious incidents, including:

a) runway excursions;

b) undershoots;

c) runway incursions;

d) landing or take-off on a taxiway; and

e) wildlife strike-related events. (see 9.4 Wildlife Hazard Reduction)

1.26.3.3. In addition to accidents and serious incidents, aerodrome operators shall report safety occurrences of the following types:

a) foreign object debris/damage- (FOD) related event;

b) other excursions (i.e. from a taxiway or apron);

c) other incursions (i.e. on taxiway or apron); and

d) ground collisions.

Note.— ICAO Doc (9981) Appendix 2 details the list of safety occurrences types and related critical data which shall be reported at an aerodrome. The related tasks for

reporting these occurrences and to feed the data when required are shared and coordinated between the various aerodrome stakeholders.

1.26.3.4. An aerodrome operator shall ensure that analysis of safety occurrences at the aerodrome is performed by competent personnel who have been trained to perform these tasks.

1.26.3.5. Aerodrome operators shall coordinate with all users of the aerodrome, including aircraft operators, ground-handling agencies, air navigation service providers and other stakeholders to improve the completeness and accuracy of the collection of safety occurrences and their related critical data.

1.26.3.6. The Brunei DCA Regulatory shall review and analyse the information provided by the aerodrome operator in the occurrences reports to ensure that:

a) all occurrences in 1.26.3.2 and 1.26.3.3 are adequately analysed by the aerodrome operator;

b) significant trends are identified (either on a specific aerodrome or at a national level). Further in-depth analysis on the subject shall be carried out if required so that the appropriate actions can be taken; and

c) the most serious/significant occurrences shall be carefully followed up by the Brunei DCA.

1.26.3.7. The output of these analyses can be used as input for the planning of continued oversight.

Note.— Variations in the frequency of occurrences reports on a specific aerodrome, other than those occurring as a result of seasonal variations in the types and/or levels of operations, could be considered to be an indicator of a potential problem in the reporting culture on the aerodrome or a specific danger that shall have been studied by the aerodrome operator. The continued oversight of the reporting processes or subjects with a high frequency of occurrence shall be reinforced.

1.26.4. Oversight of third parties

1.26.4.1. Compliance of third parties with the safety provisions established by the aerodrome operator as specified in 1.26.2.2 shall be monitored using the appropriate means.

Chapter 2. Aerodrome Certification

2.1 Aerodrome Certification Process

(a) This chapter describes the requirement for aerodromes to operate with an Aerodrome Certificate and the process of certification by the Brunei DCA [RASS].

Note. - When an aerodrome is granted a certificate, it signifies to aircraft operators and other organizations operating on the aerodrome that, at the time of certification, the aerodrome meets the specifications regarding the facility and its operation,and that it has, according to the certifying authority, the capability to maintain these specifications for the period of validity of the certificate. The certification process also establishes the baseline for continued monitoring of compliance with the specifications.

(b) Information and guidance for aerodrome operators may be issued by Brunei DCA as a separate advisory publication or incorporated into the applicable BARs to support the aerodrome certification process.

(c) The following Guidance Materials prescribed the aerodrome certification process in more details:
- i) ADR 012 - Aerodrome Certification Procedure; and
- ii) ADR 017 - Aerodrome Certification Issuance and Verification.

2.1.1. Requirement for an aerodrome certificate:

a) The operator of an aerodrome within Brunei Darussalam intended for international operations shall be in possession of an Aerodrome Certificate in accordance with the specifications contained in the BAR 14 as well as other relevant ICAO specifications through an appropriate regulatory framework.

Note.- The context meaning of aerodromes open for international operations or public use shall be in accordance with the requirements of Article 15 and Article 68 of the Chicago convention (Doc 7300).

b) The Aerodrome Certificate process shall follows a number of phases which are subject to acceptance by Brunei DCA RASS before the aerodrome operator may advance to the next phase.

c) This certification process shall consists of:

i. Phase One - Pre-application;
ii. Phase Two - Formal Application;
iii. Phase Three - Document Evaluation;
iv. Phase Four - Initial Certification Audit; and
v. Phase Five – Grant or refusal of an aerodrome Certificate.

2.1.2. Phase One - Pre-application, for an aerodrome certificate:

(a) The pre-application phase may be omitted or be shortened or be skipped to Phase Two – Formal Application, if the applicant/aerodrome operator is familiar with the requirements of the Aerodrome Regulations and the operations of an aerodrome.

(b) In case of an already functioning aerodrome that needs to be certificated, the applicant/aerodrome operator shall still need to contact Brunei DCA with his

intention to commence the process, identifying the level of operation of the aerodrome and shall brief Brunei DCA RASS on his capabilities and intentions.

Note: Further guidance (Phase One) - Pre-application is given in ADR 012 Aerodrome Certification Procedure.

2.1.3. **Phase Two - Formal Application, for an aerodrome certificate:**

(a) An application for an Aerodrome Certificate shall be submitted officially to the Brunei DCA not later than 6 months prior to intended operation, for approval.

(b) The Applicant shall apply for an aerodrome certification using the Form ADR 019 - Application for an Aerodrome Certificate.

(c) In addition to b), the Applicant shall submit but not limited to:

i. Aerodrome Manual
ii. Aerodrome Emergency Plan
iii. Acceptable Safety Management System (SMS) Manual
iv. ADR 013 – Aerodrome Manual Checklist
v. ADR 009 – SMS Evaluation

(d) Brunei DCA RASS may require other documentation to facilitate the assessment of application.

2.1.4. **Phase Three – Document Evaluation, and Assessment of Application:**

(a) The initial assessment of application shall be based on information provided by Applicant of the forms ADR 019, ADR 013, ADR 009 and other documentation as required by Brunei DCA [RASS].

(b) The Aerodrome Manual is a fundamental requirement of the aerodrome certification process and shall take the form and contains information as detailed set out in 2.2.

(c) The Aerodrome Manual and any other required documents provided by an Applicant will be assessed to ensure the intention to fully comply with the BAR 14 Vol I., as applicable to the scale of the proposed aerodrome operation.

(d) Any non-compliance, deficiency or deviation from the applicable BARs shall be discussed with the Applicant and the rectification within the specify period is required in order to proceed to the next certification phase.

(e) If the result of the initial assessment is negative, then there is no need to proceed any further and the Brunei DCA [RASS] will inform the Applicant accordingly.

(f) The Applicant may appeal to the Brunei DCA [RASS] decisions and submit revised application.

(g) The initial assessment, however, does not take into consideration land-use and environmental protection issues that may require approval of other

authorities. The Applicant shall provide information regarding these approvals as detailed in the application form ADR 019, where applicable.

2.1.5. **Phase Four - Initial Certification Audit (Demonstration)**

(a) An Initial Certification audit will only be conducted after the Brunei DCA [RASS] has been satisfied with all the documentations submitted by the Applicant in Phase Three.

(b) The Applicant will be notified the date when initial certification audit is to be conducted.

(c) Brunei DCA [RASS] shall carry out a detailed examination of the aerodrome. The initial certification audit is undertaken for the purpose of verifying the information provided in the Aerodrome Manual; and to physically check and assess the facilities, equipment, services and operational organization and ensure that they comply with BAR 14 Volume I - Aerodromes and other relevant ICAO SARPs as determined by the Brunei DCA [RASS].

Note: Guidance for initial certification checklists are given in the ADR 006 - Aerodrome Inspector Handbook

(d) An Initial Certification audit generally include the following steps:

(1) Notification
Notification by Brunei DCA on the audit date.

(2) Pre-Audit Briefing
On-site briefing regarding audit procedure, scope of audit, audit time schedule and Applicant's personnel to be made available during audit.

(3) Pre-Audit Review
Audit of documentation and other standard operating procedures, preventive and corrective maintenance plans, maintenance records, AIPs, Aeronautical Charts, NOTAMS and other relevant documentation relating to safe and efficient operations of the aerodrome.

(4) Physical Audit
Audit on facilities, equipment, services and operational organization to assess compliance with BAR 14 Volume I.

(5) Night Audit
Only for aerodromes where operations are conducted at night or where an approach lighting system is provided.

(6) Post Audit Briefing
Where audit findings on documentations, facilities, equipment, services and operational organization are informed to the Applicant.

(e) The Applicant shall allow the Brunei DCA [RASS] to access and inspect to any part of the aerodrome or any aerodrome facility, including equipment, records and documents, during the initial certification audit.

(f) The Applicant shall cooperate and facilitate with the Brunei DCA [RASS] in conduct of the initial certification audit, and relevant Applicant's personnel shall be made available to the Brunei DCA [RASS] to facilitate the audit.

Note: Details guidance of initial certification audit is given in ADR 012 – Aerodrome Certification Procedure, Para 2.3.5.

2.1.6. **Findings of Non-Compliance**

(a) For all finding of non-compliance identified, if any, the Brunei DCA [RASS] shall issue a non-compliance audit report to the Applicant within fourteen(14) working days upon the completion of a initial certification audit.

(b) The details regarding the non-compliance findings such as root cause analysis and corrective/ preventative actions, shall be registered and communicated via Non-Compliance /Observation Report Form by Brunei DCA RASS, presented in ADR 012 - Aerodrome Certification Procedure, 4.3 and Appendix 3.

(c) Findings and shortcomings are classified as follow –

(i) Level 1 Finding (major non-compliances) :

Level 1 findings are those which pose a hazard to aircraft operational safety or which contravenes a legal requirement or which lowers safety standards or *standard or* has the potential to result in loss of life, serious injury or damage to facilities and immediate action by Applicant is required.

(ii) Level 2 Finding (minor non-compliances):

A Level 2 finding non-compliance with the applicable BARs or a finding against the aerodrome operator's procedures, which could possibly hazard the aircraft operational safety or which could lower safety standards. Immediate action by Applicant is encouraged or by the date agreed with the Brunei DCA.

(iii) Observation :

An observation finding is a recommendation to improve safety standards and/or achieve a better practice by addressing: (1) opportunities for improvements or (2) deficiencies that may lead to potential findings. Immediate action by Applicant is encouraged or by the date agreed with the Brunei DCA.

2.1.7. **Remedial Action**

(a) All non-compliances registered in an audit report, and which are stated and issued to the Applicant in the Non-Compliance Form, will require corrective action by the Applicant.

(b) Applicant shall state proposed corrective action plan in the Non–Compliance Report Form together with the determined root cause and planned implementation date and to submit to the Brunei DCA [RASS] within thirty (30) days of the date of receipt of the audit report.

(c) The corrective action plan shall describe method(s) to be taken by the Applicant to address the non-compliance, the time duration required and the date which compliance will be achieved.

(d) The Brunei DCA [RASS], upon receipt and evaluation of Applicant's corrective action plan, may or may not approve the plan. Where the plan

suggested is not satisfactory or the time duration to correct the findings is considered unacceptable, the Brunei DCA [RASS] will notify the Applicant to revise his corrective action plan.

(e) A revised corrective action plan must be submitted to the Brunei DCA [RASS] within fourteen (14) days of the notification by the Brunei DCA [RASS].

(f) Regardless of the above, Brunei DCA [RASS] shall expects –

(i) Major non-compliances on aerodrome facilities, equipment and services shall be immediately corrected by the Applicant; and

(ii) Revision and amendment to correct deficiencies or discrepancies in the Aerodrome Manual and other operating procedures shall be submitted to the Brunei DCA [RASS] within thirty (30) days of the date of the audit report issued by the Brunei DCA [RASS].

(g) The Brunei DCA [RASS] may conduct a follow-up audit to certify the non-compliances that have been satisfactorily corrected.

(h) In cases where the aerodrome operator being audited does not agree with any of the finding of non-compliance, it shall direct a formal written notice of disagreement to the Brunei DCA RASS within generally 14 days after the closing audit meeting, detailing the reasons for the disagreement. The Brunei DCA RASS may review this and determine subsequent action in accordance with the regulatory requirements and the best interests of aviation safety.

Note: Further information regarding dispute or diagreement is given in ADR 025 – Aerodrome Certification Procedure, Para 2.3.5.41 & 2.3.5.42

2.1.8. **Phase Five - Grant or refusal of an aerodrome certificate**

(a) Before granting an Aerodrome Certificate, the Brunei DCA [RASS] must be satisfied that:

(1) The aerodrome facilities, services and equipment are in accordance with BAR 14 Volume I - Aerodromes and other relevant ICAO SARPs as determined by the Brunei DCA RASS;

(2) The Aerodrome Manual prepared for the applicant's aerodrome and submitted with the application contains all the pertinent information on the aerodrome site, facilities, services, equipment, operating procedures and management including a safety management system;

(3) An acceptable and suitable safety management system is in place at the aerodrome and documented within the aerodrome manual;

(4) The aerodrome Rescue Firefighting Service is staffed, trained, equipped, operated and organised to the meet the applicable requirements;

(5) The applicant and their staff have the necessary competence to operate and maintain the aerodrome properly;

(6) The aerodrome operating procedures make satisfactory provision for the safety of aircraft operations; and

(7) Payment of the appropriate aerodrome certification fee has been received (if applicable only).

(b) The Brunei DCA [RASS] may refuse to grant an Aerodrome Certificate to an applicant. In such cases, the Brunei DCA [RASS] shall notify the applicant, in writing, of its reasons no later than 60 working days after making that decision.

(c) An application for a certificate of aerodrome may be refused or delayed if –

i. Any requirement listed in 2.18 (a) is not being satisfied;

ii. Application Form ADR 019 is not complete/acceptable;

iii. Checklist ADR 013 or ADR 009 is not complete/acceptable;

iv. Aerodrome Manual or SMS Manual is either unsigned or not acceptable;

v. Required documentation are not submitted with the application;

vi. Corrective action plan are not submitted within the stipulated time;

vii. Corrective action on non-compliances are not satisfactorily rectified;

viii. Revision to documentation is not submitted within stipulated time;

ix. Corrective action plan(s) submitted are not satisfactory; or

x. Follow-up audit reveals that non-compliances are not satisfactorily rectified.

(d) If the application is successful, an aerodrome certificate incorporating conditions, as applicable, shall be signed by Director of Civil Aviation and granted to the Applicant.

Note: See ADR 012 Aerodrome Certification Procedure, 2.3.6.11 & 2.3.6.12 for essential conditions details of aerodrome certificate issued by Brunei DCA.

(e) An Aerodrome Certificate validity shall remains in force until it is suspended or revoked by the Brunei DCA, and will be subject to any conditions considered appropriate by the Brunei DCA as determined in 2.1.12 b).

(f) An Aerodrome Certificate that has been suspended or revoked must be returned immediately to the Brunei DCA.

2.1.9. **Promulgation in the AIP**

Upon satisfactory completion of the certification process, the Applicant shall provide all the information about the aerodrome including the status of certification of aerodromes to the Aeronautical Information Services for promulgation in the Aeronautical Information Publication (AIP). See paragraph 1.24.1 and PANS-AIM (Doc 10066), Appendix 2, AD 1.5. for further details.

2.1.10. **Aerodrome Certificate Surveillance/Audit by Aerodrome Inspectorates**

A continuous announced or unannounced surveillance/audit and inspection shall be conducted by the aerodrome inspectorates personnel to ascertain whether the aerodrome certificate holder is or will continue to conduct operations in accordance with the term and condition of the aerodrome certificate, the national

law, the BARs, national authority publications and to ensure that organisation's manuals and procedures are appropriately documented and followed.

Note: Guidance for surveillance checklists are given in the ADR 006 - Aerodrome Inspector Handbook

2.1.11. **Transfer of Aerodrome Certificate**

(a) An Aerodrome Certificate shall not be transferable to any person without the prior concern in writing to Brunei DCA, and any purported transfer of an Aerodrome Certificate shall be void and of no effect.

(b) The holder of the Aerodrome Certificate must notifies the Brunei DCA in writing at least 6 months before ceasing to operate the aerodrome, that the current holder will cease to operate the aerodrome as of the date specified in the notice;

(c) The holder of the Aerodrome Certificate must notifies the Brunei DCA in writing, the name of the transferee;

(d) The transferee applies in writing to the Brunei DCA at least 6 months before the holder of the Aerodrome Certificate ceases to operate the aerodrome, for the Aerodrome Certificate to be transferred to the transferee; and

(e) The requirements set out in paragraph 2.1.8. are met.

(f) If the Brunei DCA does not consent to the transfer of an Aerodrome Certificate, it shall notify the transferee, in writing, of its reasons no later than 60 working days after making that decision and in any case, not less than 60 working days prior to the expiry of the Aerodrome Certificate.

Note: Further guidance on Transfer of an Aerodrome Certificate is given in ADR 012 – Aerodrome Certification Procedure, Chapter 2.7.

2.1.12. **Endorsement of conditions on an Aerodrome Certificate.**

After successful completion of the processing of the application and the inspection of the aerodrome by the Brunei DCA [RASS], when granting the Aerodrome Certificate, Brunei DCA will endorse the conditions for the type of use of the aerodrome.

2.1.13. **Duration of the Aerodrome Certificate.**

(a) An Aerodrome Certificate shall remain in force until it is suspended or revoked.

(b) The renewal or continuing validity of Aerodrome Certificates shall depend on the satisfactory outcome of regulatory surveillance and audits activities by Brunei DCA.

Note: Further guidance on Renewal of an Aerodrome Certificate is given in ADR 012 – Aerodrome Certification Procedure, Chapter 2.6.

2.1.14. **Compliance and Enforcement**

(a) It is the responsibility of the aerodrome operator to comply with the requirements of the BAR 14. Aviation safety at aerodromes depends primarily on voluntary adherence to these requirements by the aerodrome operator. Promoting compliance with the regulations through education, training and counselling is therefore of primary importance, and only when

these efforts have failed shall formal enforcement action be taken. Sanctions shall be administrative or legal depending on the severity of the violation of the regulations and its impact on aviation safety.

(b) Administrative action in the form of a warning letter or correction letter may be considered appropriate when legal action is deemed unnecessary. Administrative enforcement action is intended to bring the violation to the attention of the aerodrome operator, to document corrective action and to require future compliance. Such actions are warranted when the violation does not result in a significant unsafe condition, is not caused by incompetence or lack of required qualifications on the part of the aerodrome operator, is not deliberately caused, the attitude of the operator is constructive and positive towards compliance with the regulations and there is no history of such a violation by the operator.

(c) Formal legal enforcement action may be warranted to prevent future violations of the regulations. Such action may include the issuance of cease-and-desist orders and injunctions and the imposition of sanctions after the act to deter violations. Such sanctions may include restriction, revocation, suspension or amendment of the certificate. Legal enforcement actions are pursuant to appropriate statutory provisions in the Brunei Legislation.

(d) Suspension is a temporary enforcement action and can be reinstated where as revocation is the enforcement action that is potentially permanent removal of privileges to operate the public aerodrome.

(e) In determining the appropriate type and measure of sanction to be applied, the factors to be considered may include the nature of the violation, whether it was deliberate or inadvertently caused; the potential or actual hazard to aviation safety created by the violation; the aerodrome operator's level of responsibility records of previous violations; the operator's attitude towards the violation, including whether the operator voluntarily disclosed the violation and whether action was taken to correct it; the impact of the proposed sanction on the violator and its value as a deterrent to other operators in similar situations.

(f) Certificate-related legal sanctions can have a significant impact on air services and may also have other repercussions. Since the public interest and aviation safety are the principal objectives of aerodrome certification regulations, recourse to the imposition of sanctions may be warranted only after all other means of resolving safety violations have failed to ensure compliance.

(g) Suspension of an aerodrome certificate may be considered if

(i) the aerodrome operator's safety management system is found to be inadequate;

(ii) it is in the interest of operational safety;

(iii) all other means for timely correction of the unsafe condition or ensuring safe aircraft operations have not yielded the required results;

(iv) the technical proficiency or qualifications of the aerodrome operator to perform the duties to meet the critical safety requirements in accordance with the regulations are found inadequate;

(v) the operator resists or is unwilling to take action to correct or mitigate the condition affecting aviation safety;

(vi) the operator wilfully fails to perform an already agreed upon corrective action and suspension of the certificate is the last resort to avoid unsafe operations in the aerodrome movement area.

(h) Revocation of an aerodrome certificate may be warranted if the aerodrome operator:

(i) is incapable or unwilling to carry out corrective action or has committed repeated serious violations;

(ii) has demonstrated a lack of responsibility, such as deliberate and flagrant acts of non-compliance or falsification of records jeopardizing aviation safety; or

(iii) has made it convincingly clear that the continued operation of the aerodrome will be detrimental to the public interest.

(i) An aerodrome certificate that has been revoked must be returned to the Brunei DCA within 10 days from the date of acknowledgement of the order of revocation of the certificate.

2.1.15. **Surrender of an Aerodrome Certificate.**

(a) An Aerodrome Certificate holder must give the Brunei DCA not less than 60 days' written notice of the date on which the certificate is to be surrendered in order that suitable promulgation action can be taken.

(b) The Brunei DCA will cancel the Aerodrome Certificate on the date specified in the notice.

2.1.16. **Amendment of an Aerodrome Certificate.**

The Brunei DCA may, provided that the appropriate rules have been met, amend an Aerodrome Certificate when, but not limited to:

(a) There is a change in the ownership or management of the aerodrome.

(b) There is a change in the use or operation of the aerodrome,

(c) There is a change in the boundaries of the aerodrome; or

(d) The holder of the Aerodrome Certificate requests an amendment.

Note: Further guidance of Amendment of an Aerodrome Certificate is given in ADR 012 – Aerodrome Certification Procedure , Chapter 2.5

2.2 Aerodrome Manual

2.2.1 Preparation of the Aerodrome Manual:

(a) The operator of a certified aerodrome shall have an Aerodrome Manual for the aerodrome.

(b) The Aerodrome Manual is a fundamental requirement of the certification process and shall take the form and contains information as detailed in ADR 013 - Aerodrome Manual Checklist.

(c) The Aerodrome Manual shall:

(1) be typewritten or printed, and signed by the aerodrome operator;

(2) be in a format that is easy to revise;

(3) have a system for recording the currency of pages and amendments thereto, including a page for logging revisions; and

(4) be organised in a manner that will facilitate the preparation, review and acceptance/approval process.

2.2.2 Location of the Aerodrome Manual

(a) The aerodrome operator shall provide the Brunei DCA [RASS] with a complete and current copy of the Aerodrome Manual.

(b) The aerodrome operator shall keep at least one complete and current copy of the Aerodrome Manual at the aerodrome and one copy at the aerodrome operator's principal place of business if other than the aerodrome.

(c) The aerodrome operator must make the Aerodrome Manual available to all aerodrome operating staff and for inspection by Brunei DCA [RASS] authorised person.

2.2.3 Information and Particulars to be included in the Aerodrome Manual

(a) The operator of a certified aerodrome shall include all pertinent information on the aerodrome site, facilities, services, equipment, operating procedures, organization and management including a safety management system.

(b) The information presented in the Aerodrome Manual shall demonstrate that the aerodrome conforms to the certification standards and practices as specified in BAR 14 Volume I - Aerodromes and other relevant ICAO SARPs as determined by the Brunei DCA [RASS] and that there are no apparent shortcomings that would adversely affect the safety of aircraft operations. From the contents of the Aerodrome Manual, Brunei DCA [RASS] will assess the suitability of the aerodrome for proposed aircraft operations and to judge an Applicant's fitness to hold a certificate.

(c) An Aerodrome Manual should be arranged under the following Parts.

Part 1. General information.

Part 2. Details of the aerodrome administration and the safety management system.

Part 3. Particulars of the aerodrome site.

Part 4. Particulars of the aerodrome required to be reported to the aeronautical information service (AIS).

Part 5. Particulars of the aerodrome operating procedures and safety measures.

2.2.4 Amendment of Aerodrome Manual

(a) The aerodrome manual is a living document, the operator of a certified aerodrome must amend the Aerodrome Manual, whenever necessary, in order to maintain the accuracy and currency of the information in the manual.

(b) To maintain the accuracy and currency of the Aerodrome Manual, the aerodrome operator shall preview the contents of Aerodrome Manual periodically at least once annually. The Brunei DCA [RASS] may also

issue a written directive to an aerodrome operator requiring the operator to alter or amend the manual in accordance with that directive.

(c) An aerodrome operator must notify the Brunei DCA [RASS], as soon as practicable, of any changes that the operator wishes to make, or has made, to the Aerodrome Manual.

2.2.5 Acceptance of the Aerodrome Manual

The Brunei DCA [RASS] shall accept the Aerodrome Manual and any amendments thereto, provided these meet the requirements of the preceding requirements in this BAR 14 and related ICAO Doc, including any amendments to ICAO standards not yet incorporated into the requirements.

2.3 Obligations of the Aerodrome Operator

2.3.1 Compliance with standards and practices.

The aerodrome operator shall comply with the standards and should endeavours to comply the recommended practices specified in BAR 14 Volume I - Aerodromes with any conditions endorsed in the aerodrome certificate pursuant to paragraphs 1.6.1 and 2.1.7.

2.3.2 Competence of operational and maintenance personnel

(a) The aerodrome operator shall employ an adequate number of competent personnel to perform all critical activities for aerodrome operation and maintenance.

(b) If the Brunei DCA or any other competent authority of the government requires competency certification for the personnel referred to in paragraph 2.3.2 (a) the aerodrome operator shall employ only those persons possessing such certificates.

(c) The aerodrome operator shall implement a programme to maintain and upgrade as required the competency of the personnel referred to in paragraph 2.3.2 (a).

2.3.3 Aerodrome operation and maintenance

(a) Subject to any directives that the Brunei DCA [RASS] may issue, the aerodrome operator shall operate and maintain the aerodrome in accordance with the procedures set out in the Aerodrome Manual.

(b) To ensure the safety of aircraft, the Brunei DCA [RASS] may give written directives to an aerodrome operator to alter the procedures set out in the Aerodrome Manual.

(c) The aerodrome operator shall ensure proper, efficient and competent maintenance of the aerodrome facilities.

(d) The aerodrome certificate holder shall coordinate with the ATS provider in order to be satisfied that appropriate air traffic services are available to ensure the safety of aircraft in the airspace associated with the aerodrome.

(e) The coordination between the aerodrome operator and the ATS provider shall cover other areas related to safety such as aeronautical information service, air traffic services, designated meteorological authorities, security, RFF, aerodrome safeguarding and any other relevant area. See 1.25.

Note. – Additional information for aerodrome safeguarding coordination with the ATS provider can be found in ICAO Doc 8168, Procedures for Air Navigation Services – Aircraft Operations Volume I and II (PANS-OPS)

(f) An aerodrome operator shall include in, or referenced to, the Aerodrome Manual the terms of a letter of agreement or contract or memorandum of understanding covering all services provided by other parties which are required to be provided by an aerodrome operator.

2.3.4 Aerodrome operator's Safety Management System

Note – The intent of a safety management system is to have in place an organised and orderly approach in the management of aerodrome safety by the aerodrome operator. BAR 19 – Safety Management contains the safety management provisions applicable to certified aerodromes. Guidance on a harmonised safety management system is given in the ICAO Safety Management Manual (Doc 9859) and in the Manual on Certification of Aerodromes (Doc 9774). Procedures on the management of change, conduct of safety assessment, reporting and analysis of safety occurrences at aerodromes and continuous monitoring to enforce compliance with applicable specifications so that identified risks are mitigated can be found in the PANS-Aerodromes(Doc 9981).

(a) The aerodrome operator of certified aerodrome shall implement a Safety Management System (SMS).

(b) The aerodrome opertor shall establish the SMS in accordance with SMS framework elements contained in BAR 19 Chapter 4 & Appendix 2 and shall comply with the latest amendments to BAR 19.

(c) The aerodrome operator shall establish and include details in the Aerodrome Manual and Safety Management System Manual for the aerodrome, describing the structure of the organisation and the duties, powers and responsibilities of the officials in the organisational structure, with a view to ensuring that operations are carried out in a demonstrably controlled way and are improved where necessary.

(d) The aerodrome operator shall establish and implement a procedure to evaluate the impact of any proposed changes to the aerodrome's physical characteristics, facilities, or equipment on the safety of existing operations.

(e) The aerodrome operator shall oblige all users of the aerodrome, including, but not limited to, fixed-base operators, apron management operators, ground handling agencies and other organisations that perform activities independently at the aerodrome in relation to flight or aircraft handling, to comply with the requirements laid down by the aerodrome operator with regard to safety at the aerodrome. The aerodrome operator shall monitor such compliance.

(f) The aerodrome operator shall require, by contract or agreement, all users of the aerodrome, including, but not limited to, fixed-base operators, ground handling agencies and other organisations referred to in paragraph 2.3.4(d), to cooperate in the programme to promote safety at, and the safe use of, the aerodrome by immediately informing it of any accidents, incidents, defects, procedural errors and faults which have a bearing on safety. (See Chapter 12 Contracted Activities)

2.3.5 Aerodrome operator's internal safety audit and safety reporting.

(a) The aerodrome operator shall arrange its own internal audit of the safety management system, including an inspection of the aerodrome facilities, procedures and equipment. The internal audit shall cover the aerodrome operator's own functions. The aerodrome operator shall also arrange its own internal audit and inspection programme for evaluating other users, including fixed-base operators, apron management operators, ground handling agencies and other organizations working at the aerodrome as referred to in parapraph 2.3.4(e).

(b) The audits referred to in paragraph 2.3.5(a) shall be carried out at intervals not exceeding 6 months or as agreed with the Brunei DCA [RASS].

(c) The aerodrome operator shall ensure that the internal audit reports, including the report on the aerodrome facilities, services and equipment, are prepared by competent safety experts.

(d) The aerodrome operator should retain a copy of the report(s) referred to in 2.3.5(c) for a period of 10 years or more. The Brunei DCA [RASS] may request a copy of the report(s) for its review and reference.

(e) The report(s) referred to in 2.3.5(c) shall be prepared and signed by the person(s) who carried out the internal audits and inspections and approved by the organisation for which the inspector worked.

2.3.6 Power to inspect

(a) The aerodrome certificate holder shall ensure that any person authorised by the Brunei DCA is allowed unrestricted access to an aerodrome or place where an aircraft has taken off or landed or which is involved in the operation or safety of the aerodrome.

(b) The aerodrome certificate holder shall ensure that any person authorised by the Brunei DCA shall have access to any documentation pertinent to the safety or certification of the aerodrome. The holder of a certificate shall be responsible for ensuring that, if requested to do so by an authorised person, documentation is produced within a period of 60 working days.

(c) Each aerodrome certificate holder or operator of an aerodrome shall comply with any request by the Brunei DCA [RASS] for a practical demonstration or test to verify compliance with BAR 14 Volume I - Aerodromes.

2.3.7 Access to the aerodrome

(a) Personnel authorised by the Brunei DCA may inspect and carry out tests on the aerodrome facilities, services and equipment, inspect the aerodrome operator's documents and records and verify the aerodrome operator's safety management system before the aerodrome certificate is granted or renewed and, subsequently, at any other time, for the purpose of ensuring safety at the aerodrome.

(b) An aerodrome operator shall, at the request of the person referred to in paragraph 2.3.7(a), allow access to any part of the aerodrome or any aerodrome facility, including equipment, records, documents and operator personnel.

(c) The aerodrome operator shall cooperate in conducting the activities referred to in paragraph 2.3.7(a).

(d) The aerodrome operator shall provide a fence or other suitable barrier to prevent the entrance of unauthorised persons onto non-public areas or animals large enough to be a hazard to aircraft which the aerodrome is intended to serve onto the aerodrome movement area.

(e) The aerodrome operator shall provide suitable means to protect ground installations and facilities essential for the safety that are located off the aerodrome.

2.3.8 Notifying and reporting

(a) An aerodrome operator shall adhere to the requirement to notify and report to the Brunei DCA, air traffic control and pilots within the specified time limits required by these requirements.

(b) Notification of inaccuracies in aeronautical information service (AIS) publications. An aerodrome operator shall review all Aeronautical Information Publications (AIPs), AIP Supplements, AIP Amendments, Notices to Airmen (NOTAMs), Pre-flight Information Bulletins and Aeronautical Information Circulars issued by AIS on receipt thereof and immediately after such reviews shall notify AIS, copied to Brunei DCA, of any inaccurate information contained therein that pertains to the aerodrome.

Note.— Specifications concerning the accuracy and integrity classification of aerodrome-related aeronautical data are contained in PANS-AIM (Doc 10066), Appendix 1

(c) Of a particular importance are changes to aeronautical information that affect charts and/or computer-based navigation systems which qualify to be notified by the aeronautical information regulation and control (AIRAC) system, as specified in Annex 15, Chapter 6. The predetermined, internationally agreed AIRAC effective dates shall be observed by the responsible aerodrome services when submitting the raw information/data to aeronautical information services.

Note.— Detailed specifications concerning the AIRAC system are contained in PANS-AIM (Doc 10066), Chapter 6.

(d) Notification of changes to the aerodrome physical characteristics, facilities, equipment and level of service planned in advance. An aerodrome operator shall notify AIS and the Brunei DCA [RASS] in writing, at least 6 months before effecting any change to the aerodrome facility or equipment or the level of service at the aerodrome that has been planned in advance and which is likely to affect the accuracy of the information contained in any AIS publication referred to in paragraph 2.3.8(b).

(e) Issues requiring immediate notification. Subject to the requirements of paragraph 2.3.8(b), an aerodrome operator shall give AIS and shall arrange for air traffic control and those responsible for flight operations to receive immediate notice detailing any of the following circumstances of which the operator has knowledge:

(1) obstacles, obstructions and hazards:

(iv) any projections by an object through an obstacle limitation surface or ICAO type A chart surface, relating to the aerodrome; and

(v) the existence of any obstruction or hazardous condition affecting aviation safety at or near the aerodrome (for example runway contamination) ;

(2) level of service; reduction in the level of service at the aerodrome as set out in any of the AIS publications referred to in paragraph 2.3.8(b);

(3) movement area: closure of any part of the movement area of the aerodrome; and

(4) any other condition that could affect aviation safety at the aerodrome and against which precautions are warranted.

(f) Immediate notification to pilots. When it is not feasible for an aerodrome operator to arrange for the air traffic control and those responsible for flight operations to receive notice of a circumstance referred to in paragraph 2.3.8(d) in accordance with that regulation , the aerodrome operator must give immediate notice direct to the pilots who may be affected by that circumstance.

2.3.9 Special inspections

An aerodrome operator shall inspect an aerodrome, as circumstances require, to ensure aviation safety:

(a) as soon as practicable after any aircraft accident or incident (including UAS) within the meaning of these terms as defined in BAR 13, where appropriate;

(b) during any period of construction or repair of the aerodrome facilities or equipment that is critical to the safety of aircraft operation; and

(c) at any other time when there are conditions at the aerodrome that could affect aviation safety.

2.3.10 Removal of obstructions from the aerodrome surface

An aerodrome operator within its authority, shall remove from the aerodrome surface any vehicle or other obstruction, such as a hole on the surface of the movement area, that is likely to be hazardous and take immediate action upon becoming aware of such obstructions to ensure that a satisfactory level of safety is maintained, including immediate closure of all or part of the aerodrome if so warranted.

2.3.11 Removal of obstructions/obstacles beyond vicinity of airport

The aerodrome operator shall seek consult with Brunei DCA in managing removal of obsructions/obstacles that is likely to be hazardous within or beyond vicinity of its airport to ensure aircraft safety is not compromised. The Civil Aviation Act (Chapter 290, Revised Edition 2024), Section 38, empowers the Director of Brunei DCA for the removal of obstructions, while Section 39 empowers the Minister to make regulations for the prohibition and restriction of use of land. See also Chapter 13 Obstacle Control.

2.3.12 Warning notices

When low flying aircraft, at or near an aerodrome, or taxiing aircraft are likely to be hazardous to people or vehicular traffic, the aerodrome operator shall:

(a) post hazard warning notices on any public way that is adjacent to the manoeuvring area; or

(b) if such a public way is not controlled by the aerodrome operator, inform the authority responsible for posting the notices on the public way that there is a hazard.

Chapter 3. Physical characteristics

3.1 Runways

Number and orientation of runways

3.1.1 **Recommendation -** The number and orientation of runways at an aerodrome should be such that the usability factor of the aerodrome is not less than 95 per cent for the aeroplanes that the aerodrome is intended to serve.

3.1.2 **Recommendation -** The sitting and orientation of runways at an aerodrome should, where possible, be such that the arrival and departure tracks minimize interference with areas approved for residential use and other noise-sensitive areas close to the aerodrome in order to avoid future noise problems.

3.1.3 **Recommendation -** Choice of maximum permissible crosswind components. In the application of paragraph 3.1.1, it should be assumed that landing or take-off of aeroplanes is, in normal circumstances, precluded when the crosswind component exceeds:

(a) 37 km/h (20 kt) in the case of aeroplanes whose reference field length is 1 500 m or over, except that when poor runway braking action owing to an insufficient longitudinal coefficient of friction is experienced with some frequency, a crosswind component not exceeding 24 km/h (13 kt) should be assumed;

(b) 24 km/h (13 kt) in the case of aeroplanes whose reference field length is 1 200 m or up to but not including 1 500 m; and

(c) 19 km/h (10 kt) in the case of aeroplanes whose reference field length is less than 1 200 m.

3.1.4 **Recommendation - Data to be used**. The selection of data to be used for the calculation of the usability factor should be based on reliable wind distribution statistics that extend over as long a period as possible, preferably of not less than five years. The observations used should be made at least eight times daily and spaced at equal intervals of time.

Location of threshold

3.1.5 **Recommendation -** A threshold should normally be located at the extremity of a runway unless operational considerations justify the choice of another location.

3.1.6 **Recommendation -** When it is necessary to displace a threshold, either permanently or temporarily, from its normal location, account should be taken of the various factors which may have a bearing on the location of the threshold. Where this displacement is due to an unserviceable runway condition, a cleared and graded area of at least 60 m in length should be available between the unserviceable area and the displaced threshold. Additional distance should also be provided to meet the requirements of the runway end safety area as appropriate.

Actual length of runways

3.1.7 **Recommendation - Primary runway**. Except as provided in paragraph 3.1.9, the actual runway length to be provided for a primary runway should be adequate to meet the operational requirements of the aeroplanes for which the runway is intended and should be not less than the longest length determined by applying

the corrections for local conditions to the operations and performance characteristics of the relevant aeroplanes.

3.1.8 **Recommendation - Secondary runway**. The length of a secondary runway should be determined similarly to primary runways except that it needs only to be adequate for those aeroplanes which require to use that secondary runway in addition to the other runway or runways in order to obtain a usability factor of at least 95 per cent.

3.1.9 **Recommendation - Runways with stopways or clearways**. Where a runway is associated with a stopway or clearway, an actual runway length less than that resulting from application of paragraph 3.1.7 or paragraph 3.1.8, as appropriate, may be considered satisfactory, but in such a case any combination of runway, stopway and clearway provided should permit compliance with the operational requirements for take-off and landing of the aeroplanes the runway is intended to serve.

3.1.10 **Recommendation - Width of runways**. The width of a runway should be not less than the appropriate dimension specified in the following tabulation:

	Outer Main Gear Wheel Span (OMGWS)			
Code Number	Up to but not including 4.5 m	4.5 m up to but not including 6 m	6 m up to but not including 9 m	9 m up to but not including 15 m
1[a]	*18 m*	*18 m*	*23 m*	–
2[a]	*23 m*	*23 m*	*30 m*	–
3	*30 m*	*30 m*	*30 m*	*45 m*
4	–	–	*45 m*	*45 m*

a. The width of a precision approach runway should be not less than 30 m where the code number is 1 or 2.

Minimum distance between parallel runways

3.1.11 **Recommendation -** Where parallel non-instrument runways are intended for simultaneous use, the minimum distance between their centre lines should be:

(a) 210 m where the higher code number is 3 or 4;

(b) 150 m where the higher code number is 2; and

(c) 120 m where the higher code number is 1.

3.1.12 **Recommendation -** Where parallel instrument runways are intended for simultaneous use subject to conditions specified in the PANS-ATM (Doc 4444) and the PANS-OPS (Doc 8168), Volume I, the minimum distance between their centre lines should be:

(a) 1 035 m for independent parallel approaches;

(b) 915 m for dependent parallel approaches;

(c) 760 m for independent parallel departures;

(d) 760 m for segregated parallel operations;

except that:

for segregated parallel operations the specified minimum distance:

(1) may be decreased by 30 m for each 150 m that the arrival runway is staggered toward the arriving aircraft, to a minimum of 300 m; and

(2) should be increased by 30 m for each 150 m that the arrival runway is staggered away from the arriving aircraft;

for independent parallel approaches, combinations of minimum distances and associated conditions other than those specified in the PANS-ATM (Doc 4444) may be applied when it is determined that such combinations would not adversely affect the safety of aircraft operations.

Slopes on runways

3.1.13 **Longitudinal slopes**

Recommendation - The slope computed by dividing the difference between the maximum and minimum elevation along the runway centre line by the runway length should not exceed:

(a) 1 per cent where the code number is 3 or 4; and

(b) 2 per cent where the code number is 1 or 2.

3.1.14 **Recommendation -** Along no portion of a runway should the longitudinal slope exceed:

(a) 1.25 per cent where the code number is 4, except that for the first and last quarter of the length of the runway the longitudinal slope should not exceed 0.8 per cent;

(b) 1.5 per cent where the code number is 3, except that for the first and last quarter of the length of a precision approach runway category II or III the longitudinal slope should not exceed 0.8 per cent; and

(c) 2 per cent where the code number is 1 or 2.

3.1.15 Longitudinal slope changes

Recommendation - Where slope changes cannot be avoided, a slope change between two consecutive slopes should not exceed:

(a) 1.5 per cent where the code number is 3 or 4; and

(b) 2 per cent where the code number is 1 or 2.

3.1.16 **Recommendation -** The transition from one slope to another should be accomplished by a curved surface with a rate of change not exceeding:

(a) 0.1 per cent per 30 m (minimum radius of curvature of 30 000 m) where the code number is 4;

(b) 0.2 per cent per 30 m (minimum radius of curvature of 15 000 m) where the code number is 3; and

(c) 0.4 per cent per 30 m (minimum radius of curvature of 7 500 m) where the code number is 1 or 2.

3.1.17 **Recommendation - Sight distance**. Where slope changes cannot be avoided, they should be such that there will be an unobstructed line of sight from:

(a) any point 3 m above a runway to all other points 3 m above the runway within a distance of at least half the length of the runway where the code letter is C, D, E or F;

(b) any point 2 m above a runway to all other points 2 m above the runway within a distance of at least half the length of the runway where the code letter is B; and

(c) any point 1.5 m above a runway to all other points 1.5 m above the runway within a distance of at least half the length of the runway where the code letter is A.

3.1.18 **Recommendation - Distance between slope changes**. Undulations or appreciable changes in slopes located close together along a runway should be avoided. The distance between the points of intersection of two successive curves should not be less than:

(a) the sum of the absolute numerical values of the corresponding slope changes multiplied by the appropriate value as follows:

(1) 30 000 m where the code number is 4;

(2) 15 000 m where the code number is 3; and

(3) 5 000 m where the code number is 1 or 2; or

(b) 45 m;

whichever is greater.

3.1.19 **Transverse slopes**

Recommendation - To promote the most rapid drainage of water, the runway surface should, if practicable, be cambered except where a single crossfall from high to low in the direction of the wind most frequently associated with rain would ensure rapid drainage. The transverse slope should ideally be:

(a) 1.5 per cent where the code letter is C, D, E or F; and

(b) 2 per cent where the code letter is A or B;

but in any event should not exceed 1.5 per cent or 2 per cent, as applicable, nor be less than 1 per cent except at runway or taxiway intersections where flatter slopes may be necessary.

For a cambered surface the transverse slope on each side of the centre line should be symmetrical.

3.1.20 **Recommendation -** The transverse slope should be substantially the same throughout the length of a runway except at an intersection with another runway or a taxiway where an even transition should be provided taking account of the need for adequate drainage.

3.1.21 **Recommendation - Strength of runways**. A runway should be capable of withstanding the traffic of aeroplanes the runway is intended to serve.

Surface of runways

3.1.22 The surface of a runway shall be constructed without irregularities that would impair the runway surface friction characteristics or otherwise adversely affect the take-off or landing of an aeroplane.

3.1.23 A paved runway shall be so constructed or resurfaced as to provide surface friction characteristics at or above the minimum friction level set by the Brunei DCA as specified in 10.2.3 Table 10-1.

3.1.24 **Recommendation -** The surface of a paved runway should be evaluated when constructed or resurfaced to determine that the surface friction characteristics achieve the design objectives.

3.1.25 **Recommendation -** Measurements of the surface friction characteristics of a new or resurfaced paved runway should be made with a continuous friction measuring device using self-wetting features.

3.1.26 **Recommendation -** The average surface texture depth of a new surface should be not less than 1.0 mm.

3.1.27 **Recommendation -** When the surface is grooved or scored, the grooves or scorings should be either perpendicular to the runway centre line or parallel to non-perpendicular transverse joints, where applicable.

3.2 Runway shoulders

General

3.2.1 **Recommendation -** Runway shoulders should be provided for a runway where the code letter is D, E or F.

Width of runway shoulders

3.2.2 **Recommendation -** For aeroplanes with OMGWS from 9 m up to but not including 15 m, the runway shoulders should extend symmetrically on each side of the runway so that the overall width of the runway and its shoulders is not less than:

(a) 60 m where the code letter is D or E;

(b) 60 m where the code letter is F with two- or three-engined aeroplanes; and

(c) 75 m where the code letter is F with four (or more)-engined aeroplanes.

Slopes on runway shoulders

3.2.3 **Recommendation -** The surface of the shoulder that abuts the runway should be flush with the surface of the runway and its transverse slope should not exceed 2.5 per cent.

Strength of runway shoulders

3.2.4 **Recommendation -** The portion of a runway shoulder between the runway edge and a distance of 30 m from the runway centre line should be prepared or constructed so as to be capable, in the event of an aeroplane running off the runway, of supporting the aeroplane without inducing structural damage to the aeroplane and of supporting ground vehicles which may operate on the shoulder.

Surface of runway shoulders

3.2.5 **Recommendation -** A runway shoulder should be prepared or constructed so as to resist erosion and the ingestion of the surface material by aeroplane engines.

3.2.6 **Recommendation -** Runway shoulders for code letter F aeroplanes should be paved to a minimum overall width of runway and shoulder of not less than 60 m.

Note.— Guidance on surface of runway shoulders is given in the Aerodrome Design Manual, (Doc 9157), Part 1.

3.3 Runway turn pads

General

3.3.1 Where the end of a runway is not served by a taxiway or a taxiway turnaround and where the code letter is D, E or F, a runway turn pad shall be provided to facilitate a 180-degree turn of aeroplanes. (See Figure 3-1.)

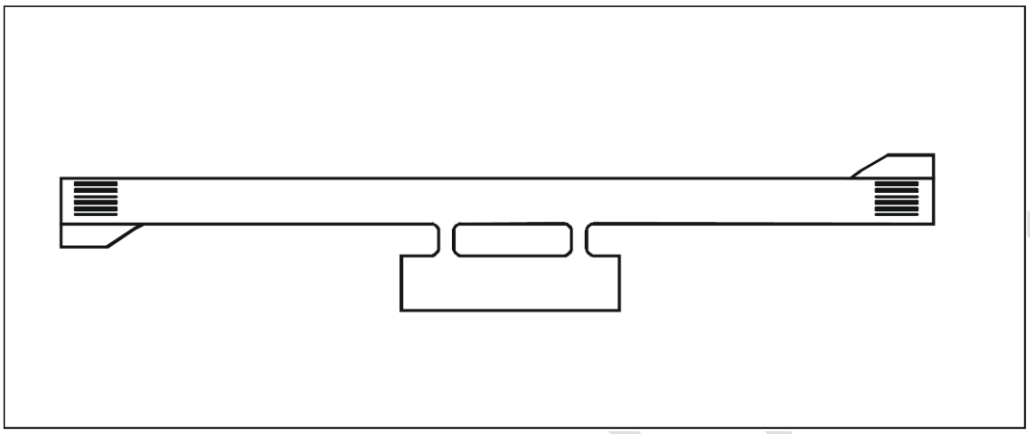

Figure 3-1. Runway turn pads layout

3.3.2 **Recommendation -** Where the end of a runway is not served by a taxiway or a taxiway turnaround and where the code letter is A, B or C, a runway turn pad should be provided to facilitate a 180-degree turn of aeroplanes.

3.3.3 **Recommendation -** The runway turn pad be located on either the left or right side of the runway and adjoining the runway pavement at both ends of the runway and at some intermediate locations where deemed necessary.

3.3.4 **Recommendation -** The intersection angle of the runway turn pad with the runway should not exceed 30 degrees.

3.3.5 **Recommendation -** The nose wheel steering angle to be used in the design of the runway turn pad should not exceed 45 degrees.

3.3.6 The design of a runway turn pad shall be such that, when the cockpit of the aeroplane for which the turn pad is intended remains over the turn pad marking, the clearance distance between any wheel of the aeroplane landing gear and the edge of the turn pad shall be not less than that given by the following tabulation:

	OMGWS			
	Up to but not including 4.5 m	4.5 m up to but not including 6 m	6 m up to but not including 9 m	9 m up to but not including 15 m
Clearance	1.50 m	2.25 m	3 m[a] or 4 m[b]	4 m

a. If the turn pad is intended to be used by aeroplanes with a wheel base less than 18 m.
b. If the turn pad is intended to be used by aeroplanes with a wheel base equal to or greater than 18 m.

Note.— Wheel base means the distance from the nose gear to the geometric centre of the main gear.

Slopes on runway turn pads

3.3.7 **Recommendation -** The longitudinal and transverse slopes on a runway turn pad should be sufficient to prevent the accumulation of water on the surface and facilitate rapid drainage of surface water. The slopes should be the same as those on the adjacent runway pavement surface.

Strength of runway turn pads

3.3.8 **Recommendation -** The strength of a runway turn pad should be at least equal to that of the adjoining runway which it serves, due consideration being given to the fact that the turn pad will be subjected to slow-moving traffic making hard turns and consequent higher stresses on the pavement.

Surface of runway turn pads

3.3.9 The surface of a runway turn pad shall not have surface irregularities that may cause damage to an aeroplane using the turn pad.

3.3.10 **Recommendation -** The surface of a runway turn pad should be so constructed or resurfaced as to provide surface friction characteristics at least equal to that of the adjoining runway.

Shoulders for runway turn pads

3.3.11 **Recommendation -** The runway turn pads should be provided with shoulders of such width as is necessary to prevent surface erosion by the jet blast of the most demanding aeroplane for which the turn pad is intended, and any possible foreign object damage to the aeroplane engines.

3.3.12 **Recommendation -** The strength of runway turn pad shoulders should be capable of withstanding the occasional passage of the aeroplane it is designed to serve without inducing structural damage to the aeroplane and to the supporting ground vehicles that may operate on the shoulder.

3.4 Runway strips

General

3.4.1 A runway and any associated stopways shall be included in a strip.

Length of runway strips

3.4.2 A strip shall extend before the threshold and beyond the end of the runway or stopway for a distance of at least:

(a) 60 m where the code number is 2, 3 or 4;

(b) 60 m where the code number is 1 and the runway is an instrument one; and

(c) 30 m where the code number is 1 and the runway is a non-instrument one.

Width of runway strips

3.4.3 A strip including a precision approach runway shall, wherever practicable, extend laterally to a distance of at least:

(a) 140 m where the code number is 3 or 4; and

(b) 70 m where the code number is 1 or 2;

on each side of the centre line of the runway and its extended centre line throughout the length of the strip.

3.4.4 **Recommendation -** A strip including a non-precision approach runway should extend laterally to a distance of at least:

(a) 140 m where the code number is 3 or 4; and

(b) 70 m where the code number is 1 or 2;

on each side of the centre line of the runway and its extended centre line throughout the length of the strip.

3.4.5 **Recommendation -** A strip including a non-instrument runway should extend on each side of the centre line of the runway and its extended centre line throughout the length of the strip, to a distance of at least:

(a) 75 m where the code number is 4;

(b) 55 m where the code number is 3;

(c) 40 m where the code number is 2; and

(d) 30 m where the code number is 1.

Objects on runway strips

3.4.6 **Recommendation -** An object situated on a runway strip which may endanger aeroplanes should be regarded as an obstacle and should, as far as practicable, be removed.

Note 1.— Consideration will have to be given to the location and design of drains on a runway strip to prevent damage to an aeroplane accidentally running off a runway. Suitably designed drain covers may be required. For further guidance, see the Aerodrome Design Manual (Doc 9157), Part 1.

Note 2.— Where open-air or covered storm water conveyances are installed, consideration will have to be given to ensure that their structure does not extend above the surrounding ground so as not to be considered an obstacle. See also 3.4.16.

Note 3.— Particular attention needs to be given to the design and maintenance of an open-air storm water conveyance in order to prevent wildlife attraction, notably birds. If needed, it can be covered by a net. Procedures on wildlife management are specified in the PANS-Aerodromes (Doc 9981). Further guidance can be found in the Airport Services Manual (Doc 9137), Part 3.

3.4.7 No fixed object, other than visual aids required for air navigation or those required for aircraft safety purposes and which must be sited on the runway strip, and satisfying the relevant frangibility requirement in Chapter 5, shall be permitted on any part of a runway strip of a precision approach runway delineated by the lower edges of the inner transitional surfaces. No mobile object shall be permitted on this part of the runway strip during the use of the runway for landing or take-off.

Note.— See Chapter 4, section 4.1 for characteristics of inner transitional surface.

Grading of runway strips

3.4.8 **Recommendation -** That portion of a strip of an instrument runway within a distance of at least:

(a) 75 m where the code number is 3 or 4; and

(b) 40 m where the code number is 1 or 2;

from the centre line of the runway and its extended centre line should provide a graded area for aeroplanes which the runway is intended to serve in the event of an aeroplane running off the runway.

Note.— Guidance on grading of a greater area of a strip including a precision approach runway where the code number is 3 or 4 is given in Chapter 15, Attachment A, Section 9.

3.4.9 **Recommendation -** That portion of a strip of a non-instrument runway within a distance of at least:

(a) 75 m where the code number is 4;

(b) 55 m where the code number is 3;

(c) 40 m where the code number is 2; and

(d) 30 m where the code number is 1;

from the centre line of the runway and its extended centre line should provide a graded area for aeroplanes which the runway is intended to serve in the event of an aeroplane running off the runway.

3.4.10 The surface of that portion of a strip that abuts a runway, shoulder or stopway shall be flush with the surface of the runway, shoulder or stopway.

3.4.11 **Recommendation -** That portion of a strip to at least 30 m before a threshold should be prepared against blast erosion in order to protect a landing aeroplane from the danger of an exposed edge.

Note 1.— The area provided to reduce the erosive effects of jet blast and propeller wash may be referred to as a blast pad.

Note 2.— Guidance on protection against aeroplane engine blast is available in the ICAO Aerodrome Design Manual (Doc 9157), Part 2.

3.4.12 **Recommendation -** Where the areas in 3.4.11 have paved surfaces, they should be able to withstand the occasional passage of the critical aeroplane for runway pavement design.

3.4.13 **Recommendation - Longitudinal slopes**. A longitudinal slope along that portion of a strip to be graded should not exceed:

(a) 1.5 per cent where the code number is 4;

(b) 1.75 per cent where the code number is 3; and

(c) 2 per cent where the code number is 1 or 2.

3.4.14 **Recommendation - Longitudinal slope changes**. Slope changes on that portion of a strip to be graded should be as gradual as practicable and abrupt changes or sudden reversals of slopes avoided.

3.4.15 **Recommendation - Transverse slopes**. Transverse slopes on that portion of a strip to be graded should be adequate to prevent the accumulation of water on the surface but should not exceed:

(a) 2.5 per cent where the code number is 3 or 4; and

(b) 3 per cent where the code number is 1 or 2;

except that to facilitate drainage the slope for the first 3 m outward from the runway, shaller or stopway edge should be negative as measured in the direction away from the runway and may be as great as 5 per cent.

3.4.16 **Recommendation -** The transverse slopes of any portion of a strip beyond that to be graded should not exceed an upward slope of 5 per cent as measured in the direction away from the runway.

Strength of runway strips

3.4.17 **Recommendation -** That portion of a strip of an instrument runway within a distance of at least:

(a) 75 m where the code number is 3 or 4; and

(b) 40 m where the code number is 1 or 2;

from the centre line of the runway and its extended centre line should be so prepared or constructed as to minimize hazards arising from differences in load-bearing capacity to aeroplanes which the runway is intended to serve in the event of an aeroplane running off the runway.

3.4.18 **Recommendation -** That portion of a strip containing a non-instrument runway within a distance of at least:

(a) 75 m where the code number is 4;

(b) 55 m where the code number is 3;

(c) 40 m where the code number is 2; and

(d) 30 m where the code number is 1;

from the centre line of the runway and its extended centre line should be so prepared or constructed as to minimize hazards arising from differences in load-bearing capacity to aeroplanes which the runway is intended to serve in the event of an aeroplane running off the runway.

3.5 Runway end safety areas

General

3.5.1 A runway end safety area shall be provided at each end of a runway strip where:

(a) the code number is 3 or 4; and

(b) the code number is 1 or 2 and the runway is an instrument one.

3.5.2 **Recommendation -** A runway end safety area should be provided at each end of a runway strip where the code number is 1 or 2 and the runway is a non-instrument one.

Dimensions of runway end safety areas

3.5.3 A runway end safety area shall extend from the end of a runway strip to a distance of at least 90 m where:

(a) the code number is 3 or 4; and

(b) the code number is 1 or 2 and the runway is an instrument one.

If an arresting system is installed, the above length may be reduced, based on the design specification of the system, subject to acceptance by the Brunei DCA.

Note.— Guidance on arresting systems is given in Chapter 15, Attachment A, Section 10.

3.5.4 **Recommendation -** A runway end safety area should, as far as practicable, extend from the end of a runway strip to a distance of at least:

(a) 240 m where the code number is 3 or 4; or a reduced length when an arresting system is installed;

(b) 120 m where the code number is 1 or 2 and the runway is an instrument one; or a reduced length when an arresting system is installed; and

(c) 30 m where the code number is 1 or 2 and the runway is a non-instrument one.

3.5.5 The width of a runway end safety area shall be at least twice that of the associated runway.

3.5.6 **Recommendation -** The width of a runway end safety area should, wherever practicable, be equal to that of the graded portion of the associated runway strip.

Objects on runway end safety areas

Note.— See 9.9 for information regarding siting of equipment and installations on runway end safety areas.

3.5.7 **Recommendation -** An object situated on a runway end safety area which may endanger aeroplanes should be regarded as an obstacle and should, as far as practicable, be removed.

Clearing and grading of runway end safety areas

3.5.8 **Recommendation -** A runway end safety area should provide a cleared and graded area for aeroplanes which the runway is intended to serve in the event of an aeroplane undershooting or overrunning the runway.

Slopes on runway end safety areas

3.5.9 **Recommendation - General**. The slopes of a runway end safety area should be such that no part of the runway end safety area penetrates the approach or take-off climb surface.

3.5.10 **Recommendation - Longitudinal slopes**. The longitudinal slopes of a runway end safety area should not exceed a downward slope of 5 per cent. Longitudinal slope changes should be as gradual as practicable and abrupt changes or sudden reversals of slopes avoided.

3.5.11 **Recommendation - Transverse slopes**. The transverse slopes of a runway end safety area should not exceed an upward or downward slope of 5 per cent. Transitions between differing slopes should be as gradual as practicable.

Strength of runway end safety areas

3.5.12 **Recommendation -** A runway end safety area should be so prepared or constructed as to reduce the risk of damage to an aeroplane undershooting or overrunning the runway, enhance aeroplane deceleration and facilitate the movement of rescue and fire fighting vehicles as required in 9.2.34 to 9.2.36.

Note.— Guidance on the strength of a runway end safety area is given in the ICAO Aerodrome Design Manual (Doc 9157), Part 1.

3.6 Clearways

Location of clearways

3.6.1 **Recommendation -** The origin of a clearway should be at the end of the take-off run available.

Length of clearways

3.6.2 **Recommendation -** The length of a clearway should not exceed half the length of the take-off run available.

Width of clearways

3.6.3 **Recommendation -** A clearway should extend laterally on each side of the extended centre line of the runway, to a distance of at least:

a) 75 m for instrument runways; and

b) half of the width of the runway strip for non-instrument runways.

Slopes on clearways

3.6.4 **Recommendation -** The ground in a clearway should not project above a plane having an upward slope of 1.25 per cent, the lower limit of this plane being a horizontal line which:

(a) is perpendicular to the vertical plane containing the runway centre line; and

(b) passes through a point located on the runway centre line at the end of the take-off run available.

3.6.5 **Recommendation -** Abrupt upward changes in slope should be avoided when the slope on the ground in a clearway is relatively small or when the mean slope is upward. In such situations, in that portion of the clearway within a distance of 22.5 m or half the runway width whichever is greater on each side of the extended centre line, the slopes, slope changes and the transition from runway to clearway should generally conform with those of the runway with which the clearway is associated.

Objects on clearways

Note.— See 9.9 for information regarding siting of equipment and installations on clearways.

3.6.6 **Recommendation -** An object situated on a clearway which may endanger aeroplanes in the air should be regarded as an obstacle and should be removed.

3.7 Stopways

Note.— The inclusion of detailed specifications for stopways in this section is not intended to imply that a stopway has to be provided. Chapter 15, Attachment A, Section 2, provides information on the use of stopways.

Width of stopways

3.7.1 A stopway shall have the same width as the runway with which it is associated, if provided.

Slopes on stopways

3.7.2 **Recommendation -** Slopes and changes in slope on a stopway, and the transition from a runway to a stopway, should comply with the specifications of 3.1.13 to 3.1.19 for the runway with which the stopway is associated except that:

(a) the limitation in 3.1.14 of a 0.8 per cent slope for the first and last quarter of the length of a runway need not be applied to the stopway; and

(b) at the junction of the stopway and runway and along the stopway the maximum rate of slope change may be 0.3 per cent per 30 m (minimum radius of curvature of 10 000 m) for a runway where the code number is 3 or 4.

Strength of stopways

3.7.3 **Recommendation -** A stopway should be prepared or constructed so as to be capable, in the event of an abandoned take-off, of supporting the aeroplane which the stopway is intended to serve without inducing structural damage to the aeroplane.

Surface of stopways

3.7.4 The surface of a paved stopway shall be so constructed or resurfaced as to provide surface friction characteristics at or above those of the associated runway.

3.8 Radio altimeter operating area

General

3.8.1 **Recommendation -** A radio altimeter operating area should be established in the pre-threshold area of a precision approach runway.

Length of the area

3.8.2 **Recommendation -** A radio altimeter operating area should extend before the threshold for a distance of at least 300 m.

Width of the area

3.8.3 **Recommendation -** A radio altimeter operating area should extend laterally, on each side of the extended centre line of the runway, to a distance of 60 m, except that, when special circumstances so warrant, the distance may be reduced to no less than 30 m if an aeronautical study indicates that such reduction would not affect the safety of operations of aircraft.

Longitudinal slope changes

3.8.4 **Recommendation -** On a radio altimeter operating area, slope changes should be avoided or kept to a minimum. Where slope changes cannot be avoided, the slope changes should be as gradual as practicable and abrupt changes or sudden reversals of slopes avoided. The rate of change between two consecutive slopes should not exceed 2 per cent per 30 m.

3.9 Taxiways

Note 1.— Unless otherwise indicated the requirements in this section are applicable to all types of taxiways.

Note 2.— See section 5.4.3 for a standardized scheme for the nomenclature of taxiways which may be used to improve situational awareness and as a part of an effective runway incursion prevention measure.

Note 3.— See Chapter 15, Attachment A, Section 22, for specific taxiway design guidance which may assist in the prevention of runway incursions when developing a new taxiway or improving existing ones with known runway incursion safety risks.

General

3.9.1 **Recommendation -** Where operationally required, taxiways should be provided to permit the safe and expeditious surface movement of aircraft.

Note.— Guidance on layout and standardized nomenclature of taxiways is given in the Aerodrome Design Manual (Doc 9157), Part 2.

3.9.2 **Recommendation -** Sufficient entrance and exit taxiways for a runway should be provided to expedite the movement of aeroplanes to and from the runway and provision of rapid exit taxiways considered when traffic volumes are high.

3.9.3 The design of a taxiway shall be such that, when the cockpit of the aeroplane for which the taxiway is intended remains over the taxiway centre line markings, the clearance distance between the outer main wheel of the aeroplane and the edge of the taxiway shall be not less than that given by the following tabulation:

	OMGWS			
	Up to but not including 4.5 m	4.5 m up to but not including 6 m	6 m up to but not including 9 m	9 m up to but not including 15 m
Clearance	1.50 m	2.25 m	3 m[a,b] or 4 m[c]	4 m

a. On straight portions.
b. On curved portions if the taxiway is intended to be used by aeroplanes with a wheel base of less than 18 m.
c. On curved portions if the taxiway is intended to be used by aeroplanes with a wheel base equal to or greater than 18 m.

Note.— Wheel base means the distance from the nose gear to the geometric centre of the main gear.

Width of taxiways

3.9.4 **Recommendation -** A straight portion of a taxiway should have a width of not less than that given by the following tabulation:

	OMGWS			
	Up to but not including 4.5 m	4.5 m up to but not including 6 m	6 m up to but not including 9 m	9 m up to but not including 15 m
Taxiway width	7.5 m	10.5 m	15 m	23 m

Note.- Guidance on width of taxiways is given in the ICAO Aerodrome Design Manual (Doc 9157), Part 2.

Taxiway curves

3.9.5 **Recommendation -** Changes in direction of taxiways should be as few and small as possible. The radii of the curves should be compatible with the manoeuvring capability and normal taxiing speeds of the aeroplanes for which the taxiway is intended. The design of the curve should be such that, when the cockpit of the aeroplane remains over the taxiway centre line markings, the clearance distance between the outer main wheels of the aeroplane and the edge of the taxiway should not be less than those specified in 3.9.3.

Note 1.— An example of widening taxiways to achieve the wheel clearance specified is illustrated in Figure 3-2. Guidance on the values of suitable dimensions is given in the Aerodrome Design Manual (Doc 9157), Part 2.

Note 2.— The location of taxiway centre line markings and lights is specified in 5.2.8.6 and 5.3.17.12.

Note 3.— Compound curves may reduce or eliminate the need for extra taxiway width.

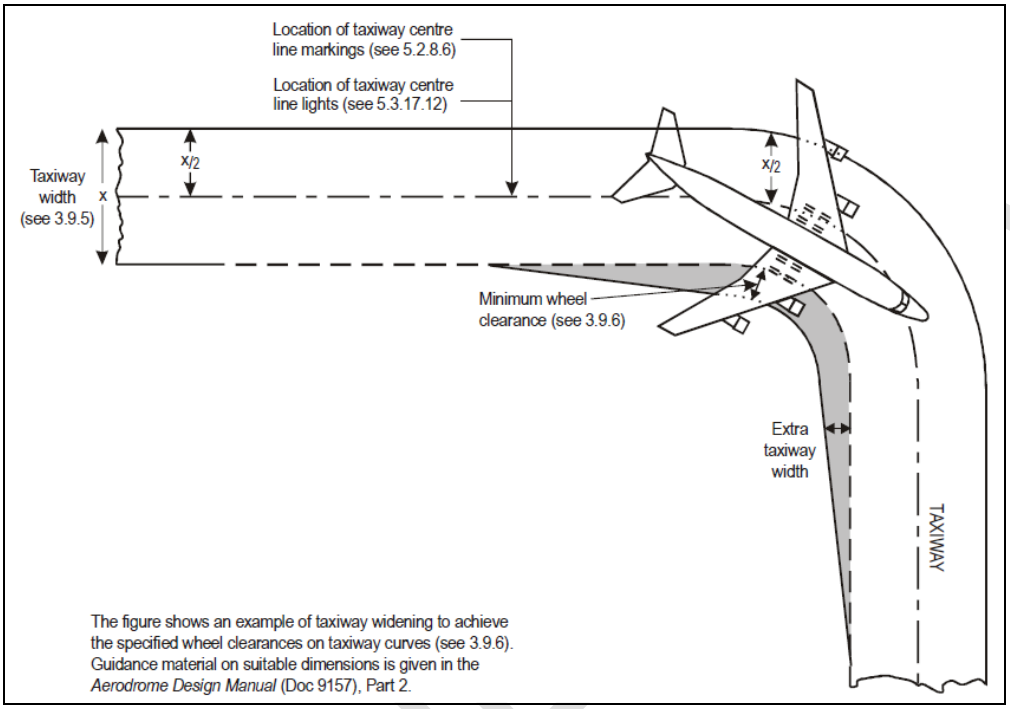

Figure 3-2. Taxiway curve

Junctions and intersections

3.9.6 **Recommendation -** To facilitate the movement of aeroplanes, fillets should be provided at junctions and intersections of taxiways with runways, aprons and other taxiways. The design of the fillets should ensure that the minimum wheel clearances specified in 3.9.3 are maintained when aeroplanes are manoeuvring through the junctions or intersections.

Taxiway minimum separation distances

3.9.7 **Recommendation -** The separation distance between the centre line of a taxiway and the centre line of a runway, the centre line of a parallel taxiway or an object should not be less than the appropriate dimension specified in Table 3-1, except that it may be permissible to operate with lower separation distances at an existing aerodrome if an aeronautical study indicates that such lower separation distances would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.

Note 1.— Guidance on factors which may be considered in the aeronautical study is given in the Aerodrome Design Manual (Doc 9157), Part 2.

Note 2.— ILS and MLS installations may also influence the location of taxiways due to interferences to ILS and MLS signals by a taxiing or stopped aircraft. Information on critical and sensitive areas surrounding ILS and MLS installations is contained in Annex 10 — Aeronautical Telecommunications, Volume I — Radio Navigation Aids, Attachments C and G (respectively).

Note 3.— The separation distances of Table 3-1, column 10, do not necessarily provide the capability of making a normal turn from one taxiway to another parallel taxiway. Guidance for this condition is given in the Aerodrome Design Manual (Doc 9157), Part 2.

Note 4.— The separation distance between the centre line of an aircraft stand taxilane and an object shown in Table 3-1, column 13, may need to be increased when jet exhaust wake velocity may cause hazardous conditions for ground servicing.

Slopes on taxiways

3.9.8 **Recommendation - Longitudinal slopes**. The longitudinal slope of a taxiway should not exceed:

(a) 1.5 per cent where the code letter is C, D, E or F; and

(b) 3 per cent where the code letter is A or B.

3.9.9 **Recommendation - Longitudinal slope changes**. Where slope changes on a taxiway cannot be avoided, the transition from one slope to another slope should be accomplished by a curved surface with a rate of change not exceeding:

(a) 1 per cent per 30 m (minimum radius of curvature of 3 000 m) where the code letter is C, D, E or F; and

(b) 1 per cent per 25 m (minimum radius of curvature of 2 500 m) where the code letter is A or B.

Table 3-1. Taxiway minimum separation distances

	Distance between taxiway centre line and runway centre line (metres)								Taxiway centre line to taxiway centre line (metres)	Taxiway other than aircraft stand taxilane, centre line to object (metres)	Aircraft stand taxilane centre line to aircraft stand taxilane centre line (metres)	Aircraft stand taxilane centre line to object (metres)
	Instrument runways Code number				Non instrument runways Code number							
Code letter	1	2	3	4	1	2	3	4				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
A	77.5	77.5	-	-	37.5	47.5	-	-	23	15.5	19.5	12
B	82	82	152	-	42	52	67	-	32	20	28.5	16.5
C	88	88	158	158	48	58	73	93	44	26	40.5	22.5
D	-	-	166	166	-	-	81	101	63	37	59.5	33.5
E	-	-	172.5	172.5	-	-	87.5	107.5	76	43.5	72.5	40
F	-	-	180	180	-	-	95	115	91	51	87.5	47.5

Note 1. The separation distances shown in columns (2) to (9) represent ordinary coordination of runways and taxiways. The basis for development of these distance is given in the ICAO Aerodrome Design Manual (Doc 9157), Part 2.

Note 2. The distances in columns (2) to (9) do not guarantee sufficient clearance behind a holding aeroplane to permit the passing of another aeroplane on a parallel taxiway. See the ICAO Aerodrome Design Manual (Doc 9157), Part 2.

3.9.10 **Recommendation - Sight distance.** Where a change in slope on a taxiway cannot be avoided, the change should be such that, from any point:

(a) 3 m above the taxiway, it will be possible to see the whole surface of the taxiway for a distance of at least 300 m from that point, where the code letter is C, D, E or F;

(b) 2 m above the taxiway, it will be possible to see the whole surface of the taxiway for a distance of at least 200 m from that point, where the code letter is B; and

(c) 1.5 m above the taxiway, it will be possible to see the whole surface of the taxiway for a distance of at least 150 m from that point, where the code letter is A.

3.9.11 **Recommendation - Transverse slopes**. The transverse slopes of a taxiway should be sufficient to prevent the accumulation of water on the surface of the taxiway but should not exceed:

(a) 1.5 per cent where the code letter is C, D, E or F; and

(b) 2 per cent where the code letter is A or B.

Strength of taxiways

3.9.12 **Recommendation -** The strength of a taxiway should be at least equal to that of the runway it serves, due consideration being given to the fact that a taxiway will be subjected to a greater density of traffic and, as a result of slow moving and stationary aeroplanes, to higher stresses than the runway it serves.

Surface of taxiways

3.9.13 **Recommendation -** The surface of a taxiway should not have irregularities that cause damage to aeroplane structures.

3.9.14 **Recommendation -** The surface of a paved taxiway should be so constructed or resurfaced as to provide suitable surface friction characteristics.

Rapid exit taxiways

Note.— The following specifications detail requirements particular to rapid exit taxiways. See Figure 3-3. General requirements for taxiways also apply to this type of taxiway. Guidance on the provision, location and design of rapid exit taxiways is included in the Aerodrome Design Manual (Doc 9157), Part 2.

3.9.15 **Recommendation -** A rapid exit taxiway should be designed with a radius of turn-off curve of at least:

(a) 550 m where the code number is 3 or 4; and

(b) 275 m where the code number is 1 or 2;

to enable exit speeds under wet conditions of:

(a) 93 km/h where the code number is 3 or 4; and

(b) 65 km/h where the code number is 1 or 2.

3.9.16 **Recommendation -** The radius of the fillet on the inside of the curve at a rapid exit taxiway should be sufficient to provide a widened taxiway throat in order to facilitate early recognition of the entrance and turn-off onto the taxiway.

3.9.17 **Recommendation -** A rapid exit taxiway should include a straight distance after the turn-off curve sufficient for an exiting aircraft to come to a full stop clear of any intersecting taxiway.

3.9.18 **Recommendation -** The intersection angle of a rapid exit taxiway with the runway should not be greater than 45° nor less than 25° and preferably should be 30°.

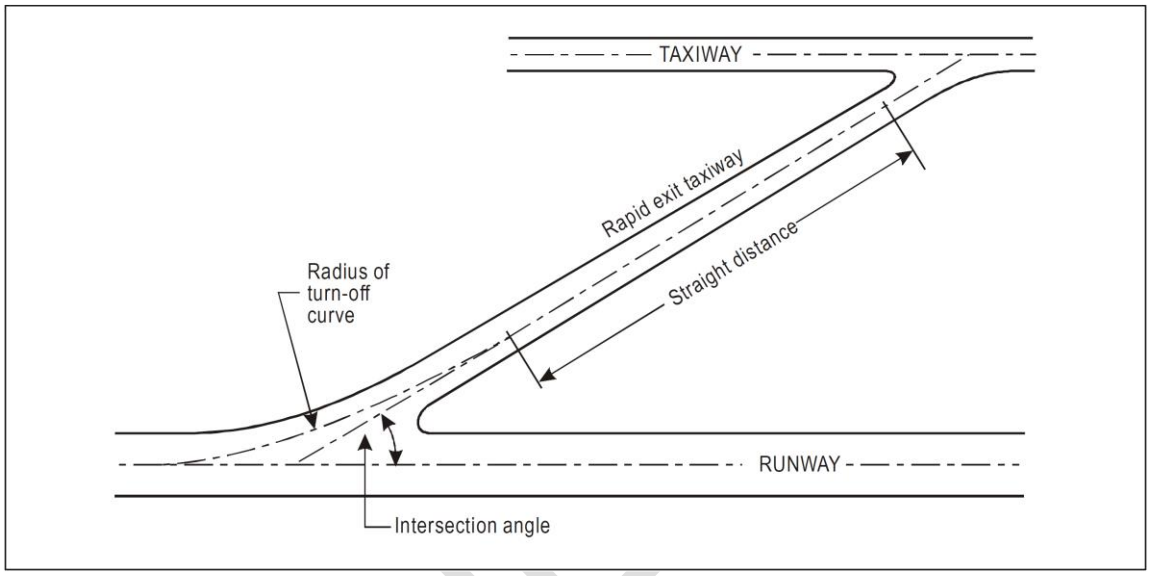

Figure 3-3. Rapid exit taxiway

Taxiways on bridges

3.9.19 The width of that portion of a taxiway bridge capable of supporting aeroplanes, as measured perpendicularly to the taxiway centre line, shall not be 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 shall not be hazardous for aeroplanes for which the taxiway is intended.

3.9.20 **Recommendation -** Access should be provided to allow rescue and fire fighting vehicles to intervene in both directions within the specified response time to the largest aeroplane for which the taxiway bridge is intended.

3.9.21 **Recommendation -** A bridge should be constructed on a straight section of the taxiway with a straight section on both ends of the bridge to facilitate the alignment of aeroplanes approaching the bridge.

3.10 Taxiway shoulders

Note.— Guidance on characteristics of taxiway shoulders and on shoulder treatment is given in the Aerodrome Design Manual (Doc 9157), Part 2.

3.10.1 **Recommendation -** Straight portions of a taxiway where the code letter is C, D, E or F should be provided with shoulders which extend symmetrically on each side of the taxiway so that the overall width of the taxiway and its shoulders on straight portions is not less than:

(1) 44 m where the code letter is F;

(2) 38 m where the code letter is E;

(3) 34 m where the code letter is D; and

(4) 25 m where the code letter is C.

On taxiway curves and on junctions or intersections where increased pavement is provided, the shoulder width should be not less than that on the adjacent straight portions of the taxiway.

3.10.2 **Recommendation -** When a taxiway is intended to be used by turbine-engined aeroplanes, the surface of the taxiway shoulder should be so prepared as to resist erosion and the ingestion of the surface material by aeroplane engines.

3.11 Taxiway strips

Note.— Guidance on characteristics of taxiway strips is given in the ICAO Aerodrome Design Manual (Doc 9157), Part 2.

General

3.11.1 A taxiway, other than an aircraft stand taxilane, shall be included in a strip.

Width of taxiway strips

3.11.2 **Recommendation -** A taxiway strip should extend symmetrically on each side of the centre line of the taxiway throughout the length of the taxiway to at least the distance from the centre line given in Table 3-1, column 11.

Objects on taxiway strips

3.11.3 **Recommendation -** The taxiway strip should provide an area clear of objects which may endanger taxiing aeroplanes.

Grading of taxiway strips

3.11.4 **Recommendation -** The centre portion of a taxiway strip should provide a graded area to a distance from the centre line of the taxiway of not less than that given by the following tabulation:

— 10.25 m where the OMGWS is up to but not including 4.5 m

— 11 m where the OMGWS is 4.5 m up to but not including 6 m

— 12.50 m where the OMGWS is 6 m up to but not including 9 m

— 17 m where the OMGWS is 9 m up to but not including 15 m, where the code letter is D

— 19 m where the OMGWS is 9 m up to but not including 15 m, where the code letter is E

— 22 m where the OMGWS is 9 m up to but not including 15 m, where the code letter is F

Note.— Guidance on width of the graded portion of a taxiway is given in the Aerodrome_Design Manual (Doc 9157), Part 2.

Slopes on taxiway strips

3.11.5 **Recommendation -** The surface of the strip should be flush at the edge of the taxiway or shaller, if provided, and the graded portion should not have an upward transverse slope exceeding:

(a) 2.5 per cent for strips where the code letter is C, D, E or F; and

(b) 3 per cent for strips of taxiways where the code letter is A or B;

the upward slope being measured with reference to the transverse slope of the adjacent taxiway surface and not the horizontal. The downward transverse slope should not exceed 5 per cent measured with reference to the horizontal.

3.11.6 **Recommendation -** The transverse slopes on any portion of a taxiway strip beyond that to be graded should not exceed an upward or downward slope of 5 per cent as measured in the direction away from the taxiway.

3.12 Holding bays, runway-holding positions, intermediate holding positions and road-holding positions

General

3.12.1 **Recommendation -** Holding bay(s) should be provided when the traffic density is medium or heavy.

3.12.2 A runway-holding position or positions shall be established:

(a) on the taxiway, at the intersection of a taxiway and a runway; and

(b) at an intersection of a runway with another runway when the former runway is part of a standard taxi-route.

3.12.3 A runway-holding position shall be established on a taxiway if the location or alignment of the taxiway is such that a taxiing aircraft or vehicle can infringe an obstacle limitation surface or interfere with the operation of radio navigation aids or penetrate the inner transitional surface.

Note.— Guidance for the positioning of runway-holding positions is given Aerodrome Design Manual (Doc 9157), Part 2 .

3.12.4 **Recommendation -** An intermediate holding position should be established on a taxiway at any point other than a runway-holding position where it is desirable to define a specific holding limit.

3.12.5 A road-holding position shall be established at an intersection of a road with a runway.

Location

3.12.6 The distance between a holding bay, runway-holding position established at a taxiway/runway intersection or road-holding position and the centre line of a runway shall be in accordance with Table 3-2 and, in the case of a precision approach runway, such that a holding aircraft or vehicle will not interfere with the operation of radio navigation aids or penetrate the inner transitional surface.

Note.— Guidance for the positioning of runway-holding positions is given Aerodrome Design Manual (Doc 9157), Part 2

3.12.7 **Recommendation -** At elevations greater than 700 m (2 300 ft) the distance of 90 m specified in Table 3-2 for a precision approach runway code number 4 should be increased as follows:

(a) up to an elevation of 2 000 m (6 600 ft); 1 m for every 100 m (330 ft) in excess of 700 m (2 300 ft)

(b) elevation in excess of 2 000 m (6 600 ft) and up to 4 000 m (13 320 ft); 13 m plus 1.5 m for every 100 m (330 ft) in excess of 2 000 m (6 600 ft); and

(c) elevation in excess of 4 000 m (13 320 ft) and up to 5 000 m (16 650 ft); 43 m plus 2 m for every 100 m (330 ft) in excess of 4 000 m (13 320 ft).

3.12.8 **Recommendation -** If a holding bay, runway-holding position or road-holding position for a precision approach runway code number 4 is at a greater elevation compared to the threshold, the distance specified in Table 3-2 should be further increased 5 m for every metre the bay or position is higher than the threshold.

3.12.9 **Until 20 November 2030**, the location of a runway-holding position established in accordance with 3.12.3 shall be such that a holding aircraft or vehicle will not infringe the obstacle free zone, approach surface, take-off climb surface or ILS/MLS critical/ sensitive area or interfere with the operation of radio navigation aids.

3.12.9 ***As of 21 November 2030****, the location of a runway-holding position established in accordance with 3.12.3 shall be such that a holding aircraft or vehicle will not infringe the inner approach surface, inner transitional surfaces, balked landing surface, approach surface, take-off climb surface or ILS/MLS critical/sensitive area or interfere with the operation of other radio navigation aids.*

Table 3-2. Minimum distance from the runway centre line to a holding bay, runway-holding position or road-holding position

Type of runway	Code number 1	2	3	4
Non-instrument	30 m	40 m	~~75m~~ 55 m	75 m
Non-precision approach	40 m	40 m	75 m	75 m
Precision approach category I	60 m[b]	60 m[b]	90 m[a,b]	90 m[a,b]
Precision approach categories II and III	—	—	90 m[a,b]	90 m[a,b]
Take-off runway	30 m	40 m	~~75m~~ 55 m	75 m

(a) If a holding bay, runway holding position or road-holding position is at a lower elevation compared to the threshold, the distance may be decreased 5 m for ever metre the bay or holding position is lower than the threshold, contingent upon not infringing the inner transitional surface.

(b) The distance may need to be increased to avoid interference with radio navigation aids, particularly the glide path and localizer facilities. Information on critical and sensitive area of ILS and MLS is contained in ICAO Annex 10, Volume 1, Attachments C and G, respectively.

Note 1. The distance of 90 m for code number 3 and 4 is based on an aircraft with a tail height of 20 m, a distance from the nose to the higher part of the tail of 52.7 m and a nose

height of 10 m holding at an angle of 45° or more with respect to the runway centre line, being clear of the obstacle free zone and not accountable for the calculation of OCA/H.

Note 2. The distance of 60 m for code number 2 is based on an aircraft with a tail height of 8 m, a distance from the nose to the higher part of the tail of 24.6 m and a nose height of 5.2 m holding at an angle of 45°or more with respect to the runway centre line, being clear of the obstacle free zone.

Note 3.— For code number 4 where the width of the inner edge of the inner approach surface is more than 120 m, a distance greater than 90 m may be necessary to ensure that a holding aircraft is clear of the obstacle free zone. For example, a distance of 100 m is based on an aircraft with a tail height of 24 m, a distance from the nose to the higher part of the tail of 62.2 m and a nose height of 10 m holding at an angle of 45° or more with respect to the runway centre line, being clear of the obstacle free zone.

3.13 Aprons

General

3.13.1 **Recommendation -** Aprons should be provided where necessary to permit the on- and off-loading of passengers, cargo or mail as well as the servicing of aircraft without interfering with the aerodrome traffic.

3.13.2 **Recommendation -** The design of aprons should take into consideration criteria for safe ground handling, including:

a) sufficient space between aircraft stands to enable personnel and equipment to move safely and efficiently;

b) adequate apron markings, apron signs and apron floodlighting;

c) adequate staging and storage areas for ground support equipment (GSE);

d) positioning of fixed ground services;

e) storage areas for unit load devices (ULD);

f) adequate access and egress routes for fuel, GSE and emergency vehicles;

g) clearly delineated and visible access and egress routes for passengers;

h) new technologies (electric charging points, autonomous vehicles, etc.);

i) avoidance of rear of aircraft stand service roads wherever practicable; and

j) appropriate protection for persons, equipment and infrastructure from jet blast and propeller wash.

Note.— Further guidance on apron design and markings is given in the Aerodrome Design Manual (Doc 9157), Part 4 — Visual Aids, and the Airport Planning Manual (Doc 9184), Part 1— Master Planning.

Size of aprons

3.13.3 **Recommendation -** The total apron area should be adequate to permit safe and expeditious handling of the aerodrome traffic at its maximum anticipated density.

Strength of aprons

3.13.4 **Recommendation -** Each part of an apron should be capable of withstanding the traffic of the aircraft it is intended to serve, due consideration being given to the fact that some portions of the apron will be subjected to a higher density of traffic

and, as a result of slow moving or stationary aircraft, to higher stresses than a runway.

Slopes on aprons

3.13.5 **Recommendation -** Slopes on an apron, including those on an aircraft stand taxilane, should be sufficient to prevent accumulation of water on the surface of the apron but should be kept as level as drainage requirements permit.

3.13.6 **Recommendation -** On an aircraft stand the maximum slope should not exceed 1 per cent.

Clearance distances on aircraft stands

3.13.7 **Recommendation -** An aircraft stand should provide the following minimum clearances between an aircraft using the stand and any adjacent building, aircraft on another stand and other objects:

Code letter	*Clearance*
A	*3 m*
B	*3 m*
C	*4.5 m*
D	*7.5 m*
E	*7.5 m*
F	*7.5 m*

When special circumstances so warrant, these clearances may be reduced at a nose-in aircraft stand, where the code letter is D, E or F:

(1) between the terminal, including any fixed passenger boarding bridge, and the nose of an aircraft; and

(2) over any portion of the stand provided with azimuth guidance by a visual docking guidance system.

3.14 Isolated aircraft parking position

3.14.1 An isolated aircraft parking position shall be designated or the aerodrome control tower shall be advised of an area or areas suitable for the parking of an aircraft which is known or believed to be the subject of unlawful interference, or which for other reasons needs isolation from normal aerodrome activities.

3.14.2 **Recommendation -** The isolated aircraft parking position should be located at the maximum distance practicable and in any case never less than 100 m from other parking positions, buildings or public areas, etc. Care should be taken to ensure that the position is not located over underground utilities such as gas and aviation fuel and, to the extent feasible, electrical or communication cables.

3.15 De-icing/anti-icing facilities

3.15.1 Reserved

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4 Obstacle Restriction and Removal

(Applicable until 20 November 2030)

Note.- Information of Annex 14 Volume I Amendment 18 regarding the new **CHAPTER 4. Obstacle Restriction and Removal** (Applicable as of 21 November 2030) is available from ICAO / Brunei DCA (Regulatory)

4.1 Obstacle limitation surfaces

Note.— See Figure 4-1.

Outer horizontal surface

Note.— Guidance on the need to provide an outer horizontal surface and its characteristics is contained in the Airport Services Manual (Doc 9137), Part 6.

Conical surface

4.1.1 **Description**.— Conical surface. A surface sloping upwards and outwards from the periphery of the inner horizontal surface.

4.1.2 **Characteristics**.— The limits of the conical surface shall comprise:

(a) a lower edge coincident with the periphery of the inner horizontal surface; and

(b) an upper edge located at a specified height above the inner horizontal surface.

4.1.3 The slope of the conical surface shall be measured in a vertical plane perpendicular to the periphery of the inner horizontal surface.

Inner horizontal surface

4.1.4 **Description**.— Inner horizontal surface. A surface located in a horizontal plane above an aerodrome and its environs.

4.1.5 **Characteristics**.— The radius or outer limits of the inner horizontal surface shall be measured from a reference point or points established for such purpose.

4.1.6 The height of the inner horizontal surface shall be measured above an elevation datum established for such purpose.

Approach surface

4.1.7 **Description**.— Approach surface. An inclined plane or combination of planes preceding the threshold.

4.1.8 **Characteristics**.— The limits of the approach surface shall comprise:

(a) an inner edge of specified length, horizontal and perpendicular to the extended centre line of the runway and located at a specified distance before the threshold;

(b) two sides originating at the ends of the inner edge and diverging uniformly at a specified rate from the extended centre line of the runway;

(c) an outer edge parallel to the inner edge; and

(d) the above surfaces shall be varied when lateral offset, offset or curved approaches are utilized, specifically, two sides originating at the ends of

the inner edge and diverging uniformly at a specified rate from the extended centre line of the lateral offset, offset or curved ground track.

4.1.9 The elevation of the inner edge shall be equal to the elevation of the midpoint of the threshold.

4.1.10 The slope(s) of the approach surface shall be measured in the vertical plane containing the centre line of the runway and shall continue containing the centre line of any lateral offset or curved ground track.

Note.— See Figure 4-2.

Inner approach surface

4.1.11 **Description**.— Inner approach surface. A rectangular portion of the approach surface immediately preceding the threshold.

4.1.12 **Characteristics**.— The limits of the inner approach surface shall comprise:

(a) an inner edge coincident with the location of the inner edge of the approach surface but of its own specified length;

(b) two sides originating at the ends of the inner edge and extending parallel to the vertical plane containing the centre line of the runway; and

(c) an outer edge parallel to the inner edge.

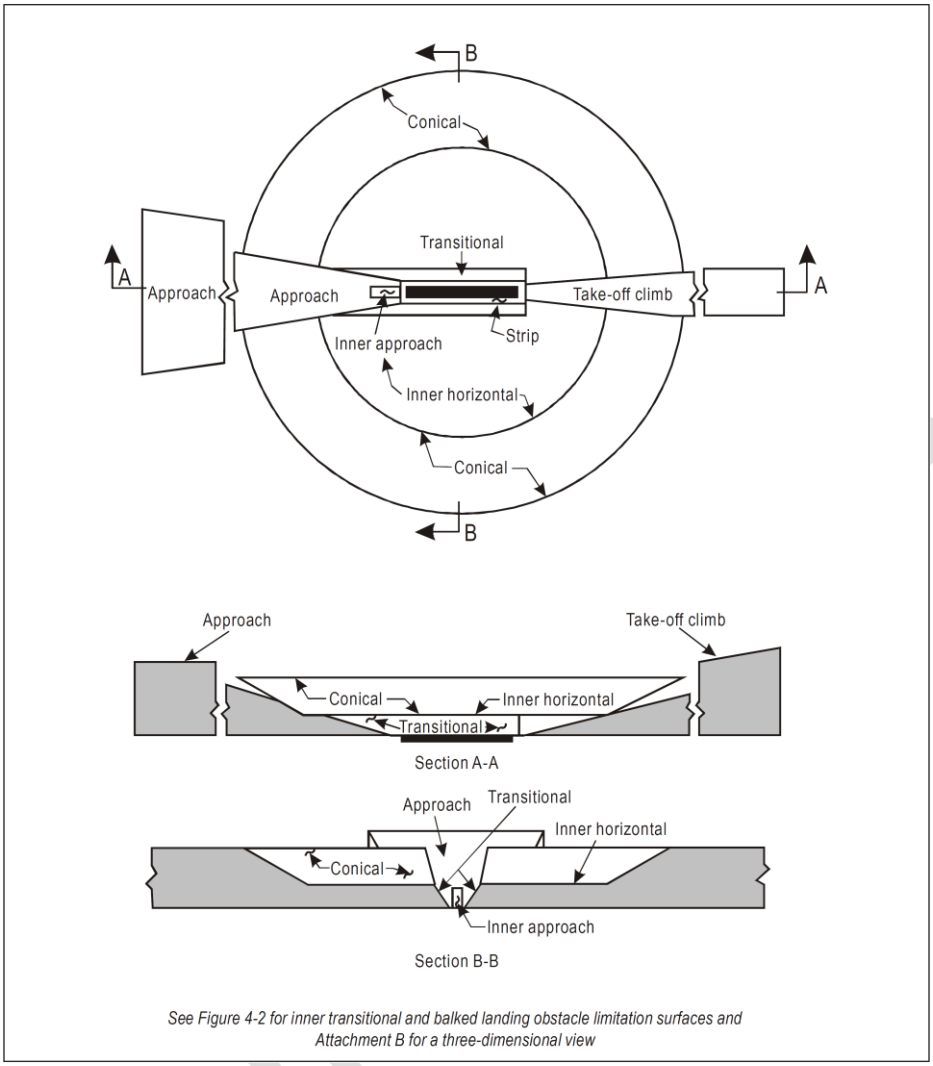


Figure 4-1. Obstacle limitation surfaces

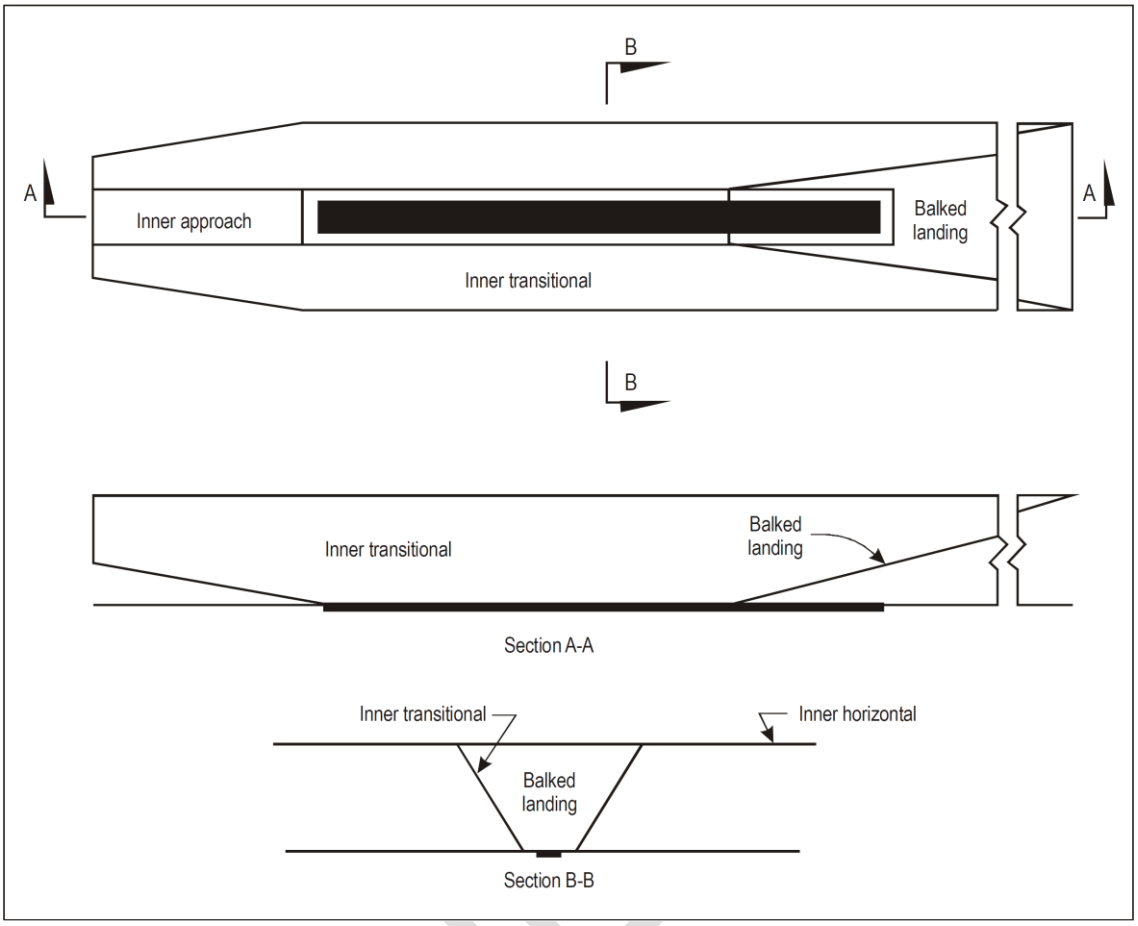


Figure 4-2. Inner approach, inner traditional and balked landing obstacle limitation surfaces

Transitional surface

4.1.13 **Description.**— Transitional surface. A complex surface along the side of the strip and part of the side of the approach surface, that slopes upwards and outwards to the inner horizontal surface.

4.1.14 **Characteristics.**— The limits of a transitional surface shall comprise:

(a) a lower edge beginning at the intersection of the side of the approach surface with the inner horizontal surface and extending down the side of the approach surface to the inner edge of the approach surface and from there along the length of the strip parallel to the runway centre line; and

(b) an upper edge located in the plane of the inner horizontal surface.

4.1.15 The elevation of a point on the lower edge shall be:

(a) along the side of the approach surface — equal to the elevation of the approach surface at that point; and

(b) along the strip — equal to the elevation of the nearest point on the centre line of the runway or its extension.

4.1.16 The slope of the transitional surface shall be measured in a vertical plane at right angles to the centre line of the runway.

Inner transitional surface

4.1.17 **Description.**— Inner transitional surface. A surface similar to the transitional surface but closer to the runway.

4.1.18 **Characteristics**.— The limits of an inner transitional surface shall comprise:

(a) a lower edge beginning at the end of the inner approach surface and extending down the side of the inner approach surface to the inner edge of that surface, from there along the strip parallel to the runway centre line to the inner edge of the balked landing surface and from there up the side of the balked landing surface to the point where the side intersects the inner horizontal surface; and

(b) an upper edge located in the plane of the inner horizontal surface.

4.1.19 The elevation of a point on the lower edge shall be:

(a) along the side of the inner approach surface and balked landing surface — equal to the elevation of the particular surface at that point; and

(b) along the strip — equal to the elevation of the nearest point on the centre line of the runway or its extension.

4.1.20 The slope of the inner transitional surface shall be measured in a vertical plane at right angles to the centre line of the runway.

Balked landing surface

4.1.21 **Description.**— Balked landing surface. An inclined plane located at a specified distance after the threshold, extending between the inner transitional surfaces.

4.1.22 **Characteristics**.— The limits of the balked landing surface shall comprise:

(a) an inner edge horizontal and perpendicular to the centre line of the runway and located at a specified distance after the threshold;

(b) two sides originating at the ends of the inner edge and diverging uniformly at a specified rate from the vertical plane containing the centre line of the runway; and

(c) an outer edge parallel to the inner edge and located in the plane of the inner horizontal surface.

4.1.23 The elevation of the inner edge shall be equal to the elevation of the runway centre line at the location of the inner edge.

4.1.24 The slope of the balked landing surface shall be measured in the vertical plane containing the centre line of the runway.

Take-off climb surface

4.1.25 **Description.**— Take-off climb surface. An inclined plane or other specified surface beyond the end of a runway or clearway.

4.1.26 **Characteristics**.— The limits of the take-off climb surface shall comprise:

(a) an inner edge horizontal and perpendicular to the centre line of the runway and located either at a specified distance beyond the end of the runway or at the end of the clearway when such is provided and its length exceeds the specified distance;

(b) two sides originating at the ends of the inner edge, diverging uniformly at a specified rate from the take-off track to a specified final width and

continuing thereafter at that width for the remainder of the length of the take-off climb surface; and

(c) an outer edge horizontal and perpendicular to the specified take-off track.

4.1.27 The elevation of the inner edge shall be equal to the highest point on the extended runway centre line between the end of the runway and the inner edge, except that when a clearway is provided the elevation shall be equal to the highest point on the ground on the centre line of the clearway.

4.1.28 In the case of a straight take-off flight path, the slope of the take-off climb surface shall be measured in the vertical plane containing the centre line of the runway.

4.1.29 In the case of a take-off flight path involving a turn, the take-off climb surface shall be a complex surface containing the horizontal normals to its centre line, and the slope of the centre line shall be the same as that for a straight take-off flight path.

4.2 Obstacle limitation requirements

Non-instrument runways

4.2.1 The following obstacle limitation surfaces shall be established for a non-instrument runway:

(a) conical surface;

(b) inner horizontal surface;

(c) transitional surfaces.

4.2.2 The heights and slopes of the surfaces shall not be greater than, and their other dimensions not less than, those specified in Table 4-1.

4.2.3 New objects or extensions of existing objects shall not be permitted above an approach or transitional surface except when, in the opinion of the Brunei DCA, the new object or extension would be shielded by an existing immovable object.

4.2.4 **Recommendation -** New objects or extensions of existing objects should not be permitted above the conical surface or inner horizontal surface except when, in the opinion of the Brunei DCA, the object would be shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.

4.2.5 **Recommendation -** Existing objects above any of the surfaces required by 4.2.1 should as far as practicable be removed except when, in the opinion of the Brunei DCA, the object is shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.

4.2.6 **Recommendation -** In considering proposed construction, account should be taken of the possible future development of an instrument runway and consequent requirement for more stringent obstacle limitation surfaces.

Non-precision approach runways

4.2.7 The following obstacle limitation surfaces shall be established for a non-precision approach runway:

(a) conical surface;

(b) inner horizontal surface;

(c) approach surface; and

(d) transitional surfaces.

4.2.8 The heights and slopes of the surfaces shall not be greater than, and their other dimensions not less than, those specified in Table 4-1, except in the case of the horizontal section of the approach surface (see 4.2.9).

4.2.9 The approach surface shall be horizontal beyond the point at which the 2.5 per cent slope intersects:

(a) a horizontal plane 150 m above the threshold elevation; or

(b) the horizontal plane passing through the top of any object that governs the obstacle clearance altitude/height (OCA/H); whichever is the higher.

Table 4-1. Dimensions and slopes of obstacle limitations surfaces – Approach runways

APPROACH RUNWAYS

	RUNWAY CLASSIFICATION									
	Non-instrument Code number				Non-precision approach Code number			Precision approach category I Code number		II or III Code number
Surface and dimensions[a]	1	2	3	4	1,2	3	4	1,2	3,4	3,4
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
CONICAL										
Slope	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Height	35 m	55 m	75 m	100 m	60 m	75 m	100 m	60 m	100 m	100 m
INNER HORIZONTAL										
Height	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m
Radius	2 000 m	2 500 m	4 000 m	4 000 m	3 500 m	4 000 m	4 000 m	3 500 m	4 000 m	4 000 m
INNER APPROACH										
Width	—	—	—	—	—	—	—	90 m	120 m[e]	120 m[e]
Distance from threshold	—	—	—	—	—	—	—	60 m	60 m	60 m
Length	—	—	—	—	—	—	—	900 m	900 m	900 m
Slope								2.5%	2%	2%
APPROACH										
Length of inner edge	60 m	80 m	~~150~~ 110m	150 m	140 m	280 m	280 m	140 m	280 m	280 m
Distance from threshold	30 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m
Divergence (each side)	10%	10%	10%	10%	15%	15%	15%	15%	15%	15%
First section										
Length	1 600 m	2 500 m	3 000 m	3 000 m	2 500 m	3 000 m	3 000 m	3 000 m	3 000 m	3 000 m
Slope	5%	4%	3.33%	2.5%	3.33%	2%	2%	2.5%	2%	2%
Second section										
Length	—	—	—	—	—	3 600 m[b]	3 600 m[b]	12 000 m	3 600 m[b]	3 600 m[b]
Slope	—	—	—	—	—	2.5%	2.5%	3%	2.5%	2.5%
Horizontal section										
Length	—	—	—	—	—	8 400 m[b]	8 400 m[b]	—	8 400 m[b]	8 400 m[b]
Total length	—	—	—	—	—	15 000 m	15 000 m	15 000 m	15 000 m	15 000 m
TRANSITIONAL										
Slope	20%	20%	14.3%	14.3%	20%	14.3%	14.3%	14.3%	14.3%	14.3%
INNER TRANSITIONAL										
Slope	—	—	—	—	—	—	—	40%	33.3%	33.3%
BALKED LANDING SURFACE										
Length of inner edge	—	—	—	—	—	—	—	90 m	120 m[e]	120 m[e]
Distance from threshold	—	—	—	—	—	—	—	c	1 800 m[d]	1 800 m[d]
Divergence (each side)	—	—	—	—	—	—	—	10%	10%	10%
Slope	—	—	—	—	—	—	—	4%	3.33%	3.33%

a. All dimensions are measured horizontally unless specified otherwise.
b. Variable length (see 4.2.9 or 4.2.17).
c. Distance to the end of strip.
d. Or end of runway whichever is less.
e. Where the code letter is F (Table 1-1), the width is increased to 140 m except for those aerodromes that accommodate a code letter F aeroplane equipped with digital avionics that provide steering commands to maintain an established track during the go-around manoeuvre.

Note.— See Circulars 301 and 345 (forthcoming), and Chapter 4 of the PANS-Aerodromes, Part I (Doc 9981) for further information.

4.2.10 New objects or extensions of existing objects shall not be permitted above an approach surface within 3 000 m of the inner edge or above a transitional surface except when, in the opinion of the Brunei DCA, the new object or extension would be shielded by an existing immovable object.

4.2.11 **Recommendation -** New objects or extensions of existing objects should not be permitted above the approach surface beyond 3 000 m from the inner edge, the conical surface or inner horizontal surface except when, in the opinion of the Brunei DCA, the object would be shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.

4.2.12 **Recommendation -** Existing objects above any of the surfaces required by 4.2.7 should as far as practicable be removed except when, in the opinion of the Brunei DCA, the object is shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.

Precision approach runways

4.2.13 The following obstacle limitation surfaces shall be established for a precision approach runway category I:

(a) conical surface;

(b) inner horizontal surface;

(c) approach surface; and

(d) transitional surfaces.

4.2.14 **Recommendation -** The following obstacle limitation surfaces should be established for a precision approach runway category I:

(a) inner approach surface;

(b) inner transitional surfaces; and

(c) balked landing surface.

4.2.15 The following obstacle limitation surfaces shall be established for a precision approach runway category II or III:

(a) conical surface;

(b) inner horizontal surface;

(c) approach surface and inner approach surface;

(d) transitional surfaces;

(e) inner transitional surfaces; and

(f) balked landing surface.

4.2.16 The heights and slopes of the surfaces shall not be greater than, and their other dimensions not less than, those specified in Table 4-1, except in the case of the horizontal section of the approach surface (see 4.2.17).

4.2.17 The approach surface shall be horizontal beyond the point at which the 2.5 per cent slope intersects:

(a) a horizontal plane 150 m above the threshold elevation; or

(b) the horizontal plane passing through the top of any object that governs the obstacle clearance limit;

whichever is the higher.

4.2.18 Fixed objects shall not be permitted above the inner approach surface, the inner transitional surface or the balked landing surface, except for frangible objects which because of their function must be located on the strip. Mobile objects shall not be permitted above these surfaces during the use of the runway for landing.

4.2.19 New objects or extensions of existing objects shall not be permitted above an approach surface or a transitional surface except when, in the opinion of the Brunei DCA, the new object or extension would be shielded by an existing immovable object.

Note. Circumstances in which the shielding principle may be appled are described in the ICAO Airport Services Manual (Doc. 9137), Part 6.

4.2.20 **Recommendation -** New objects or extensions of existing objects should not be permitted above the conical surface and the inner horizontal surface except when, in the opinion of the Brunei DCA, an object would be shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.

4.2.21 **Recommendation -** Existing objects above an approach surface, a transitional surface, the conical surface and inner horizontal surface should as far as practicable be removed except when, in the opinion of the Brunei DCA, an object is shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.

Runways meant for take-off

4.2.22 The following obstacle limitation surface shall be established for a runway meant for take-off:

(a) take-off climb surface.

4.2.23 The dimensions of the surface shall be not less than the dimensions specified in Table 4-2, except that a lesser length may be adopted for the take-off climb surface where such lesser length would be consistent with procedural measures adopted to govern the outward flight of aeroplanes.

4.2.24 **Recommendation -** The operational characteristics of aeroplanes for which the runway is intended should be examined to see if it is desirable to reduce the slope specified in Table 4-2 when critical operating conditions are to be catered to. If the specified slope is reduced, corresponding adjustment in the length of the take-off climb surface should be made so as to provide protection to a height of 300 m.

4.2.25 New objects or extensions of existing objects shall not be permitted above a take-off climb surface except when, in the opinion of the Brunei DCA, the new object or extension would be shielded by an existing immovable object.

4.2.26 **Recommendation -** If no object reaches the 2 per cent (1:50) take-off climb surface, new objects should be limited to preserve the existing obstacle free surface or a surface down to a slope of 1.6 per cent (1:62.5).

Table 4-2 Dimensions and slopes of obstacle limitation surfaces

RUNWAYS MEANT FOR TAKE-OFF

Surface and dimensions[a]	Code number 1	2	3 or 4
(1)	(2)	(3)	(4)
TAKE-OFF CLIMB			
Length of inner edge	60 m	80 m	180 m
Distance from runway end[b]	30 m	60 m	60 m
Divergence (each side)	10%	10%	12.5%
Final width	380 m	580 m	1 200 m 1 800 m[c]
Length	1 600 m	2 500 m	15 000 m
Slope	5%	4%	2%[d]

a. All dimensions are measured horizontally unless specified otherwise.
b. The take-off climb surface starts at the end of the clearway if the clearway length exceeds the specified distance.
c. 1 800 m when the intended track includes changes of heading greater than 15° for operations conducted in IMC, VMC by night.
d. See 4.2.24 and 4.2.26.

4.2.27 **Recommendation -** Existing objects that extend above a take-off climb surface should as far as practicable be removed except when, in the opinion of the Brunei DCA, an object is shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.

4.3 Objects outside the obstacle limitation surfaces

Note.- See 13.1 Obstacle Control

4.3.1 **Recommendation -** Arrangements should be made to enable the Brunei DCA to be consulted concerning proposed construction beyond the limits of the obstacle limitation surfaces that extend above a height established by the Brunei DCA, in order to permit an aeronautical study of the effect of such construction on the operation of aeroplanes.

4.3.2 **Recommendation -** In areas beyond the limits of the obstacle limitation surfaces, at least those objects which extend to a height of 150 m or more above ground elevation should be regarded as obstacles, unless a special aeronautical study indicates that they do not constitute a hazard to aeroplanes.

Note. – Additional information for arrangement can be found in ICAO Doc 8168, Procedures for Air Navigation Services – Aircraft Operations Volume I and II (PANS-OPS)

4.4 Other objects

4.4.1 **Recommendation -** Objects which do not project through the approach surface but which would nevertheless adversely affect the optimum sitting or performance of visual or non-visual aids should, as far as practicable, be removed.

4.4.2 **Recommendation -** Anything which may, in the opinion of the Brunei DCA after aeronautical study, endanger aeroplanes on the movement area or in the air within the limits of the inner horizontal and conical surfaces should be regarded as an obstacle and should be removed in so far as practicable.

Note. – Additional information for arrangement can be found in ICAO Doc 8168, Procedures for Air Navigation Services – Aircraft Operations Volume I and II (PANS-OPS)

5 Visual Aids for Navigation

5.1 Indicators and signalling devices

5.1.1 Wind direction indicator

Application

5.1.1.1 An aerodrome shall be equipped with at least one wind direction indicator.

Location

5.1.1.2 A wind direction indicator shall be located so as to be visible from aircraft in flight or on the movement area and in such a way as to be free from the effects of air disturbances caused by nearby objects.

Characteristics

5.1.1.3 **Recommendation -** The wind direction indicator should be in the form of a truncated cone made of fabric and should have a length of not less than 3.6 m and a diameter, at the larger end, of not less than 0.9 m. It should be constructed so that it gives a clear indication of the direction of the surface wind and a general indication of the wind speed. The colour or colours should be so selected as to make the wind direction indicator clearly visible and understandable from a height of at least 300 m, having regard to background. Where practicable, a single colour, preferably white or orange, should be used. Where a combination of two colours is required to give adequate conspicuity against changing backgrounds, they should preferably be orange and white, red and white, or black and white, and should be arranged in five alternate bands, the first and last bands being the darker colour.

5.1.1.4 **Recommendation -** The location of at least one wind direction indicator should be marked by a circular band 15 m in diameter and 1.2 m wide. The band should be centred about the wind direction indicator support and should be in a colour chosen to give adequate conspicuity, preferably white.

5.1.1.5 **Recommendation -** Provision should be made for illuminating at least one wind indicator at an aerodrome intended for use at night.

5.1.2 Landing direction indicator

Location

5.1.2.1 Where provided, a landing direction indicator shall be located in a conspicuous place on the aerodrome.

Characteristics

5.1.2.2 **Recommendation -** The landing direction indicator should be in the form of a “T”.

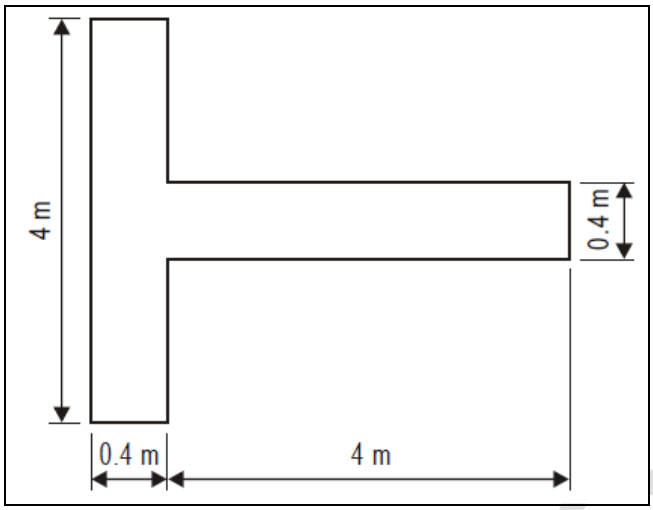


Figure 5-1. Landing direction indicator

5.1.2.3 The shape and minimum dimensions of a landing "T" shall be as shown in Figure 7. The colour of the landing "T" shall be either white or orange, the choice being dependent on the colour that contrasts best with the background against which the indicator will be viewed. Where required for use at night the landing "T" shall either be illuminated or outlined by white lights.

5.1.3 Signalling lamp

Application

5.1.3.1 A signalling lamp shall be provided at a controlled aerodrome in the aerodrome control tower.

Characteristics

5.1.3.2 **Recommendation -** A signalling lamp should be capable of producing red, green and white signals, and of:

(1) being aimed manually at any target as required;

(2) giving a signal in any one colour followed by a signal in either of the two other colours; and

(3) transmitting a message in any one of the three colours by Morse Code up to a speed of at least four words per minute.

When selecting the green light, use should be made of the restricted boundary of green.

5.1.3.3 **Recommendation -** The beam spread should be not less than 1° nor greater than 3°, with negligible light beyond 3°. When the signalling lamp is intended for use in the daytime the intensity of the coloured light should be not less than 6 000 cd.

5.1.4 Signal panels and signal area

Location of signal area

5.1.4.1 **Recommendation -** The signal area, if provided should be located so as to be visible for all angles of azimuth above an angle of 10° above the horizontal when viewed from a height of 300 m.

Characteristics of signal area

5.1.4.2 The signal area shall be an even horizontal surface at least 9 m square.

5.1.4.3 **Recommendation -** The colour of the signal area should be chosen to contrast with the colours of the signal panels used, and it should be surrounded by a white border not less than 0.3 m wide.

5.2 Markings

5.2.1 General

Interruption of runway markings

5.2.1.1 At an intersection of two (or more) runways the markings of the more important runway, except for the runway side stripe marking, shall be displayed and the markings of the other runway(s) shall be interrupted. The runway side stripe marking of the more important runway may be either continued across the intersection or interrupted.

5.2.1.2 **Recommendation -** The order of importance of runways for the display of runway markings should be as follows:

1st — precision approach runway;

2nd — non-precision approach runway; and

3rd — non-instrument runway.

5.2.1.3 At an intersection of a runway and taxiway the markings of the runway shall be displayed and the markings of the taxiway interrupted, except that runway side stripe markings may be interrupted.

Colour and conspicuity

5.2.1.4 Runway markings shall be white.

Note .— It has been found that, on runway surfaces of light colour, the conspicuity of white markings can be improved by outlining them in black.

5.2.1.5 Taxiway markings, runway turn pad markings and aircraft stand markings shall be yellow.

5.2.1.6 Apron safety lines shall be red.

5.2.1.7 **Recommendation -** At aerodromes where operations take place at night, pavement markings should be made with reflective materials designed to enhance the visibility of the markings.

Note.— Guidance on reflective materials is given in the Aerodrome Design Manual (Doc 9157), Part 4.

Unpaved taxiways

5.2.1.8 **Recommendation -** An unpaved taxiway should be provided, so far as practicable, with the markings prescribed for paved taxiways.

5.2.2 Runway designation marking

Application

5.2.2.1 A runway designation marking shall be provided at the thresholds of a paved runway.

5.2.2.2 **Recommendation -** A runway designation marking should be provided, so far as practicable, at the thresholds of an unpaved runway.

Location

5.2.2.3 A runway designation marking shall be located at a threshold as shown in Figure 5-2 as appropriate.

Characteristics

5.2.2.4 A runway designation marking shall consist of a two-digit number and on parallel runways shall be supplemented with a letter. On a single runway, dual parallel runways and triple parallel runways the two-digit number shall be the whole number nearest the one-tenth of the magnetic North when viewed from the direction of approach. On four or more parallel runways, one set of adjacent runways shall be numbered to the nearest one-tenth magnetic azimuth and the other set of adjacent runways numbered to the next nearest one-tenth of the magnetic azimuth. When the above rule would give a single digit number, it shall be preceded by a zero.

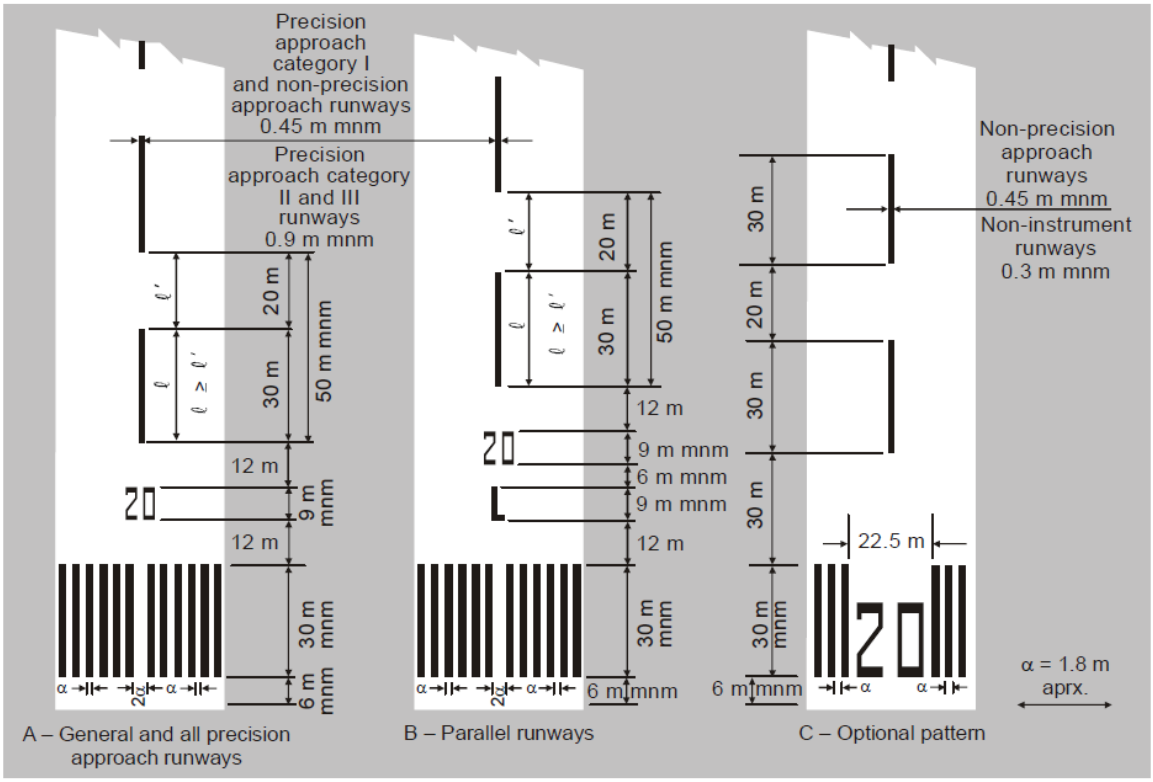


Figure 5-2. Runway designation, centre line and threshold markings

5.2.2.5 In the case of parallel runways, each runway designation number shall be supplemented by a letter as follows, in the order shown from left to right when viewed from the direction of approach:

— for two parallel runways: “L” “R”;

— for three parallel runways: “L” “C” “R”;

— for four parallel runways: “L” “R” “L” “R”;

— for five parallel runways: “L” “C” “R” “L” “R” or “L” “R” “L” “C” “R”; and

— for six parallel runways: “L” “C” “R” “L” “C” “R”.

5.2.2.6 The numbers and letters shall be in the form and proportion shown in Figure 5-3. The dimensions shall be not less than those shown in Figure 5-3, but where the numbers are incorporated in the threshold marking, larger dimensions shall be used in order to fill adequately the gap between the stripes of the threshold marking.

5.2.3 Runway centre line marking

Application

5.2.3.1 A runway centre line marking shall be provided on a paved runway.

Location

5.2.3.2 A runway centre line marking shall be located along the centre line of the runway between the runway designation markings as shown in Figure 5-2, except when interrupted in compliance with 5.2.1.1.

Characteristics

5.2.3.3 A runway centre line marking shall consist of a line of uniformly spaced stripes and gaps. The length of a stripe plus a gap shall be not less than 50 m or more than 75 m. The length of each stripe shall be at least equal to the length of the gap or 30 m, whichever is greater.

5.2.3.4 The width of the stripes shall be not less than:

- 0.90 m on precision approach category II and III runways;
- 0.45 m on non-precision approach runways where the code number is 3 or 4, and precision approach category I runways; and
- 0.30 m on non-precision approach runways where the code number is 1 or 2, and on non-instrument runways.

5.2.4 Threshold marking

Application

5.2.4.1 A threshold marking shall be provided at the threshold of a paved runway.

5.2.4.2 **Recommendation -** A threshold marking should be provided, so far as practicable, at the thresholds of an unpaved runway.

Location

5.2.4.3 The stripes of the threshold marking shall commence 6 m from the threshold.

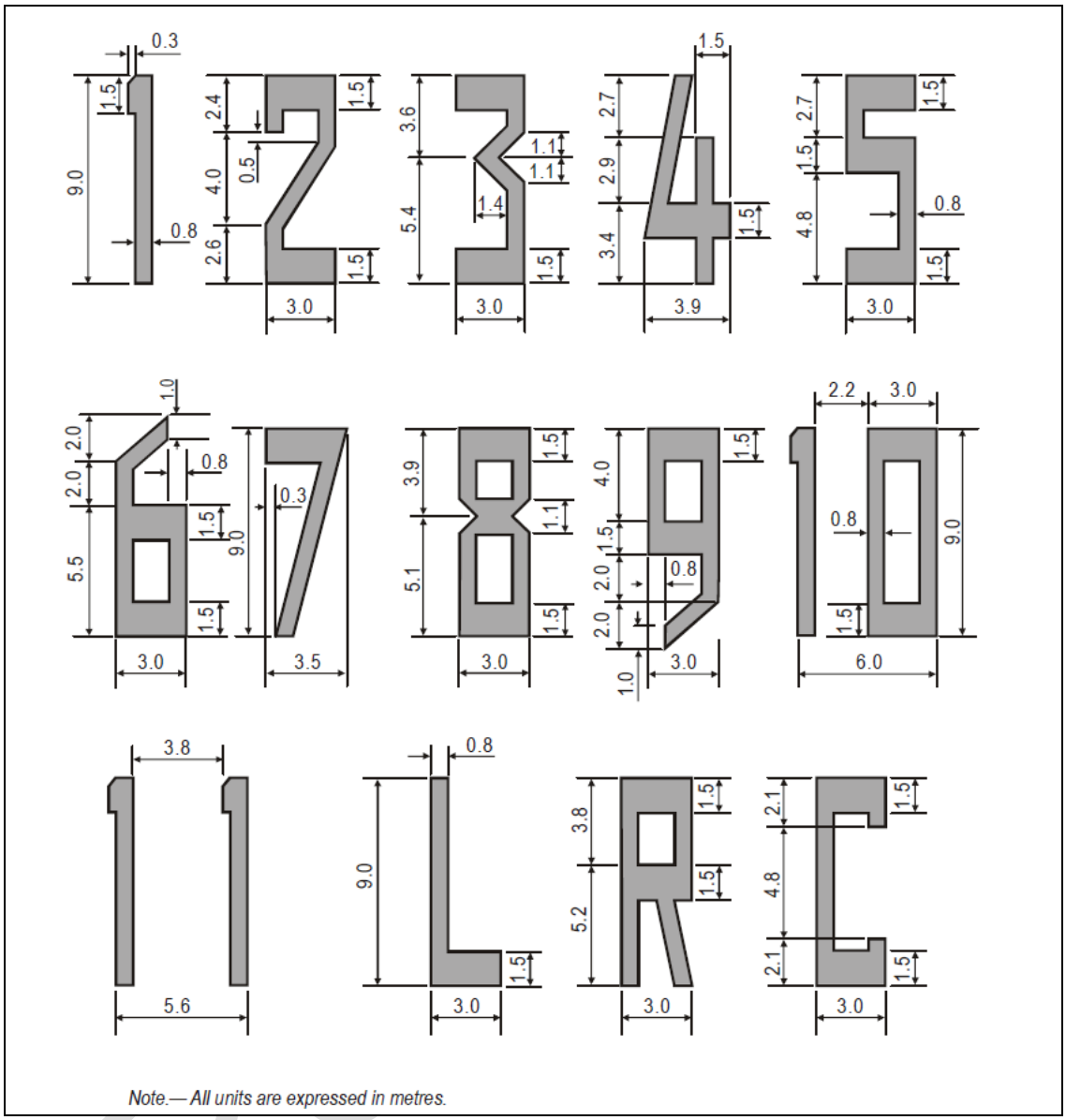


Figure 5-3. Form and proportion of numbers and letters for runway designation markings

Characteristics

5.2.4.4 A runway threshold marking shall consist of a pattern of longitudinal stripes of uniform dimensions disposed symmetrically about the centre line of a runway as shown in Figure 5-2 (A) and (B) for a runway width of 45 m. The number of stripes shall be in accordance with the runway width as follows:

Runway width	Number of stripes
18 m	4
23 m	6
30 m	8

Runway width	Number of stripes
45 m	12
60 m	16

except that on non-precision approach and non-instrument runways 45 m or greater in width, they may be as shown in Figure 5-2 (C).

5.2.4.5 The stripes shall extend laterally to within 3 m of the edge of a runway or to a distance of 27 m on either side of a runway centre line, whichever results in the smaller lateral distance. Where a runway designation marking is placed within a threshold marking there shall be a minimum of three stripes on each side of the centre line of the runway. Where a runway designation marking is placed above a threshold marking, the stripes shall be continued across the runway. The stripes shall be at least 30 m long and approximately 1.80 m wide with spacings of approximately 1.80 m between them except that, where the stripes are continued across a runway, a double spacing shall be used to separate the two stripes nearest the centre line of the runway, and in the case where the designation marking is included within the threshold marking this spacing shall be 22.5 m.

Transverse stripe

5.2.4.6 **Recommendation -** Where a threshold is displaced from the extremity of a runway or where the extremity of a runway is not square with the runway centre line, a transverse stripe as shown in Figure 5-4 (B) should be added to the threshold marking.

5.2.4.7 A transverse stripe shall be not less than 1.80 m wide.

Arrows

5.2.4.8 Where a runway threshold is permanently displaced, arrows conforming to Figure 5-4 (B) shall be provided on the portion of the runway before the displaced threshold.

5.2.4.9 When a runway threshold is temporarily displaced from the normal position, it shall be marked as shown in Figure 5-4 (A) or 5-4 (B) and all markings prior to the displaced threshold shall be obscured except the runway centre line marking, which shall be converted to arrows.

Note 1.— In the case where a threshold is temporarily displaced for only a short period of time, it has been found satisfactory to use markers in the form and colour of a displaced threshold marking rather than attempting to paint this marking on the runway.

Note 2.— When the runway before a displaced threshold is unfit for the surface movement of aircraft, closed markings,as described in 7.1.1 are required to be provided.

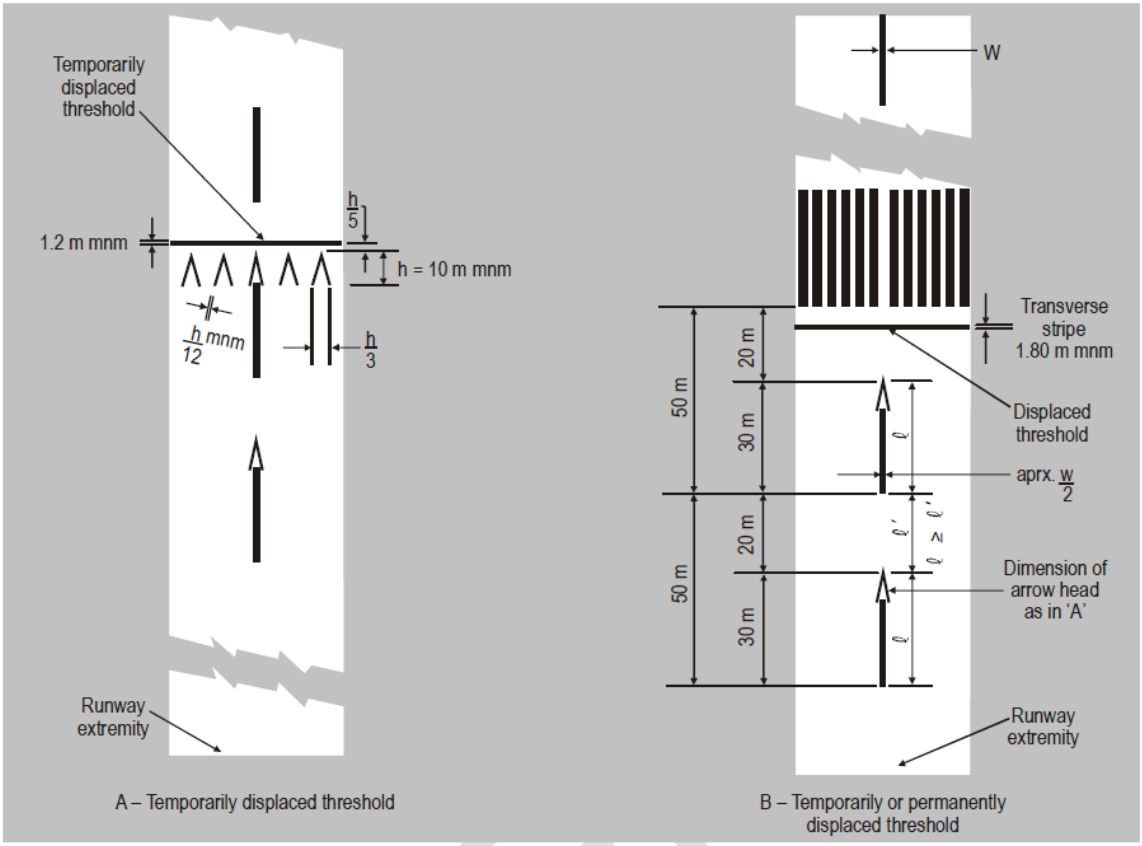


Figure 5-4. Displaced threshold markings

5.2.5 Aiming point marking

Application

5.2.5.1 An aiming point marking shall be provided at each approach end of a paved instrument runway where the code number is 2, 3 or 4.

5.2.5.2 **Recommendation -** An aiming point marking should be provided at each approach end of:

(1) a paved non-instrument runway where the code number is 3 or 4;

(2) a paved instrument runway where the code number is 1;

when additional conspicuity of the aiming point is desirable.

Location

5.2.5.3 The aiming point marking shall commence no closer to the threshold than the distance indicated in the appropriate column of Table 5-1, except that, on a runway equipped with a visual approach slope indicator system, the beginning of the marking shall be coincident with the visual approach slope origin.

5.2.5.4 An aiming point marking shall consist of two conspicuous stripes. The dimensions of the stripes and the lateral spacing between their inner sides shall be in accordance with the provisions of the appropriate column of Table 5-1. Where a touchdown zone marking is provided, the lateral spacing between the markings shall be the same as that of the touchdown zone marking.

5.2.6 Touchdown zone marking

Application

5.2.6.1 A touchdown zone marking shall be provided in the touchdown zone of a paved precision approach runway where the code number is 2, 3 or 4.

5.2.6.2 **Recommendation -** A touchdown zone marking should be provided in the touchdown zone of a paved non- precision approach or non-instrument runway where the code number is 3 or 4 and additional conspicuity of the touchdown zone is desirable.

Table 5-1. Location and dimension of aiming point marking

	Landing distance available			
Location and dimensions (1)	Less than 800 m (2)	800 m up to but not including 1 200 m (3)	1 200 m up to but not including 2 400 m (4)	2 400 m and above (5)
Distance from threshold to beginning of marking	150 m	250 m	300 m	400 m
Length of stripe[a]	30–45 m	30–45 m	45–60 m	45–60 m
Width of stripe	4 m	6 m	6–10 m[b]	6–10 m[b]
Lateral spacing between inner sides of stripes	6 m[c]	9 m[c]	18–22.5 m	18–22.5 m

a. The greater dimensions of the specified ranges are intended to be used where increased conspicuity is required.
b. The lateral spacing may be varied within these limits to minimize the contamination of the marking by rubber deposits.
c. These figures were deduced by reference to the outer main gear wheel span which is element 2 of the aerodrome reference code at Chapter 1, Table 1-1.

Location and characteristics

5.2.6.3 A touchdown zone marking shall consist of pairs of rectangular markings symmetrically disposed about the runway centre line with the number of such pairs related to the landing distance available and, where the marking is to be displayed at both the approach directions of a runway, the distance between the thresholds, as follows:

Landing distance available or the distance between thresholds	Pair(s) of markings
less than 900 m	1
900 m up to but not including 1 200 m	2
1 200 m up to but not including 1 500 m	3
1 500 m up to but not including 2 400 m	4
2 400 m or more	6

5.2.6.4 A touchdown zone marking shall conform to either of the two patterns shown in Figure 5-5. For the pattern shown in Figure 5-5 (A), the markings shall be not less than 22.5 m long and 3 m wide. For the pattern shown in Figure 5-5 (B), each stripe of each marking shall be not less than 22.5 m long and 1.8 m wide with a spacing of 1.5 m between adjacent stripes. The lateral spacing between the inner sides of the rectangles shall be equal to that of the aiming point marking where provided. Where an aiming point marking is not provided, the lateral spacing between the inner sides of the rectangles shall correspond to the lateral spacing specified for the aiming point marking in Table 5-1 (columns 2, 3, 4 or 5, as appropriate). The pairs of markings shall be provided at longitudinal spacings of 150 m beginning from the threshold, except that pairs of touchdown zone markings coincident with or located within 50 m of an aiming point marking shall be deleted from the pattern.

5.2.6.5 **Recommendation -** On a non-precision approach runway where the code number is 2, an additional pair of touchdown zone marking stripes should be provided 150 m beyond the beginning of the aiming point marking.

5.2.7 Runway side stripe marking

Application

5.2.7.1 A runway side stripe marking shall be provided between the thresholds of a paved runway where there is a lack of contrast between the runway edges and the shoulders or the surrounding terrain.

5.2.7.2 **Recommendation -** A runway side stripe marking should be provided on a precision approach runway irrespective of the contrast between the runway edges and the shoulders or the surrounding terrain.

Location

5.2.7.3 **Recommendation -** A runway side stripe marking should consist of two stripes, one placed along each edge of the runway with the outer edge of each stripe approximately on the edge of the runway, except that, where the runway is greater than 60 m in width, the stripes should be located 30 m from the runway centre line.

5.2.7.4 **Recommendation -** Where a runway turn pad is provided, the runway side stripe marking should be continued between the runway and the runway turn pad.

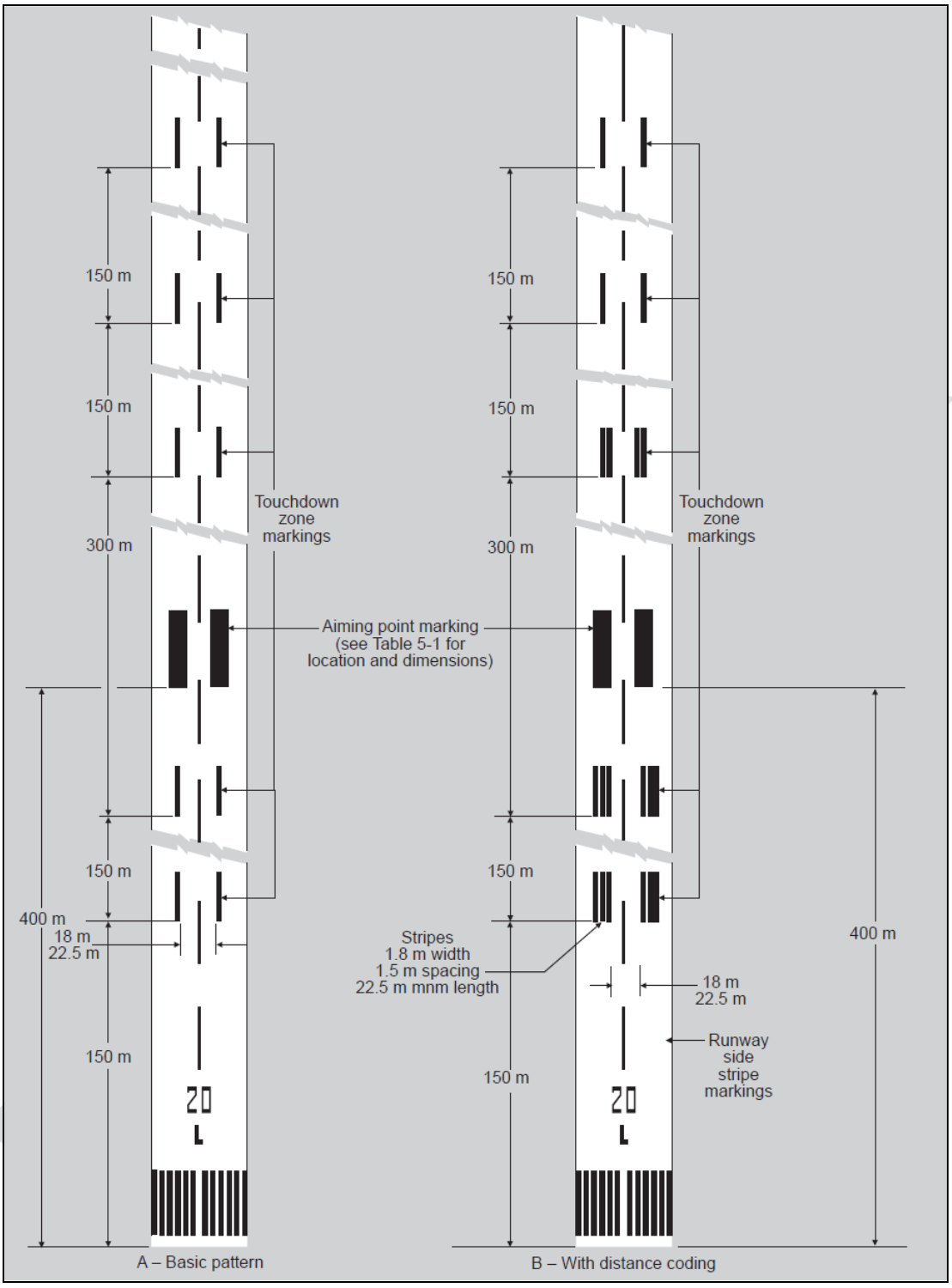


Figure 5-5. Aiming point and touchdown zone markings (illustrated for a runway with a length of 2.400 m or more)

Characteristics

5.2.7.5 **Recommendation -** A runway side stripe should have an overall width of at least 0.9 m on runways 30 m or more in width and at least 0.45 m on narrower runways.

5.2.8 Taxiway centre line marking

Application

5.2.8.1 Taxiway centre line marking shall be provided on a paved taxiway and apron where the code number is 3 or 4 in such a way as to provide continuous guidance between the runway centre line and aircraft stands.

5.2.8.2 **Recommendation -** Taxiway centre line marking should be provided on a paved taxiway and apron where the code number is 1 or 2 in such a way as to provide continuous guidance between the runway centre line and aircraft stands.

5.2.8.3 Taxiway centre line marking shall be provided on a paved runway when the runway is part of a standard taxi- route and:

(1) there is no runway centre line marking; or

(2) where the taxiway centre line is not coincident with the runway centre line.

5.2.8.4 **Recommendation -** Where it is necessary to denote the proximity of a runway-holding position, enhanced taxiway centre line marking should be provided.

5.2.8.5 Where provided on any taxiway on an aerodrome, enhanced taxiway centre line marking shall be installed at each taxiway/runway intersection.

Location

5.2.8.6 **Recommendation -** On a straight section of a taxiway, the taxiway centre line marking should be located along the taxiway centre line. On a taxiway curve, the marking should continue from the straight portion of the taxiway at a constant distance from the outside edge of the curve.

Note.— See 3.9.5 and Figure 3-2.

5.2.8.7 **Recommendation -** At an intersection of a taxiway with a runway where the taxiway serves as an exit from the runway, the taxiway centre line marking should be curved into the runway centre line marking as shown in Figures 5-6 and 5-26. The taxiway centre line marking should be extended parallel to the runway centre line marking for a distance of at least 60 m beyond the point of tangency where the code number is 3 or 4, and for a distance of at least 30 m where the code number is 1 or 2.

5.2.8.8 **Recommendation -** Where taxiway centre line marking is provided on a runway in accordance with 5.2.8.3, the marking should be located on the centre line of the designated taxiway.

5.2.8.9 Where provided:

(1) An enhanced taxiway centre line marking shall extend from the runway-holding position Pattern A (as defined in Figure 5-6, Taxiway markings) to a distance of up to 47 m in the direction of travel away from the runway. See Figure 5-7 (a).

(2) If the enhanced taxiway centre line marking intersects another runway-holding position marking, such as for a precision approach category II or III runway that is located within 47 m of the first runway-holding position marking the enhanced taxiway centre line marking shall be interrupted 0.9 m prior to and after the intersected runway-holding position marking. The enhanced taxiway centre line marking shall

continue beyond the intersected runway-holding position marking for at least three dashed line segments or 47 m from start to finish, whichever is greater. See Figure 5-7 (b).

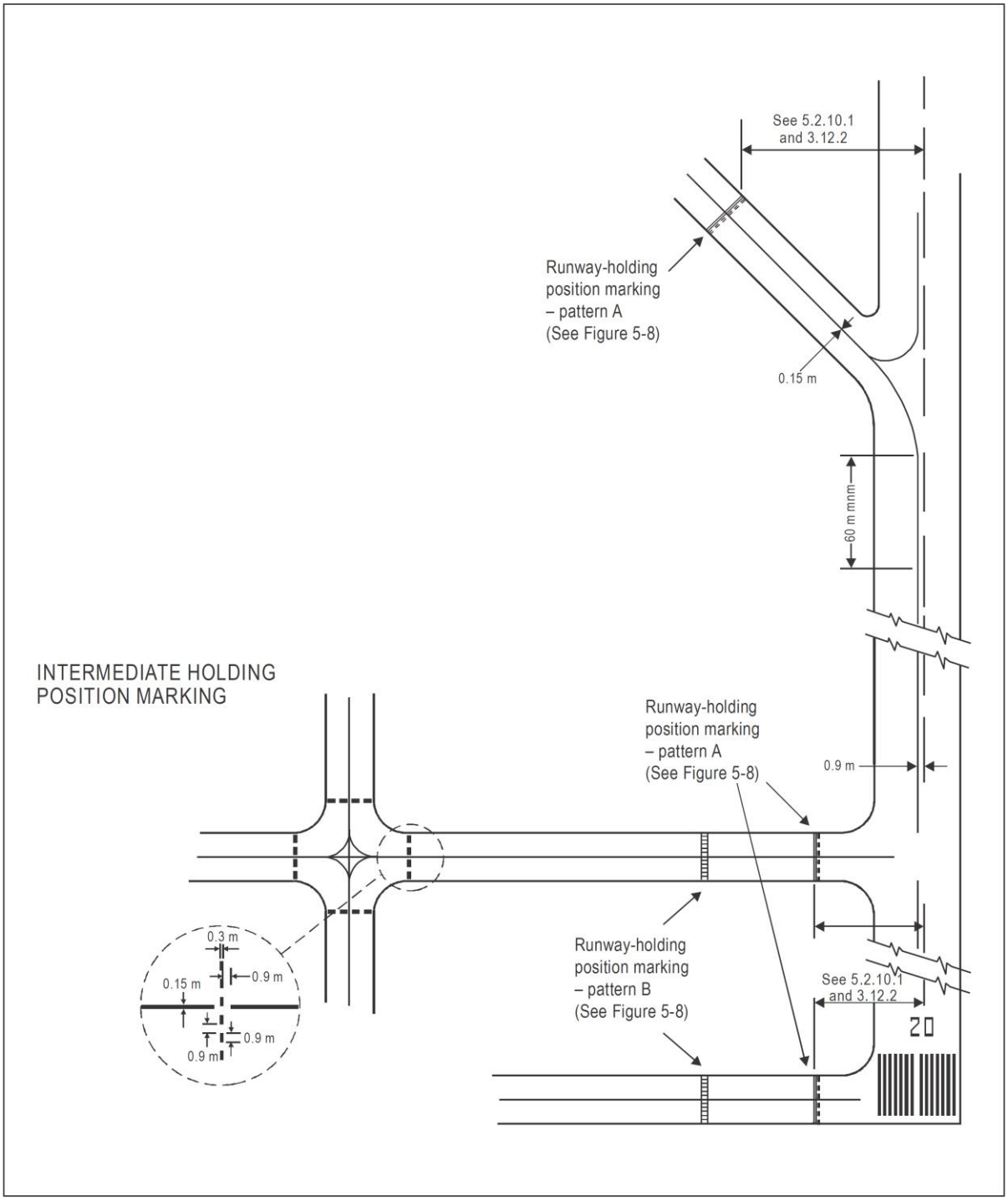


Figure 5-6. Taxiway markings
(shown with basic runway markings)

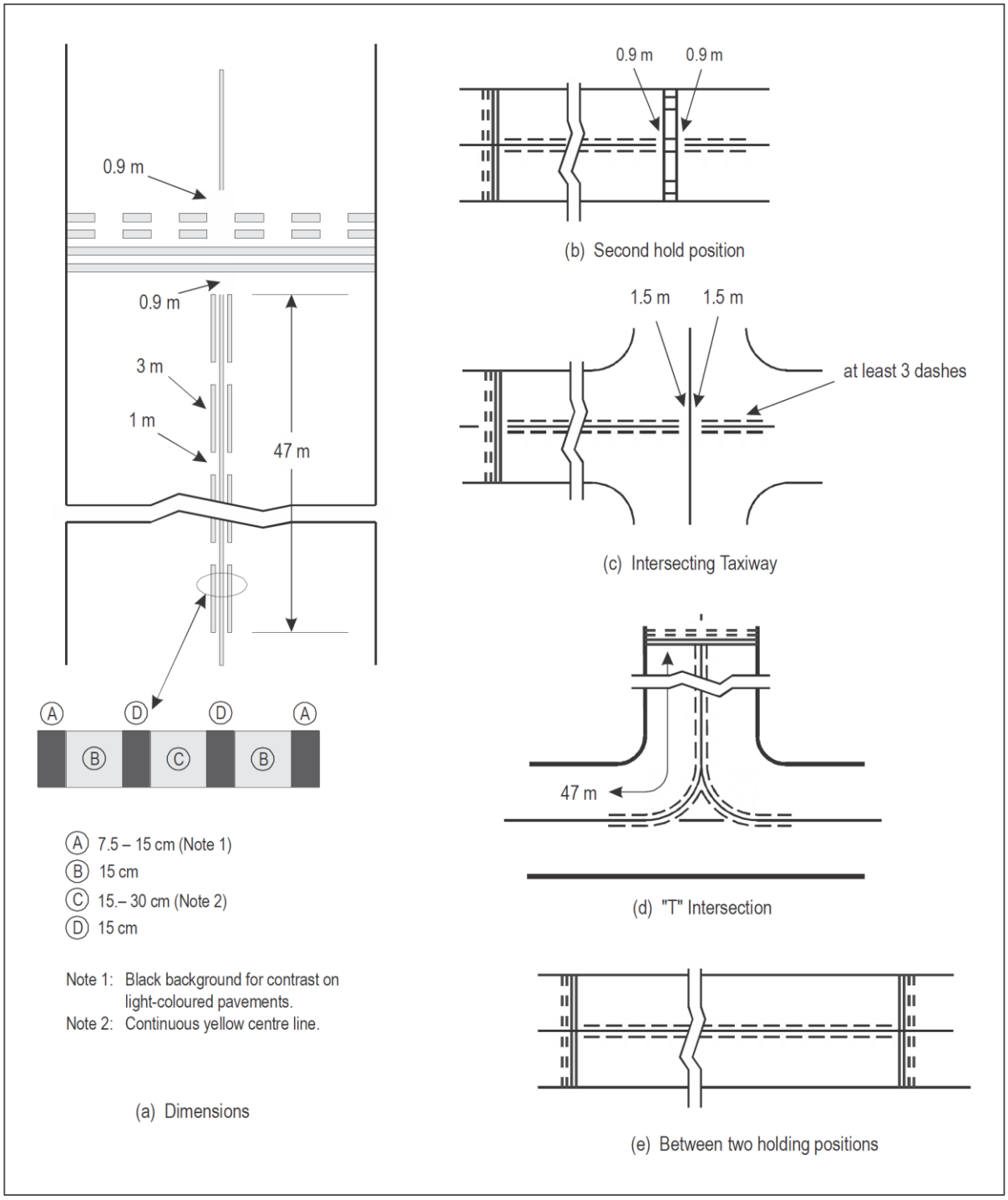


Figure 5-7. Enhanced taxiway centre line marking

(3) If the enhanced taxiway centre line marking continues through a taxiway/taxiway intersection that is located within 47 m of the runway-holding position marking, the enhanced taxiway centre line marking shall be interrupted 1.5 m prior to and after the point where the intersected taxiway centre line crosses the enhanced taxiway centre line. The enhanced taxiway centre line marking shall continue beyond

the taxiway/taxiway intersection for at least three dashed line segments or 47 m from start to finish, whichever is greater. See Figure 5-7 (c).

(4) Where two taxiway centre lines converge at or before the runway-holding position marking, the inner dashed line shall not be less than 3 m in length. See Figure 5-7 (d).

(5) Where there are two opposing runway-holding position markings and the distance between the markings is less than 94 m, the enhanced taxiway centre line markings shall extend over this entire distance. The enhanced taxiway centre line markings shall not extend beyond either runway-holding position marking. See Figure 5-7 (e).

Characteristics

5.2.8.10 A taxiway centre line marking shall be at least 15 cm in width and continuous in length except where it intersects with a runway-holding position marking or an intermediate holding position marking as shown in Figure 5-6.

5.2.8.11 Enhanced taxiway centre line marking shall be as shown in Figure 5-7.

5.2.9 Runway turn pad marking

Application

5.2.9.1 Where a runway turn pad is provided, a runway turn pad marking shall be provided for continuous guidance to enable an aeroplane to complete a 180-degree turn and align with the runway centre line.

Location

5.2.9.2 **Recommendation -** The runway turn pad marking should be curved from the runway centre line into the turn pad. The radius of the curve should be compatible with the manoeuvring capability and normal taxiing speeds of the aeroplanes for which the runway turn pad is intended. The intersection angle of the runway turn pad marking with the runway centre line should not be greater than 30 degrees.

5.2.9.3 **Recommendation -** The runway turn pad marking should be extended parallel to the runway centre line marking for a distance of at least 60 m beyond the point of tangency where the code number is 3 or 4, and for a distance of at least 30 m where the code number is 1 or 2.

5.2.9.4 **Recommendation -** A runway turn pad marking should guide the aeroplane in such a way as to allow a straight portion of taxiing before the point where a 180-degree turn is to be made. The straight portion of the runway turn pad marking should be parallel to the outer edge of the runway turn pad.

5.2.9.5 **Recommendation -** The design of the curve allowing the aeroplane to negotiate a 180-degree turn should be based on a nose wheel steering angle not exceeding 45 degrees.

5.2.9.6 **Recommendation -** The design of the turn pad marking should be such that, when the cockpit of the aeroplane remains over the runway turn pad marking, the clearance distance between any wheel of the aeroplane landing gear and the edge of the runway turn pad should be not less than those specified in 3.3.6.

Characteristics

5.2.9.7 A runway turn pad marking shall be at least 15 cm in width and continuous in length.

5.2.10 Runway-holding position marking

Application and location

5.2.10.1 A runway-holding position marking shall be displayed along a runway-holding position.

Note.— See 5.4.2 concerning the provision of signs at runway-holding positions.

Characteristics

5.2.10.2 At an intersection of a taxiway and a non-instrument, non-precision approach or take-off runway, the runway- holding position marking shall be as shown in Figure 5-6, pattern A.

5.2.10.3 Where a single runway-holding position is provided at an intersection of a taxiway and a precision approach category I, II or III runway, the runway-holding position marking shall be as shown in Figure 5-6, pattern A. Where two or three runway-holding positions are provided at such an intersection, the runway-holding position marking closer (closest) to the runway shall be as shown in Figure 5-6, pattern A and the markings farther from the runway shall be as shown in Figure 5-6, pattern B.

5.2.10.4 The runway-holding position marking displayed at a runway-holding position established in accordance with 3.12.3 shall be as shown in Figure 5-6, pattern A.

5.2.10.5 Until 26 November 2026, the dimensions of runway-holding position markings shall be as shown in Figure 5-8, pattern A1 (or A2) or pattern B1 (or B2), as appropriate.

5.2.10.6 As of 26 November 2026, the dimensions of runway-holding position markings shall be as shown in Figure 5-8, pattern A2 or pattern B2, as appropriate.

5.2.10.7 **Recommendation -** Where increased conspicuity of the runway-holding position is required, the runway- holding position marking should be as shown in Figure 5-8, pattern A or pattern B, as appropriate.

Note.— An increased conspicuity of the runway-holding position can be required, notably to avoid incursion risks.

5.2.10.8 **Recommendation -** Where a pattern B runway-holding position marking is located on an area where it would exceed 60 m in length, the term “CAT II” or “CAT III” as appropriate should be marked on the surface at the ends of the runway-holding position marking and at equal intervals of 45 m maximum between successive marks. The letters should be not less than 1.8 m high and should be placed not more than 0.9 m beyond the holding position marking.

5.2.10.9 The runway-holding position marking displayed at a runway/runway intersection shall be perpendicular to the centre line of the runway forming part of the standard taxi-route. The pattern of the marking shall be as shown in Figure 5-8, pattern A2.

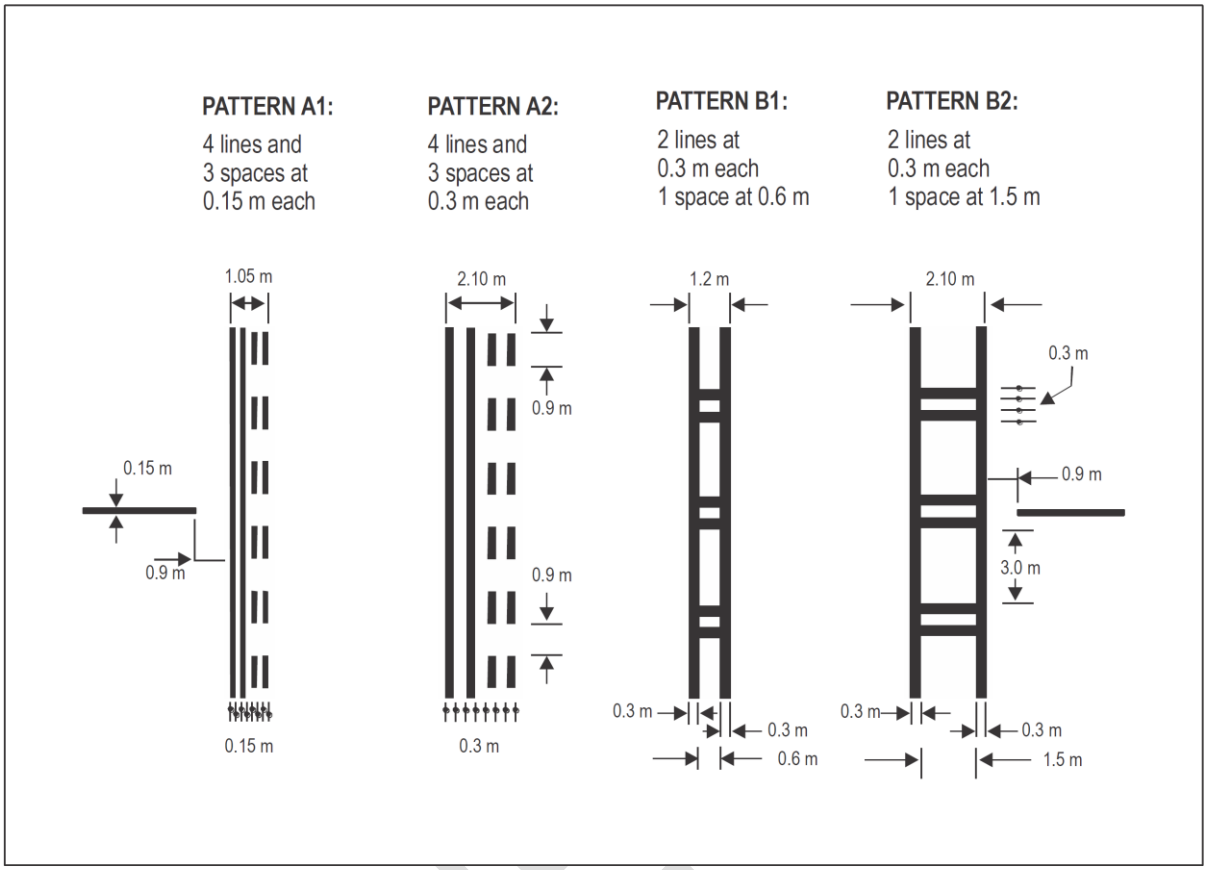


Figure 5-8. Runway holding position markings

Note. – Patterns A1 and B1 are no longer valid after 2026

5.2.11 Intermediate holding position marking

Application and location

5.2.11.1 **Recommendation -** An intermediate holding position marking should be displayed along an intermediate holding position.

5.2.11.2 Reserved

5.2.11.3 Where an intermediate holding position marking is displayed at an intersection of two paved taxiways, it shall be located across the taxiway at sufficient distance from the near edge of the intersecting taxiway to ensure safe clearance between taxiing aircraft. It shall be coincident with a stop bar or intermediate holding position lights, where provided.

5.2.11.4 Reserved

Characteristics

5.2.11.5 An intermediate holding position marking shall consist of a single broken line as shown in Figure 5-6.

5.2.12 VOR aerodrome checkpoint marking

Application

5.2.12.1 When a VOR aerodrome checkpoint is established, it shall be indicated by a VOR aerodrome checkpoint marking and sign.

5.2.12.2 Site selection

Note. Guidance on the selection of sites of VOR aerodrome checkpoints is given in ICAO Annex 10, Volume I, Attachment E.

Location

5.2.12.3 A VOR aerodrome checkpoint marking shall be centred on the spot at which an aircraft is to be parked to receive the correct VOR signal.

Characteristics

5.2.12.4 A VOR aerodrome checkpoint marking shall consist of a circle 6 m in diameter and have a line width of 15 cm (see Figure 5-9 (A)).

5.2.12.5 **Recommendation -** When it is preferable for an aircraft to be aligned in a specific direction, a line should be provided that passes through the centre of the circle on the desired azimuth. The line should extend 6 m outside the circle in the desired direction of heading and terminate in an arrowhead. The width of the line should be 15 cm (see Figure 5-9 (B)).

5.2.12.6 **Recommendation -** A VOR aerodrome checkpoint marking should preferably be white in colour but should differ from the colour used for the taxiway markings.

Note.— To provide contrast, markings may be bordered with black.

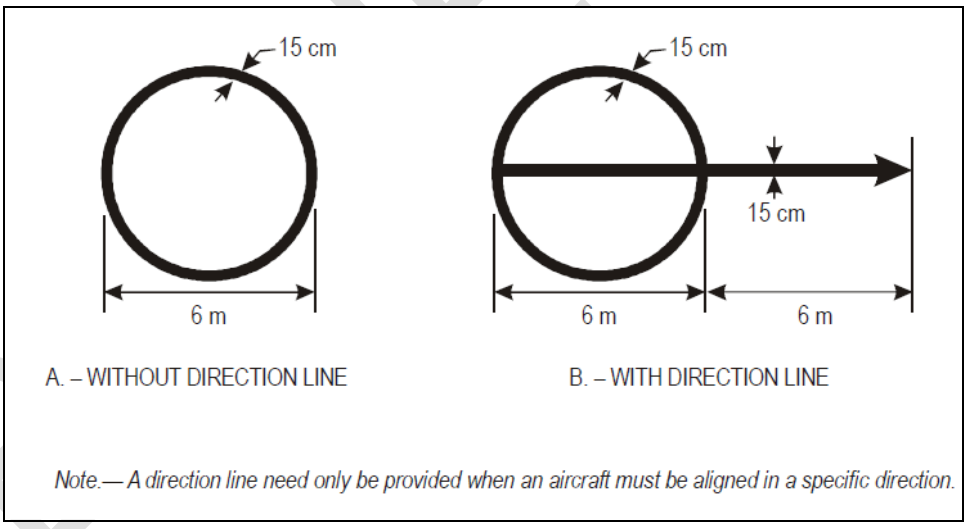


Figure 5-9. VOR aerodrome checkpoint marking

5.2.13 Aircraft stand marking

Note.— Guidance on the layout of aircraft stand markings is contained in the ICAO Aerodrome Design Manual (Doc 9157), Part 4.

Application

5.2.13.1 **Recommendation -** Aircraft stand markings should be provided for designated parking positions on a paved apron.

Location

5.2.13.2 **Recommendation -** Aircraft stand markings on a paved apron should be located so as to provide the clearances specified in 3.13.6 and in 3.15.9, respectively, when the nose wheel follows the stand marking.

Characteristics

5.2.13.3 **Recommendation -** Aircraft stand markings should include such elements as stand identification, lead-in line, turn bar, turning line, alignment bar, stop line and lead-out line, as are required by the parking configuration and to complement other parking aids.

5.2.13.4 **Recommendation -** An aircraft stand identification (letter and/or number) should be included in the lead-in line a short distance after the beginning of the lead-in line. The height of the identification should be adequate to be readable from the cockpit of aircraft using the stand.

5.2.13.5 **Recommendation -** Where two sets of aircraft stand markings are superimposed on each other in order to permit more flexible use of the apron and it is difficult to identify which stand marking should be followed, or safety would be impaired if the wrong marking was followed, then identification of the aircraft for which each set of markings is intended should be added to the stand identification.

5.2.13.6 **Recommendation -** Lead-in, turning and lead-out lines should normally be continuous in length and have a width of not less than 15 cm. Where one or more sets of stand markings are superimposed on a stand marking, the lines should be continuous for the most demanding aircraft and broken for other aircraft.

5.2.13.7 **Recommendation -** The curved portions of lead-in, turning and lead-out lines should have radii appropriate to the most demanding aircraft type for which the markings are intended.

5.2.13.8 **Recommendation -** Where it is intended that an aircraft proceed in one direction only, arrows pointing in the direction to be followed should be added as part of the lead-in and lead-out lines.

5.2.13.9 **Recommendation -** A turn bar should be located at right angles to the lead-in line, abeam the left pilot position at the point of initiation of any intended turn. It should have a length and width of not less than 6 m and 15 cm, respectively, and include an arrowhead to indicate the direction of turn.

5.2.13.10 **Recommendation -** If more than one turn bar and/or stop line is required, they should be coded.

5.2.13.11 **Recommendation -** An alignment bar should be placed so as to be coincident with the extended centre line of the aircraft in the specified parking position and visible to the pilot during the final part of the parking manoeuvre. It should have a width of not less than 15 cm.

5.2.13.12 **Recommendation -** A stop line should be located at right angles to the alignment bar, abeam the left pilot position at the intended point of stop. It should have a length and width of not less than 6 m and 15 cm, respectively.

Note: Where an aircraft stand is used by two or three types of aircraft or more, airport operator should indicate by a painted inscription the aircraft type for which each set of markings is intended.(see Doc 9157, Part 4, 2.3.18)

5.2.14 Apron safety lines

Note.1— Guidance on apron safety lines is contained in the ICAO Aerodrome Design Manual (Doc 9157), Part 4

Note.2 – Additional guidance on apron markings is given in the Airports Council International (ACI)/International Air Transport Association (IATA) Apron Markings & Signs Handbook which gives examples of current best practices.

Application

5.2.14.1 Apron safety lines shall be provided on a paved apron as required by the parking configurations and ground facilities.

Location

5.2.14.2 Apron safety lines shall be located so as to define the areas intended for use by ground vehicles and other aircraft servicing equipment, etc., to provide safe separation from aircraft.

Note: Safety lines will be required on an apron to mark the limits of parking areas for ground equipment, service roads and passengers' paths, etc. These lines are narrower and of a different colour to differentiate them from the guide lines used for aircraft. (see Doc 9157, Part 4, 2.3.20)

Characteristics

5.2.14.3 **Recommendation -** Apron safety lines should include such elements as wing tip clearance lines and service road boundary lines as required by the parking configurations and ground facilities.

5.2.14.4 **Recommendation -** An apron safety line should be continuous in length and at least 10 cm in width.

5.2.15 Road-holding position marking

Application

5.2.15.1 A road-holding position marking shall be provided at all road entrances to a runway.

Location

5.2.15.2 The road-holding position marking shall be located across the road at the holding position.

Characteristics

5.2.15.3 The road-holding position marking shall be in accordance with the local road traffic requirements, except that yellow may not be used to mark any part or edge of a road on an aerodrome.

5.2.16 Mandatory instruction marking

Application

5.2.16.1 Where it is impracticable to install a mandatory instruction sign in accordance with 5.4.2.1, a mandatory instruction marking shall be provided on the surface of the pavement.

5.2.16.2 **Recommendation -** Where operationally required, such as on taxiways exceeding 60 m in width, or to assist in the prevention of a runway incursion, a mandatory instruction sign should be supplemented by a mandatory instruction marking.

Location

5.2.16.3 The mandatory instruction marking on taxiways where the OMGWS is up to but not including 9 m shall be located across the taxiway equally placed about the taxiway centre line and on the holding side of the runway-holding position

marking as shown in Figure 5-10 (A). The distance between the nearest edge of the marking and the runway-holding position marking or the taxiway centre line marking shall be not less than 1 m.

5.2.16.4 The mandatory instruction marking on taxiways where the OMGWS is up to but not including 15 m shall be located on both sides of the taxiway centre line marking and on the holding side of the runway-holding position marking as shown in Figure 5-10 (B). The distance between the nearest edge of the marking and the runway-holding position marking or the taxiway centre line marking shall be not less than 1 m.

5.2.16.5 **Recommendation -** Except where operationally required, a mandatory instruction marking should not be located on a runway.

Characteristics

5.2.16.6 A mandatory instruction marking shall consist of an inscription in white on a red background. Except for a NO ENTRY marking, the inscription shall provide information identical to that of the associated mandatory instruction sign.

5.2.16.7 A NO ENTRY marking shall consist of an inscription in white reading NO ENTRY on a red background.

5.2.16.8 Where there is insufficient contrast between the marking and the pavement surface, the mandatory instruction marking shall include an appropriate border, preferably white or black.

5.2.16.9 **Recommendation -** The character height should be 4 m for inscriptions where the OMGWS is from 6 m up to but not including 15 m, and 2 m where the OMGWS is up to but not including 6 m. The inscriptions should be in the form and proportions shown in ICAO Annex 14, Volume I, Appendix 3.

5.2.16.10 The background shall be rectangular and extend a minimum of 0.5 m laterally and vertically beyond the extremities of the inscription.

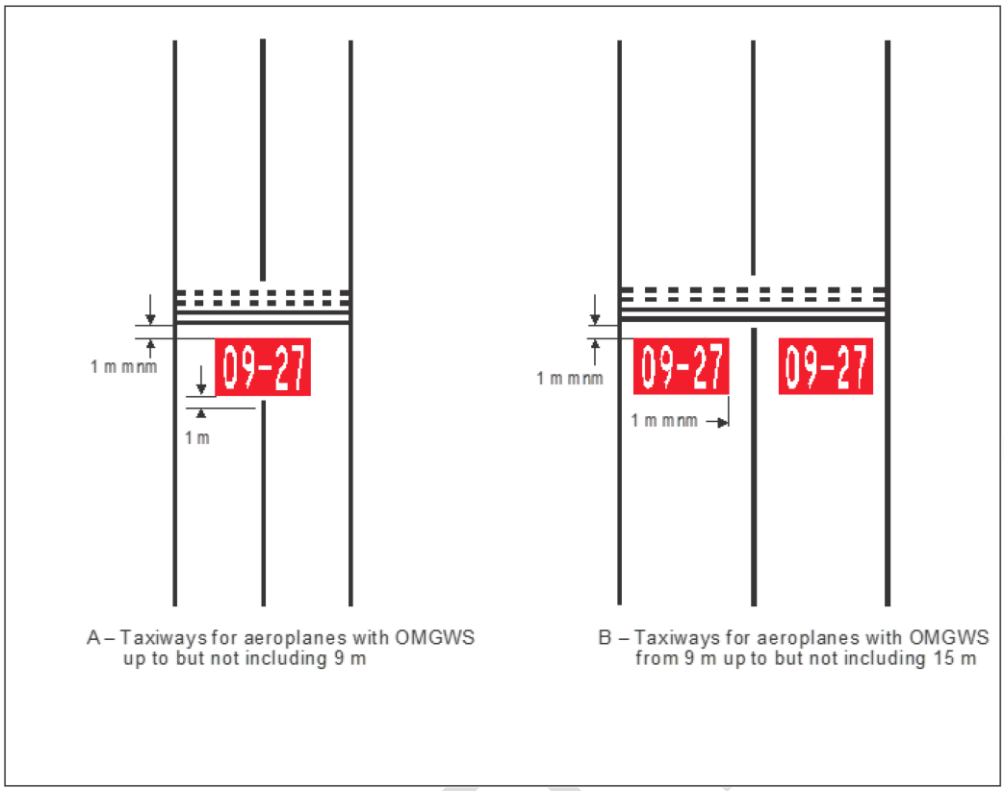


Figure 5-10. Mandatory instruction marking

5.2.17 Information marking

Note.— Guidance on information marking is contained in the ICAO Aerodrome Design Manual (Doc 9157), Part 4.

Application

5.2.17.1 Where an information sign would normally be installed and is impractical to install, as determined by the Brunei DCA Regulatory, an information marking shall be displayed on the surface of the pavement.

5.2.17.2 **Recommendation -** Where operationally required an information sign should be supplemented by an information marking.

5.2.17.3 **Recommendation -** An information (location/direction) marking should be displayed prior to and following complex taxiway intersections and where operational experience has indicated the addition of a taxiway location marking could assist flight crew ground navigation.

5.2.17.4 **Recommendation -** An information (location) marking should be displayed on the pavement surface at regular intervals along taxiways of great length.

Location

5.2.17.5 **Recommendation -** The information marking should be displayed across the surface of the taxiway or apron where necessary and positioned so as to be legible from the cockpit of an approaching aircraft.

Characteristics

5.2.17.6 An information marking shall consist of:

(1) an inscription in yellow upon a black background, when it replaces or supplements a location sign; and

(2) an inscription in black upon a yellow background, when it replaces or supplements a direction or destination sign.

5.2.17.7 Where there is insufficient contrast between the marking background and the pavement surface, the marking shall include:

(1) a black border where the inscriptions are in black; and

(2) a yellow border where the inscriptions are in yellow.

5.2.17.8 **Recommendation -** The character height should be 4 m. The inscriptions should be in the form and proportions shown in Appendix 3 of Annex 14.

5.3 Lights

5.3.1 General

Lights which may endanger the safety of aircraft

5.3.1.1 A non-aeronautical ground light near an aerodrome which might endanger the safety of aircraft shall be extinguished, screened or otherwise modified so as to eliminate the source of danger.

Laser emissions which may endanger the safety of aircraft

Note.- Additional information guidance on the establishment of laser beam free flight zone is given in ICAO Doc 9815 – Manual on Laser Emitters and Flight Safety.

5.3.1.2 **Recommendation -** To protect the safety of aircraft against the hazardous effects of laser emitters, the following protected zones should be established around aerodromes:

- a laser-beam free flight zone (LFFZ)
- a laser-beam critical flight zone (LCFZ)
- a laser-beam sensitive flight zone (LSFZ).

Note 1.— Figures 5-11, 5-12 and 5-13 may be used to determine the exposure levels and distances that adequately protect flight operations.

Note 2.— The restrictions on the use of laser beams in the three protected flight zones, LFFZ, LCFZ and LSFZ, refer to visible laser beams only. Laser emitters operated by the authorities in a manner compatible with flight safety are excluded. In all navigable airspace, the irradiance level of any laser beam, visible or invisible, is expected to be less than or equal to the maximum permissible exposure (MPE) unless such emission has been notified to the authority and permission obtained.

Note 3.— The protected flight zones are established in order to mitigate the risk of operating laser emitters in the vicinity of aerodromes.

Note 4.— Further guidance on how to protect flight operations from the hazardous effects of laser emitters is contained in the Manual on Laser Emitters and Flight Safety (Doc 9815).

Note 5.— See also BAR 11 — Air Traffic Services, Chapter 2.

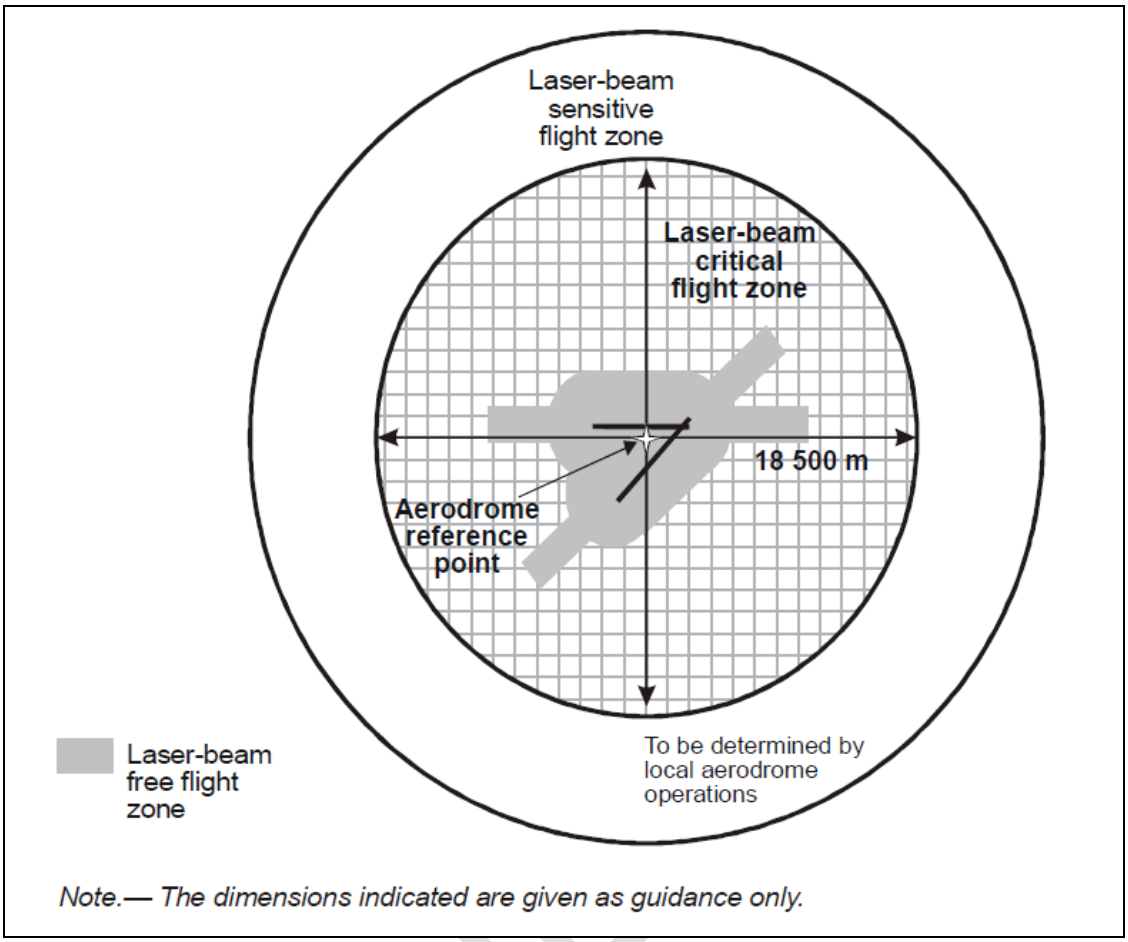


Figure 5-111. Protected Flight Zones

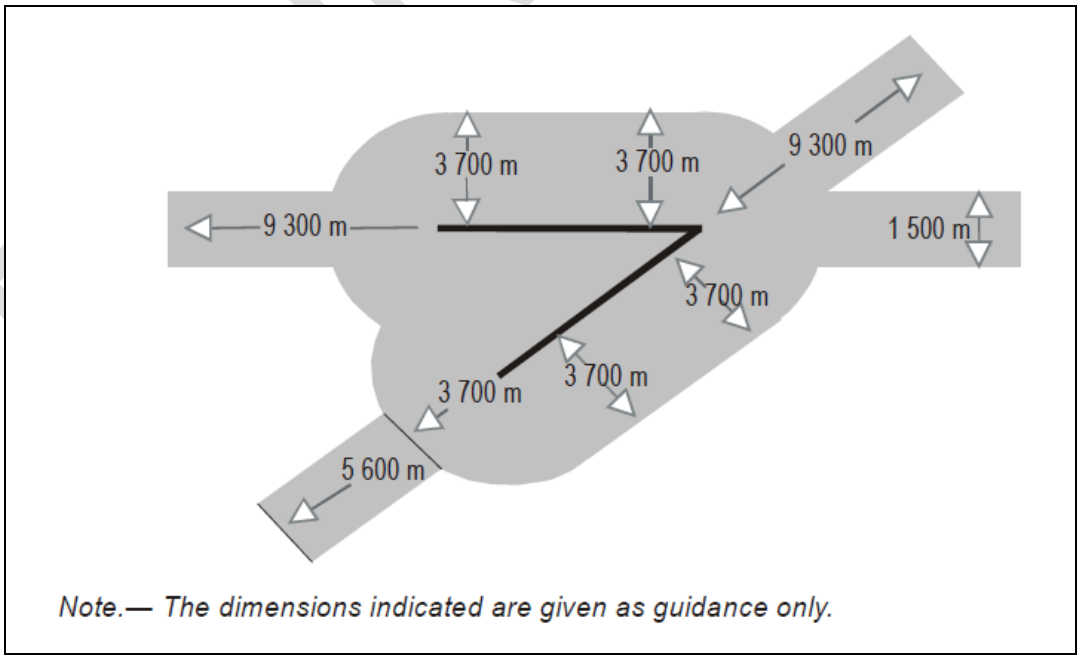


Figure 5-12. Multiple runway laser-bean free flight zone

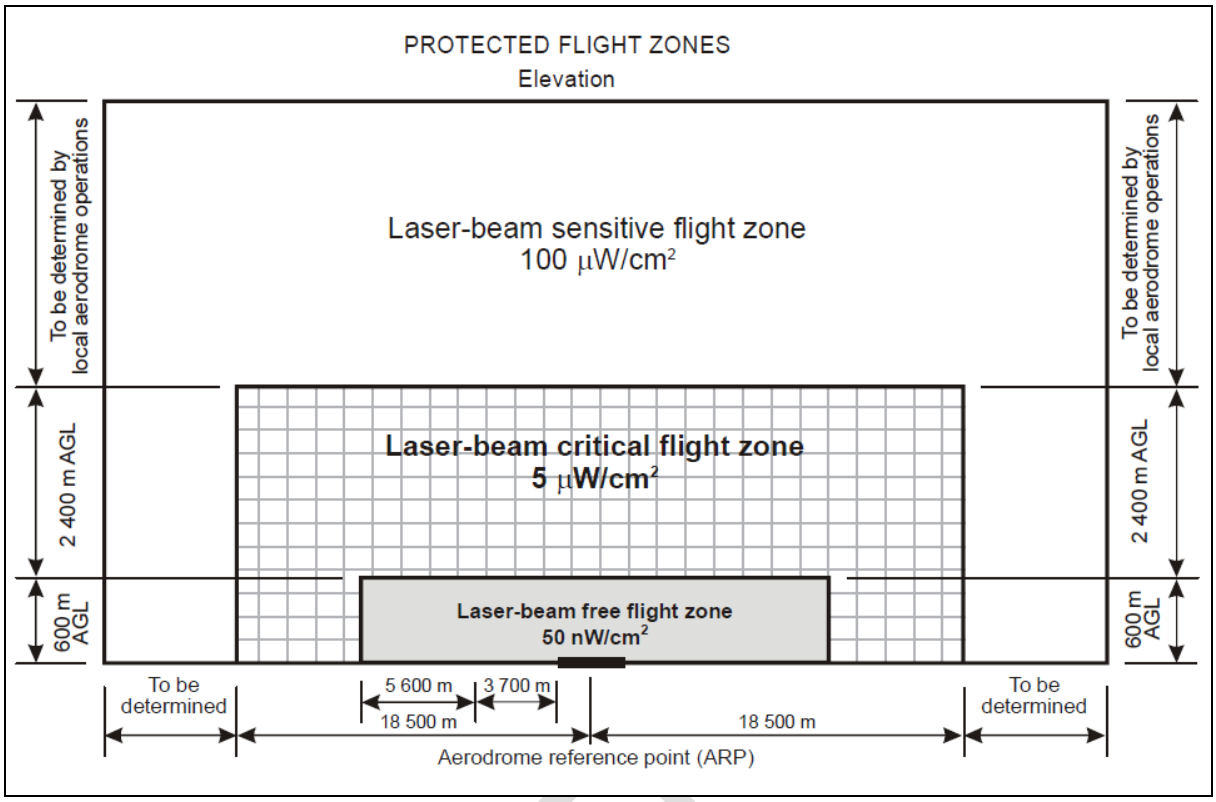


Figure 5-13. Protected Flight Zones with indication of maximum irradiance levels for vehicle laser beams

Lights which may cause confusion

5.3.1.3 **Recommendation -** A non-aeronautical ground light which, by reason of its intensity, configuration or colour, might prevent, or cause confusion in, the clear interpretation of aeronautical ground lights should be extinguished, screened or otherwise modified so as to eliminate such a possibility. In particular, attention should be directed to a non- aeronautical ground light visible from the air within the areas described hereunder:

(1) Instrument runway — code number 4:

within the areas before the threshold and beyond the end of the runway extending at least 4 500 m in length from the threshold and runway end and 750 m either side of the extended runway centre line in width.

(2) Instrument runway — code number 2 or 3:

as in a), except that the length should be at least 3 000 m.

(3) Instrument runway — code number 1;

and non-instrument runway:

within the approach area.

Aeronautical ground lights which may cause confusion to mariners

Note: In the case of aeronautical ground lights near navigable waters, consideration needs to be given to ensuring that the lights do not cause confusion to mariners.

Light fixtures and supporting structures

Note: See para. 9.9 for information regarding siting of equipment and installations on operational areas, and the ICAO Aerodrome Design Manual (Doc 9157), Part 6, for guidance on frangibility of light fixtures and supporting structures.

Elevated approach lights

5.3.1.4 Elevated approach lights and their supporting structures shall be frangible except that, in that portion of the approach lighting system beyond 300 m from the threshold:

(1) where the height of a supporting structure exceeds 12 m, the frangibility requirement shall apply to the top 12 m only; and

(2) where a supporting structure is surrounded by non-frangible objects, only that part of the structure that extends above the surrounding objects shall be frangible.

5.3.1.5 When an approach light fixture or supporting structure is not in itself sufficiently conspicuous, it shall be suitably marked.

Elevated lights

5.3.1.6 Elevated runway, stopway and taxiway lights shall be frangible. Their height shall be sufficiently low to preserve clearance for propellers and for the engine pods of jet aircraft.

Surface lights

5.3.1.7 Light fixtures inset in the surface of runways, stopways, taxiways and aprons shall be so designed and fitted as to withstand being run over by the wheels of an aircraft without damage either to the aircraft or to the lights themselves.

5.3.1.8 Reserved

Light intensity and control

Note.— In dusk or poor visibility conditions by day, lighting can be more effective than marking. For lights to be effective in such conditions or in poor visibility by night, they must be of adequate intensity. To obtain the required intensity, it will usually be necessary to make the light directional, in which case the arcs over which the light shows will have to be adequate and so orientated as to meet the operational requirements. The runway lighting system will have to be considered as a whole, to ensure that the relative light intensities are suitably matched to the same end. (See 15.1 Attachment A, Section 16, *and the ICAO* Aerodrome Design Manual *(Doc 9157), Part 4).*

5.3.1.9 The intensity of runway lighting shall be adequate for the minimum conditions of visibility and ambient light in which use of the runway is intended, and compatible with that of the nearest section of the approach lighting system when provided.

5.3.1.10 Where a high-intensity lighting system is provided, a suitable intensity control shall be incorporated to allow for adjustment of the light intensity to meet the prevailing conditions. Separate intensity controls or other suitable methods shall be provided to ensure that the following systems, when installed, can be operated at compatible intensities:

- approach lighting system;

- runway edge lights;
- runway threshold lights;
- runway end lights;
- runway centre line lights;
- runway touchdown zone lights; and
- taxiway centre line lights

5.3.1.11 On the perimeter of and within the ellipse defining the main beam in ICAO Annex 14 Volume I, Appendix 2, Figures A2-1 to A2-10, the maximum light intensity value shall not be greater than three times the minimum light intensity value measured in accordance with Appendix 2, collective notes for Figures A2-1 to A2-11, Note 2.

5.3.1.12 On the perimeter of and within the rectangle defining the main beam in ICAO Annex 14 Volume I, Appendix 2, Figures A2-12 to A2-20, the maximum light intensity value shall not be greater than three times the minimum light intensity value measured in accordance with Appendix 2, collective notes for Figures A2-12 to A2-21, Note 2.

5.3.2 Emergency lighting

Application

5.3.2.1 **Recommendation -** At an aerodrome provided with runway lighting and without a secondary power supply, sufficient emergency lights should be conveniently available for installation on at least the primary runway in the event of failure of the normal lighting system.

Location

5.3.2.2 **Recommendation -** When installed on a runway the emergency lights should, as a minimum, conform to the configuration required for a non-instrument runway.

Characteristics

5.3.2.3 **Recommendation -** The colour of the emergency lights should conform to the colour requirements for runway lighting, except that, where the provision of coloured lights at the threshold and the runway end is not practicable, all lights may be variable white or as close to variable white as practicable.

5.3.3 Aeronautical beacons

Application

5.3.3.1 Where operationally necessary an aerodrome beacon or an identification beacon shall be provided at each aerodrome intended for use at night.

5.3.3.2 The operational requirement shall be determined having regard to the requirements of the air traffic using the aerodrome, the conspicuity of the aerodrome features in relation to its surroundings and the installation of other visual and non-visual aids useful in locating the aerodrome.

Aerodrome beacon

5.3.3.3 An aerodrome beacon shall be provided at an aerodrome intended for use at night if one or more of the following conditions exist:

(1) aircraft navigate predominantly by visual means;

(2) reduced visibilities are frequent; or

(3) it is difficult to locate the aerodrome from the air due to surrounding lights or terrain.

Location

5.3.3.4 The aerodrome beacon shall be located on or adjacent to the aerodrome in an area of low ambient background lighting.

5.3.3.5 **Recommendation -** The location of the beacon should be such that the beacon is not shielded by objects in significant directions and does not dazzle a pilot approaching to land.

Characteristics

5.3.3.6 The aerodrome beacon shall show either coloured flashes alternating with white flashes, or white flashes only. The frequency of total flashes shall be from 20 to 30 per minute. Where used, the coloured flashes emitted by beacons at land aerodromes shall be green, and coloured flashes emitted by beacons at water aerodromes shall be yellow. In the case of a combined water and land aerodrome, coloured flashes, if used, shall have the colour characteristics of whichever section of the aerodrome is designated as the principal facility.

5.3.3.7 The light from the beacon shall show at all angles of azimuth. The vertical light distribution shall extend upwards from an elevation of not more than 1° to an elevation determined by the appropriate authority to be sufficient to provide guidance at the maximum elevation at which the beacon is intended to be used, and the effective intensity of the flash shall be not less than 2 000 cd.

Note: At locations where a high ambient background lighting level cannot be avoided, the effective intensity of the flash may be increased by a factor up to a value of 10.

Identification beacon

Application

5.3.3.8 An identification beacon shall be provided at an aerodrome which is intended for use at night and cannot be easily identified from the air by other means.

Location

5.3.3.9 The identification beacon shall be located on the aerodrome in an area of low ambient background lighting.

5.3.3.10 **Recommendation -** The location of the beacon should be such that the beacon is not shielded by objects in significant directions and does not dazzle a pilot approaching to land.

Characteristics

5.3.3.11 An identification beacon at a land aerodrome shall show at all angles of azimuth. The vertical light distribution shall extend upwards from an elevation of not more than 1° to an elevation determined by the appropriate authority to be sufficient to provide guidance at the maximum elevation at which the beacon is intended to be used, and the effective intensity of the flash shall be not less than 2 000 cd.

Note: At locations where a high ambient background lighting level cannot be avoided, the effective intensity of the flash may be increased by a factor up to a value of 10.

5.3.3.12 An identification beacon shall show flashing-green at a land aerodrome and flashing-yellow at a water aerodrome.

5.3.3.13 The identification characters shall be transmitted in the International Morse Code.

5.3.3.14 **Recommendation -** The speed of transmission should be between six and eight words per minute, the corresponding range of duration of the Morse dots being from 0.15 to 0.2 seconds per dot.

5.3.4 Approach lighting systems

Application

5.3.4.1 Application

A.— Non-instrument runway

Recommendation - Where physically practicable, a simple approach lighting system as specified in 5.3.4.2 to 5.3.4.9 should be provided to serve a non-instrument runway where the code number is 3 or 4 and intended for use at night, except when the runway is used only in conditions of good visibility and sufficient guidance is provided by other visual aids.

B.— Non-precision approach runway

Where physically practicable, a simple approach lighting system as specified in 5.3.4.2 to 5.3.4.9 shall be provided to serve a non-precision approach runway, except when the runway is used only in conditions of good visibility or sufficient guidance is provided by other visual aids.

C.— Precision approach runway category I

Where physically practicable, a precision approach category I lighting system as specified in 5.3.4.10 to 5.3.4.21 shall be provided to serve a precision approach runway category I.

D.— Precision approach runway categories II and III

A precision approach category II and III lighting system as specified in 5.3.4.22 to 5.3.4.39 shall be provided to serve a precision approach runway category II or III.

Simple approach lighting system

Location

5.3.4.2 A simple approach lighting system shall consist of a row of lights on the extended centre line of the runway extending, whenever possible, over a distance of not less than 420 m from the threshold with a row of lights forming a crossbar 18 m or 30 m in length at a distance of 300 m from the threshold.

5.3.4.3 The lights forming the crossbar shall be as nearly as practicable in a horizontal straight line at right angles to, and bisected by, the line of the centre line lights. The lights of the crossbar shall be spaced so as to produce a linear effect, except that, when a crossbar of 30 m is used, gaps may be left on each side of the centre line. These gaps shall be kept to a minimum to meet local requirements and each shall not exceed 6 m.

5.3.4.4 The lights forming the centre line shall be placed at longitudinal intervals of 60 m, except that, when it is desired to improve the guidance, an interval of 30 m may be used. The innermost light shall be located either 60 m or 30 m from

the threshold, depending on the longitudinal interval selected for the centre line lights.

5.3.4.5 **Recommendation -** If it is not physically possible to provide a centre line extending for a distance of 420 m from the threshold, it should be extended to 300 m so as to include the crossbar. If this is not possible, the centre line lights should be extended as far as practicable, and each centre line light should then consist of a barrette at least 3 m in length. Subject to the approach system having a crossbar at 300 m from the threshold, an additional crossbar may be provided at 150 m from the threshold.

5.3.4.6 The system shall lie as nearly as practicable in the horizontal plane passing through the threshold, provided that:

(a) no object other than an ILS or MLS azimuth antenna shall protrude through the plane of the approach lights within a distance of 60 m from the centre line of the system; and

(b) no light other than a light located within the central part of a crossbar or a centre line barrette (not their extremities) shall be screened from an approaching aircraft.

Any ILS or MLS azimuth antenna protruding through the plane of the lights shall be treated as an obstacle and marked and lighted accordingly.

Characteristics

5.3.4.7 The lights of a simple approach lighting system shall be fixed lights and the colour of the lights shall be such as to ensure that the system is readily distinguishable from other aeronautical ground lights, and from extraneous lighting if present. Each centre line light shall consist of either:

(a) a single source; or

(b) a barrette at least 3 m in length.

5.3.4.8 **Recommendation -** Where provided for a non-instrument runway, the lights should show at all angles in azimuth necessary to a pilot on base leg and final approach. The intensity of the lights should be adequate for all conditions of visibility and ambient light for which the system has been provided.

5.3.4.9 **Recommendation -** Where provided for a non-precision approach runway, the lights should show at all angles in azimuth necessary to the pilot of an aircraft which on final approach does not deviate by an abnormal amount from the path defined by the non-visual aid. The lights should be designed to provide guidance during both day and night in the most adverse conditions of visibility and ambient light for which it is intended that the system should remain usable.

Precision approach category I lighting system

Location

5.3.4.10 A precision approach category I lighting system shall consist of a row of lights on the extended centre line of the runway extending, wherever possible, over a distance of 900 m from the runway threshold with a row of lights forming a crossbar 30 m in length at a distance of 300 m from the runway threshold.

5.3.4.11 The lights forming the crossbar shall be as nearly as practicable in a horizontal straight line at right angles to, and bisected by, the line of the centre line lights. The lights of the crossbar shall be spaced so as to produce a linear effect,

except that gaps may be left on each side of the centre line. These gaps shall be kept to a minimum to meet local requirements and each shall not exceed 6 m.

5.3.4.12 The lights forming the centre line shall be placed at longitudinal intervals of 30 m with the innermost light located 30 m from the threshold.

5.3.4.13 The system shall lie as nearly as practicable in the horizontal plane passing through the threshold, provided that:

(a) no object other than an ILS or MLS azimuth antenna shall protrude through the plane of the approach lights within a distance of 60 m from the centre line of the system; and

(b) no light other than a light located within the central part of a crossbar or a centre line barrette (not their extremities) shall be screened from an approaching aircraft.

Any ILS or MLS azimuth antenna protruding through the plane of the lights shall be treated as an obstacle and marked and lighted accordingly.

Characteristics

5.3.4.14 The centre line and crossbar lights of a precision approach category I lighting system shall be fixed lights showing variable white. Each centre line light position shall consist of either:

(a) a single light source in the innermost 300 m of the centre line, two light sources in the central 300 m of the centre line and three light sources in the outer 300 m of the centre line to provide distance information; or

(b) a barrette.

5.3.4.15 Where the serviceability level of the approach lights specified as a maintenance objective in 10.5.10 can be demonstrated to the satisfaction of the Brunei DCA Regulatory, each centre line light position may consist of either:

(a) a single light source; or

(b) a barrette.

5.3.4.16 The barrettes shall be at least 4 m in length. When barrettes are composed of lights approximating to point sources, the lights shall be uniformly spaced at intervals of not more than 1.5 m.

5.3.4.17 Reserved

5.3.4.18 Reserved

5.3.4.19 If the centre line consists of lights as described in 5.3.4.14 a) or 5.3.4.15 a), additional crossbars of lights to the crossbar provided at 300 m from the threshold shall be provided at 150 m, 450 m, 600 m and 750 m from the threshold. The lights forming each crossbar shall be as nearly as practicable in a horizontal straight line at right angles to, and bisected by, the line of the centre line lights. The lights shall be spaced so as to produce a linear effect, except that gaps may be left on each side of the centre line. These gaps shall be kept to a minimum to meet local requirements and each shall not exceed 6 m.

Note.— See 15.1 Attachment A, Section 12, for detailed configuration.

5.3.4.20 Where the additional crossbars described in 5.3.4.19 are incorporated in the system, the outer ends of the crossbars shall lie on two straight lines that either are parallel to the line of the centre line lights or converge to meet the runway centre line 300 m from threshold.

5.3.4.21 The lights shall be in accordance with the specification of ICAO Annex 14 Volume I, Appendix 2, Figure A2-1.

Precision approach category II and III lighting system

Location

5.3.4.22 The approach lighting system shall consist of a row of lights on the extended centre line of the runway, extending, wherever possible, over a distance of 900 m from the runway threshold. In addition, the system shall have two side rows of lights, extending 270 m from the threshold, and two crossbars, one at 150 m and one at 300 m from the threshold, all as shown in Figure 5-14. Where the serviceability level of the approach lights specified as maintenance objectives in 10.5.7 can be demonstrated, the system may have two side rows of lights, extending 240 m from the threshold, and two crossbars, one at 150 m and one at 300 m from the threshold, all as shown in Figure 5-15.

5.3.4.23 The lights forming the centre line shall be placed at longitudinal intervals of 30 m with the innermost lights located 30 m from the threshold.

5.3.4.24 The lights forming the side rows shall be placed on each side of the centre line, at a longitudinal spacing equal to that of the centre line lights and with the first light located 30 m from the threshold. Where the serviceability level of the approach lights specified as maintenance objectives in 10.5.7 can be demonstrated, lights forming the side rows may be placed on each side of the centre line, at a longitudinal spacing of 60 m with the first light located 60 m from the threshold. The lateral spacing (or gauge) between the innermost lights of the side rows shall be not less than 18 m nor more than 22.5 m, and preferably 18 m, but in any event shall be equal to that of the touchdown zone lights.

5.3.4.25 The crossbar provided at 150 m from the threshold shall fill in the gaps between the centre line and side row lights.

5.3.4.26 The crossbar provided at 300 m from the threshold shall extend on both sides of the centre line lights to a distance of 15 m from the centre line.

5.3.4.27 If the centre line beyond a distance of 300 m from the threshold consists of lights as described in 5.3.4.31 b) or 5.3.4.32 b), additional crossbars of lights shall be provided at 450 m, 600 m and 750 m from the threshold.

5.3.4.28 Where the additional crossbars described in 5.3.4.27 are incorporated in the system, the outer ends of these crossbars shall lie on two straight lines that either are parallel to the centre line or converge to meet the runway centre line 300 m from the threshold.

5.3.4.29 The system shall lie as nearly as practicable in the horizontal plane passing through the threshold, provided that:

(a) no object other than an ILS or MLS azimuth antenna shall protrude through the plane of the approach lights within a distance of 60 m from the centre line of the system; and

(b) no light other than a light located within the central part of a crossbar or a centre line barrette (not their extremities) shall be screened from an approaching aircraft.

Any ILS or MLS azimuth antenna protruding through the plane of the lights shall be treated as an obstacle and marked and lighted accordingly.

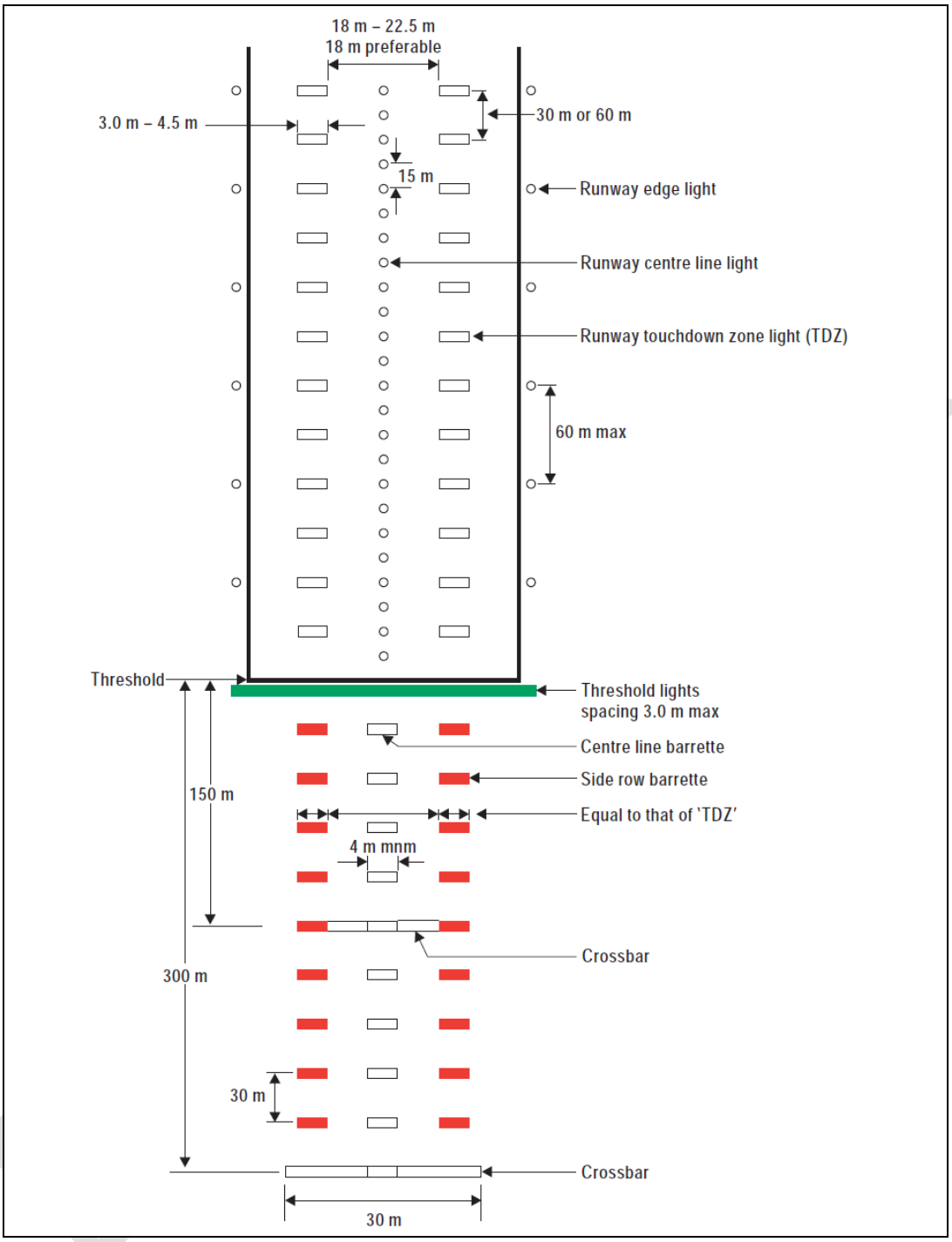


Figure 5-14. Inner 300m approach and runway lighting for precision approach runways, categories II and III

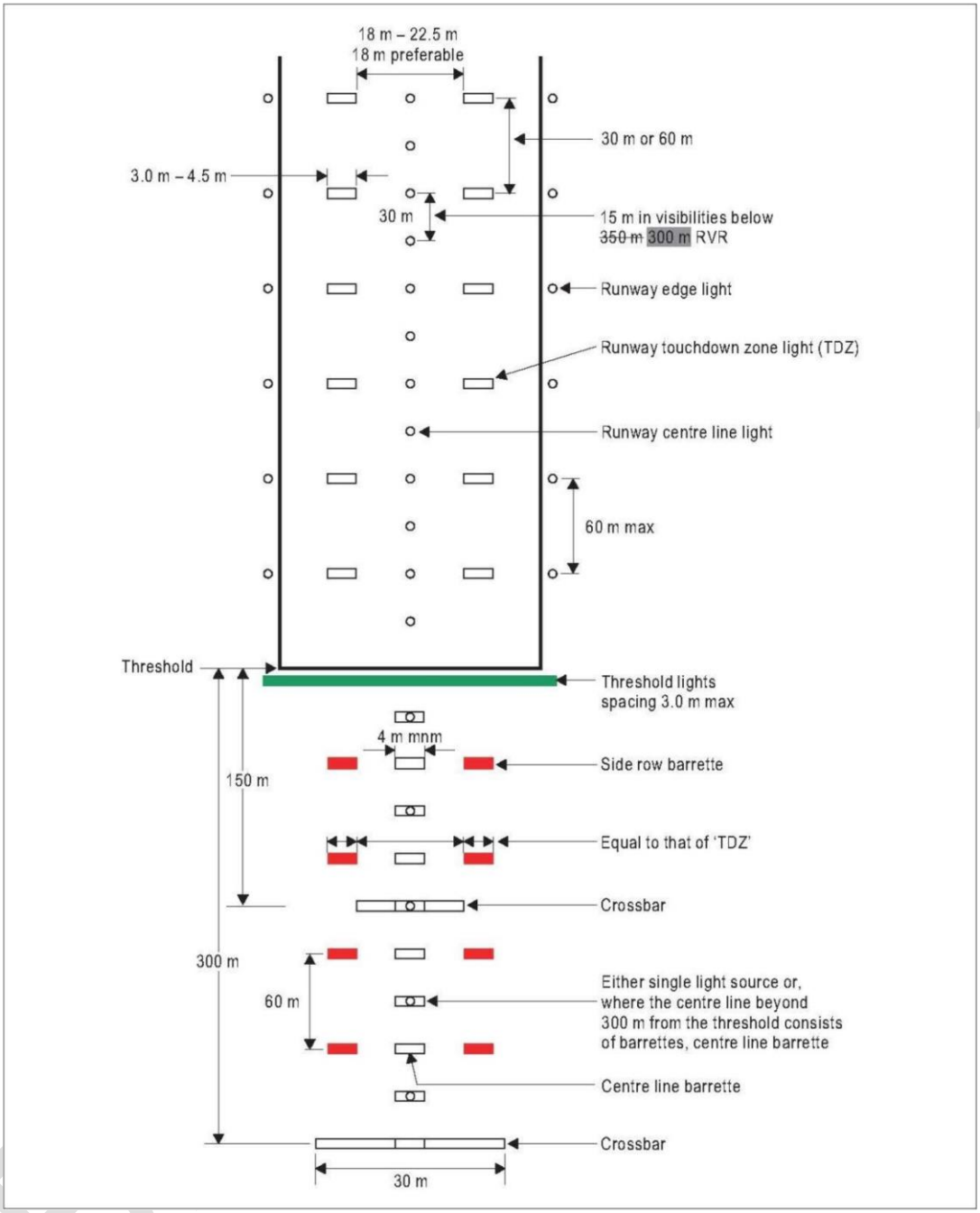


Figure 5-15: Inner 300 m approach and runway lighting for precision approach runways, categories II and III, where the serviceability levels of the lights specified as maintenance objectives in Chapter 10 can be demonstrated

Characteristics

5.3.4.30 The centre line of a precision approach category II and III lighting system for the first 300 m from the threshold shall consist of barrettes showing variable white, except that, where the threshold is displaced 300 m or more, the centre line may consist of single light sources showing variable white. Where the serviceability level of the approach lights specified as maintenance objectives in 10.5.7 can be demonstrated to the satisfaction of the Brunei DCA, the centre line

of a precision approach category II and III lighting system for the first 300 m from the threshold may consist of either:

(a) barrettes, where the centre line beyond 300 m from the threshold consists of barrettes as described in 5.3.4.32 a); or

(b) alternate single light sources and barrettes, where the centre line beyond 300 m from the threshold consists of single light sources as described in 5.3.4.32 b), with the innermost single light source located 30 m and the innermost barrette located 60 m from the threshold; or

(c) single light sources where the threshold is displaced 300 m or more;

all of which shall show variable white.

5.3.4.31 Beyond 300 m from the threshold each centre line light position shall consist of either:

(a) a barrette as used on the inner 300 m; or

(b) two light sources in the central 300 m of the centre line and three light sources in the outer 300 m of the centre line;

all of which shall show variable white.

5.3.4.32 Where the serviceability level of the approach lights specified as maintenance objectives in 10.5.7 can be demonstrated, beyond 300 m from the threshold each centre line light position may consist of either:

(a) a barrette; or

(b) a single light source;

all of which shall show variable white.

5.3.4.33 The barrettes shall be at least 4 m in length. When barrettes are composed of lights approximating to point sources, the lights shall be uniformly spaced at intervals of not more than 1.5 m.

5.3.4.34 **Recommendation -** If the centre line beyond 300 m from the threshold consists of barrettes as described in 5.3.4.31 a) or 5.3.4.32 a), each barrette beyond 300 m should be supplemented by a flashing light, except where such lighting is considered unnecessary taking into account the characteristics of the system and the nature of the meteorological conditions.

5.3.4.35 Each flashing light shall be flashed twice a second in sequence, beginning with the outermost light and progressing toward the threshold to the innermost light of the system. The design of the electrical circuit shall be such that these lights can be operated independently of the other lights of the approach lighting system.

5.3.4.36 The side row shall consist of barrettes showing red. The length of a side row barrette and the spacing of its lights shall be equal to those of the touchdown zone light barrettes.

5.3.4.37 The lights forming the crossbars shall be fixed lights showing variable white. The lights shall be uniformly spaced at intervals of not more than 2.7 m.

5.3.4.38 The intensity of the red lights shall be compatible with the intensity of the white lights.

5.3.5 Visual approach slope indicator systems

Application

5.3.5.1 A visual approach slope indicator system shall be provided to serve the approach to a runway whether or not the runway is served by other visual approach aids or by non-visual aids, where one or more of the following conditions exist:

(a) the runway is used by turbojet or other aeroplanes with similar approach guidance requirements;

(b) the pilot of any type of aeroplane may have difficulty in judging the approach due to:

(1) inadequate visual guidance such as is experienced during an approach over water or featureless terrain by day or in the absence of sufficient extraneous lights in the approach area by night; or

(2) misleading information such as is produced by deceptive surrounding terrain or runway slopes;

(c) the presence of objects in the approach area may involve serious hazard if an aeroplane descends below the normal approach path, particularly if there are no non-visual or other visual aids to give warning of such objects;

(d) physical conditions at either end of the runway present a serious hazard in the event of an aeroplane undershooting or overrunning the runway; and

(e) terrain or prevalent meteorological conditions are such that the aeroplane may be subjected to unusual turbulence during approach.

5.3.5.2 The standard visual approach slope indicator systems shall consist of PAPI and APAPI systems conforming to the specifications contained in 5.3.5.24 to 5.3.5.41 inclusive as shown in Figure 5-16.

5.3.5.3 PAPI shall be provided where the code number is 3 or 4 when one or more of the conditions specified in 5.3.5.1 exist.

5.3.5.4 Reserved

5.3.5.5 PAPI or APAPI shall be provided where the code number is 1 or 2 when one or more of the conditions specified in 5.3.5.1 exist.

5.3.5.6 **Recommendation -** Where a runway threshold is temporarily displaced from the normal position and one or more of the conditions specified in 5.3.5.1 exist, a PAPI should be provided except that where the code number is 1 or 2 an APAPI may be provided.

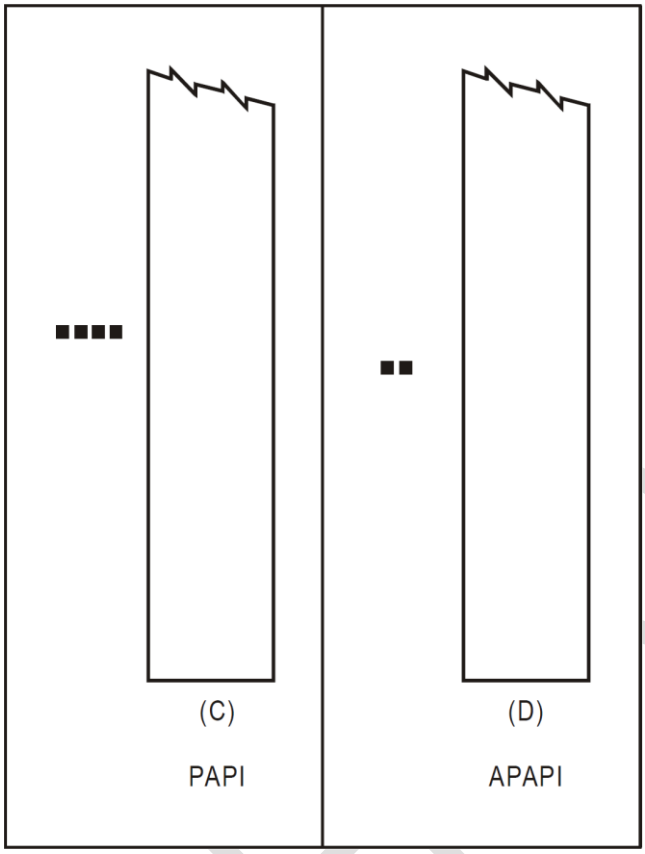


Figure 5-16. Visual approach slope indicator system

T-VASIS and AT-VASIS

Description

5.3.5.7 Reserved

5.3.5.8 Reserved

5.3.5.9 Reserved

Siting

5.3.5.10 Reserved

Characteristics of the light units

5.3.5.11 Reserved

5.3.5.12 Reserved

5.3.5.13 Reserved

5.3.5.14 Reserved

5.3.5.15 Reserved

5.3.5.16 Reserved

5.3.5.17 Reserved

5.3.5.18 Reserved

Approach slope and elevation setting of light beams

5.3.5.19 Reserved

5.3.5.20 Reserved

5.3.5.21 Reserved

5.3.5.22 Reserved

5.3.5.23 Reserved

PAPI and APAPI

Description

5.3.5.24 The PAPI system shall consist of a wing bar of four sharp transition multi-lamp (or paired single lamp) units equally spaced. The system shall be located on the left side of the runway unless it is physically impracticable to do so.

5.3.5.25 The APAPI system shall consist of a wing bar of two sharp transition multi-lamp (or paired single lamp) units. The system shall be located on the left side of the runway unless it is physically impracticable to do so.

5.3.5.26 The wing bar of a PAPI shall be constructed and arranged in such a manner that a pilot making an approach will:

(a) when on or close to the approach slope, see the two units nearest the runway as red and the two units farthest from the runway as white;

(b) when above the approach slope, see the one unit nearest the runway as red and the three units farthest from the runway as white; and when further above the approach slope, see all the units as white; and

(c) when below the approach slope, see the three units nearest the runway as red and the unit farthest from the runway as white; and when further below the approach slope, see all the units as red.

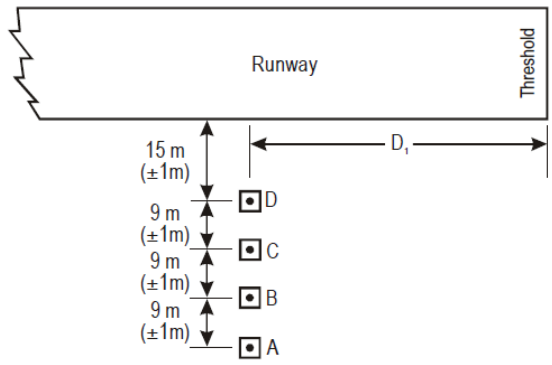
5.3.5.27 The wing bar of an APAPI shall be constructed and arranged in such a manner that a pilot making an approach will:

(a) when on or close to the approach slope, see the unit nearer the runway as red and the unit farther from the runway as white;

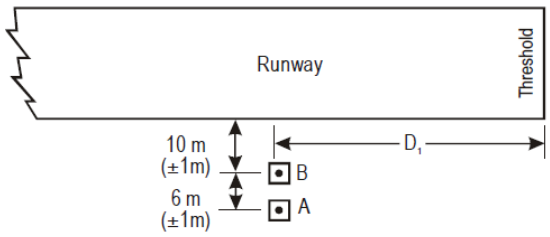
(b) when above the approach slope, see both the units as white; and c) when below the approach slope, see both the units as red.

Siting

5.3.5.28 The light units shall be located as in the basic configuration illustrated in Figure 5-19, subject to the installation tolerances given therein. The units forming a wing bar shall be mounted so as to appear to the pilot of an approaching aeroplane to be substantially in a horizontal line. The light units shall be mounted as low as possible and shall be frangible.



Typical PAPI wing bar



Typical APAPI wing bar

INSTALLATION TOLERANCES

a) Where a PAPI or APAPI is installed on a runway not equipped with an ILS or MLS, the distance D_1 shall be calculated to ensure that the lowest height at which a pilot will see a correct approach path indication (Figure 5-20, angle B for a PAPI and angle A for an APAPI) provides the wheel clearance over the threshold specified in Table 5-2 for the most demanding amongst aeroplanes regularly using the runway.

b) Where a PAPI or APAPI is installed on a runway equipped with an ILS and/or MLS, the distance D_1 shall be calculated to provide the optimum compatibility between the visual and non-visual aids for the range of eye-to-antenna heights of the aeroplanes regularly using the runway. The distance shall be equal to that between the threshold and the effective origin of the ILS glide path or MLS minimum glide path, as appropriate, plus a correction factor for the variation of eye-to-antenna heights of the aeroplanes concerned. The correction factor is obtained by multiplying the average eye-to-antenna height of those aeroplanes by the cotangent of the approach angle. However, the distance shall be such that in no case will the wheel clearance over the threshold be lower than that specified in column (3) of Table 5-2.

Note.— See Section 5.2.5 for specifications on aiming point marking. Guidance on the harmonization of PAPI, ILS and/or MLS signals is contained in the *Aerodrome Design Manual* (Doc 9157), Part 4.

c) If a wheel clearance, greater than that specified in a) above is required for specific aircraft, this can be achieved by increasing D_1.

d) Distance D_1 shall be adjusted to compensate for differences in elevation between the lens centres of the light units and the threshold.

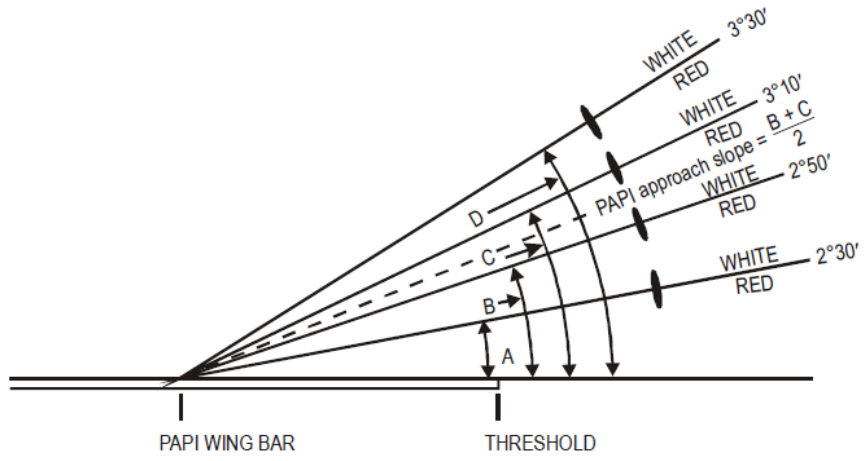
e) To ensure that units are mounted as low as possible and to allow for any transverse slope, small height adjustments of up to 5 cm between units are acceptable. A lateral gradient not greater than 1.25 per cent can be accepted provided it is uniformly applied across the units.

f) A spacing of 6 m (±1 m) between PAPI units should be used on code numbers 1 and 2. In such an event, the inner PAPI unit shall be located not less than 10 m (±1 m) from the runway edge.

Note.— Reducing the spacing between light units results in a reduction in usable range of the system.

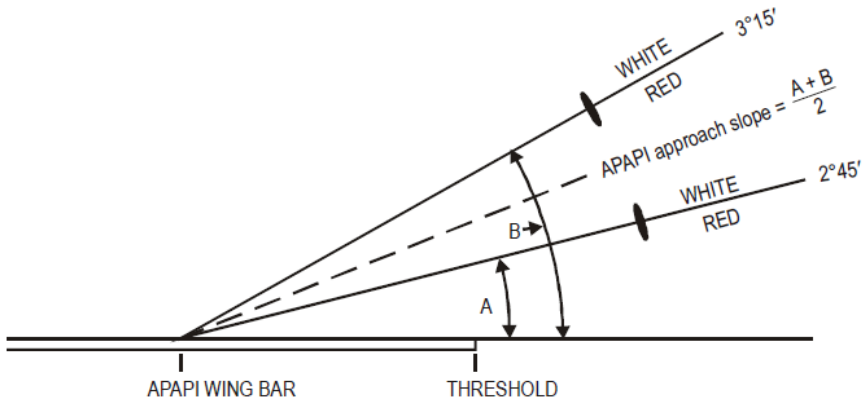
g) The lateral spacing between APAPI units may be increased to 9 m (±1 m) if greater range is required or later conversion to a full PAPI is anticipated. In the latter case, the inner APAPI unit shall be located 15 m (±1 m) from the runway edge.

Figure 5-19. Sitting of PAPI and APAPI



The height of the pilot's eye above the aircraft's ILS glide path/MLS antenna varies with the type of aeroplane and approach attitude. Harmonization of the PAPI signal and ILS glide path and/or MLS minimum glide path to a point closer to the threshold may be achieved by increasing the on-course sector from 20′ to 30′. The setting angles for a 3° glide slope would then be 2°25′, 2°45′, 3°15′ and 3°35′.

A — 3° PAPI ILLUSTRATED



B — 3° APAPI ILLUSTRATED

Figure 5-20. Light beams and angle of elevation setting of PAPI and APAPI

Table 5-2. Wheel clearance over threshold for PAPI and APAPI

Eye-to-wheel height of aeroplane in the approach configuration[a]	Desired wheel clearance (metres)[b,c]	Minimum wheel clearance (metres)[d]
(1)	(2)	(3)
up to but not including 3 m	6	3[e]
3 m up to but not including 5 m	9	4
5 m up to but not including 8 m	9	5
8 m up to but not including 14 m	9	6

a. In selecting the eye-to-wheel height group, only aeroplanes meant to use the system on a regular basis shall be considered. The most demanding amongst such aeroplanes shall determine the eye-to-wheel height group.
b. Where practicable the desired wheel clearances shown in column (2) shall be provided.
c. The wheel clearances in column (2) may be reduced to no less than those in column (3) where an aeronautical study indicates that such reduced wheel clearances are acceptable.
d. When a reduced wheel clearance is provided at a displaced threshold it shall be ensured that the corresponding desired wheel clearance specified in column (2) will be available when an aeroplane at the top end of the eye-to-wheel height group chosen overflies the extremity of the runway.
e. This wheel clearance may be reduced to 1.5 m on runways used mainly by light-weight non-turbojet aeroplanes.

Characteristics of the light units

5.3.5.29 The system shall be suitable for both day and night operations.

5.3.5.30 The colour transition from red to white in the vertical plane shall be such as to appear to an observer, at a distance of not less than 300 m, to occur within a vertical angle of not more than 3′.

5.3.5.31 At full intensity the red light shall have a Y coordinate not exceeding 0.320.

5.3.5.32 The light intensity distribution of the light units shall be as shown in Appendix 2, Figure A2-23 of ICAO Annex 14 Volume I.

Note. – See the Aerodrome Design Manual (Doc 9157), Part 4, for additional guidance on the characteristics of light units.

5.3.5.33 Suitable intensity control shall be provided so as to allow adjustment to meet the prevailing conditions and to avoid dazzling the pilot during approach and landing.

5.3.5.34 Each light unit shall be capable of adjustment in elevation so that the lower limit of the white part of the beam may be fixed at any desired angle of elevation between 1°30′ and at least 4°30′ above the horizontal.

5.3.5.35 The light units shall be so designed that deposits of condensation, dirt, sand, etc., on optically transmitting or reflecting surfaces shall interfere to the least possible extent with the light signals and shall not affect the contrast between the red and white signals and the elevation of the transition sector.

Approach slope and elevation setting of light units

5.3.5.36 The approach slope as defined in Figure 5-20 shall be appropriate for use by the aeroplanes using the approach.

5.3.5.37 When the runway is equipped with an ILS and/or MLS, the sitting and the angle of elevation of the light units shall be such that the visual approach slope conforms as closely as possible with the glide path of the ILS and/or the minimum glide path of the MLS, as appropriate.

5.3.5.38 The angle of elevation settings of the light units in a PAPI wing bar shall be such that, during an approach, the pilot of an aeroplane observing a signal of one white and three reds will clear all objects in the approach area by a safe margin (see Table 5-2).

5.3.5.39 The angle of elevation settings of the light units in an APAPI wing bar shall be such that, during an approach, the pilot of an aeroplane observing the lowest onslope signal, i.e. one white and one red, will clear all objects in the approach area by a safe margin (see Table 5-2).

5.3.5.40 The azimuth spread of the light beam shall be suitably restricted where an object located outside the obstacle protection surface of the PAPI or APAPI system, but within the lateral limits of its light beam, is found to extend above the plane of the obstacle protection surface and an aeronautical study indicates that the object could adversely affect the safety of operations. The extent of the restriction shall be such that the object remains outside the confines of the light beam.

5.3.5.41 Where wing bars are installed on each side of the runway to provide roll guidance, corresponding units shall be set at the same angle so that the signals of each wing bar change symmetrically at the same time.

Obstacle protection surface

Note.— The following specifications apply to PAPI and APAPI.

5.3.5.42 An obstacle protection surface shall be established when it is intended to provide a visual approach slope indicator system.

5.3.5.43 The characteristics of the obstacle protection surface, i.e. origin, divergence, length and slope, shall correspond to those specified in the relevant column of Table 5-3 and in Figure 5-21.

5.3.5.44 New objects or extensions of existing objects shall not be permitted above an obstacle protection surface except when, in the opinion of Brunei DCA Regulatory, the new object or extension would be shielded by an existing immovable object.

5.3.5.45 Existing objects above an obstacle protection surface shall be removed except when, in the opinion of Brunei DCA Regulatory, the object is shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety of operations of aeroplanes.

Table 5-3. Dimensions and slopes of the obstacle protection surface

	Runway type/code number							
	Non-instrument Code number				Instrument Code number			
Surface dimensions	1	2	3	4	1	2	3	4
Length of inner edge	60 m	80 m[a]	150 m	150 m	150 m	150 m	300 m	300 m
Distance from threshold	30 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m
Divergence (each side)	10%	10%	10%	10%	15%	15%	15%	15%
Total length	7 500 m	7 500 m[b]	15 000 m	15 000 m	7 500 m	7 500 m[b]	15 000 m	15 000 m
Slope								
a) T-VASIS and AT-VASIS	–[c]	1.9°	1.9°	1.9°	–	1.9°	1.9°	1.9°
b) PAPI[d]	–	A–0.57°	A–0.57°	A–0.57°	A–0.57°	A–0.57°	A–0.57°	A–0.57°
c) APAPI[d]	A–0.9°	A–0.9°	–	–	A–0.9°	A–0.9°	–	–

a. This length is to be increased to 150 m for a T-VASIS or AT-VASIS.
b. This length is to be increased to 15 000 m for a T-VASIS or AT-VASIS.
c. No slope has been specified if a system is unlikely to be used on runway type/code number indicated.
d. Angles as indicated in Figure 5-20.

5.3.5.46 Where an aeronautical study indicates that an existing object extending above an obstacle protection surface could adversely affect the safety of operations of aeroplanes one or more of the following measures shall be taken:

(a) suitably raise the approach slope of the system;

(b) reduce the azimuth spread of the system so that the object is outside the confines of the beam;

(c) displace the axis of the system and its associated obstacle protection surface by no more than 5°;

(d) suitably displace the threshold; and

(e) where d) is found to be impracticable, suitably displace the system upwind of the threshold to provide an increase in threshold crossing height equal to the height of the object penetration.

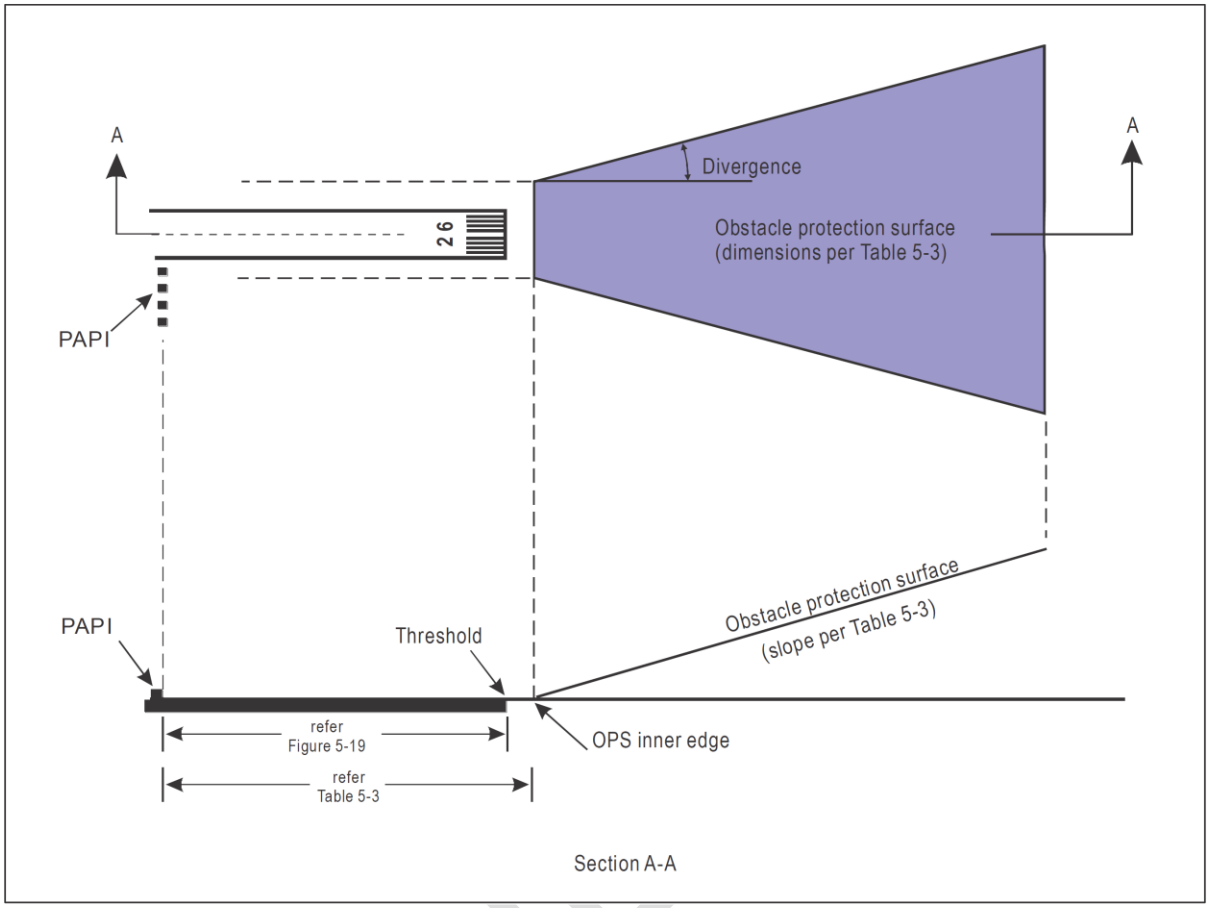


Figure 5-21. Obstacle protection surface for visual approach slope indicator systems.

5.3.6 Circling guidance lights

Application

5.3.6.1 **Recommendation -** Circling guidance lights should be provided when existing approach and runway lighting systems do not satisfactorily permit identification of the runway and/or approach area to a circling aircraft in the conditions for which it is intended the runway be used for circling approaches.

Location

5.3.6.2 **Recommendation -** The location and number of circling guidance lights should be adequate to enable a pilot, as appropriate, to:

(a) join the downwind leg or align and adjust the aircraft's track to the runway at a required distance from it and to distinguish the threshold in passing; and

(b) keep in sight the runway threshold and/or other features which will make it possible to judge the turn on to base leg and final approach, taking into account the guidance provided by other visual aids.

5.3.6.3 **Recommendation -** Circling guidance lights should consist of:

(a) lights indicating the extended centre line of the runway and/or parts of any approach lighting system; or

(b) lights indicating the position of the runway threshold; or

(c) lights indicating the direction or location of the runway;

or a combination of such lights as is appropriate to the runway under consideration.

Note.— Guidance on installation of circling guidance lights is given in the Aerodrome Design Manual (Doc 9157),Part 4.

Characteristics

5.3.6.4 **Recommendation -** Circling guidance lights should be fixed or flashing lights of an intensity and beam spread adequate for the conditions of visibility and ambient light in which it is intended to make visual circling approaches. The flashing lights should be white, and the steady lights either white or gaseous discharge lights.

5.3.6.5 **Recommendation -** The lights should be designed and be installed in such a manner that they will not dazzle or confuse a pilot when approaching to land, taking off or taxiing.

5.3.7 Runway lead-in lighting systems

Application

5.3.7.1 **Recommendation -** A runway lead-in lighting system should be provided where it is desired to provide visual guidance along a specific approach path, for reasons such as avoiding hazardous terrain or for purposes of noise abatement.

Note.— Guidance on providing lead-in lighting systems is given in the ICAO Aerodrome Design Manual (Doc 9157), Part 4.

Location

5.3.7.2 **Recommendation -** A runway lead-in lighting system should consist of groups of lights positioned so as to define the desired approach path and so that one group may be sighted from the preceding group. The interval between adjacent groups should not exceed approximately 1 600 m.

5.3.7.3 **Recommendation -** A runway lead-in lighting system should extend from a point as determined by the Brunei DCA Regulatory, up to a point where the approach lighting system, if provided, or the runway or the runway lighting system is in view.

Characteristics

5.3.7.4 **Recommendation -** Each group of lights of a runway lead-in lighting system should consist of at least three flashing lights in a linear or cluster configuration. The system may be augmented by steady burning lights where such lights would assist in identifying the system.

5.3.7.5 **Recommendation -** The flashing lights should be white, and the steady burning lights gaseous discharge lights.

5.3.7.6 **Recommendation -** Where practicable, the flashing lights in each group should flash in sequence towards the runway.

5.3.8 Runway threshold identification lights

Application

5.3.8.1 **Recommendation -** Runway threshold identification lights should be installed:

(a) at the threshold of a non-precision approach runway when additional threshold conspicuity is necessary or where it is not practicable to provide other approach lighting aids; and

(b) where a runway threshold is permanently displaced from the runway extremity or temporarily displaced from the normal position and additional threshold conspicuity is necessary.

Location

5.3.8.2 Runway threshold identification lights shall be located symmetrically about the runway centre line, in line with the threshold and approximately 10 m outside each line of runway edge lights.

Characteristics

5.3.8.3 **Recommendation -** Runway threshold identification lights should be flashing white lights with a flash frequency between 60 and 120 per minute.

5.3.8.4 The lights shall be visible only in the direction of approach to the runway.

5.3.9 Runway edge lights

Application

5.3.9.1 Runway edge lights shall be provided for a runway intended for use at night or for a precision approach runway intended for use by day or night.

5.3.9.2 **Recommendation -** Runway edge lights should be provided on a runway intended for take-off with an operating minimum below an RVR of the order of 800 m by day.

Location

5.3.9.3 Runway edge lights shall be placed along the full length of the runway and shall be in two parallel rows equidistant from the centre line.

5.3.9.4 Runway edge lights shall be placed along the edges of the area declared for use as the runway or outside the edges of the area at a distance of not more than 3 m.

5.3.9.5 **Recommendation -** Where the width of the area which could be declared as runway exceeds 60 m, the distance between the rows of lights should be determined taking into account the nature of the operations, the light distribution characteristics of the runway edge lights, and other visual aids serving the runway.

5.3.9.6 The lights shall be uniformly spaced in rows at intervals of not more than 60 m for an instrument runway, and at intervals of not more than 100 m for a non-instrument runway. The lights on opposite sides of the runway axis shall be on lines at right angles to that axis. At intersections of runways, lights may be spaced irregularly or omitted, provided that adequate guidance remains available to the pilot.

Characteristics

5.3.9.7 Runway edge lights shall be fixed lights showing variable white, except that:

(a) in the case of a displaced threshold, the lights between the beginning of the runway and the displaced threshold shall show red in the approach direction; and

(b) a section of the lights 600 m or one-third of the runway length, whichever is the less, at the remote end of the runway from the end at which the take-off run is started, may show yellow when no centre line is available.

5.3.9.8 The runway edge lights shall show at all angles in azimuth necessary to provide guidance to a pilot landing or taking off in either direction. When the runway edge lights are intended to provide circling guidance, they shall show at all angles in azimuth (see 5.3.6.1).

5.3.9.9 In all angles of azimuth required in 5.3.9.8, runway edge lights shall show at angles up to 15° above the horizontal with an intensity adequate for the conditions of visibility and ambient light in which use of the runway for take-off or landing is intended. In any case, the intensity shall be at least 50 cd except that at an aerodrome without extraneous lighting, the intensity of the lights may be reduced to not less than 25 cd to avoid dazzling the pilot.

5.3.9.10 Runway edge lights on a precision approach runway shall be in accordance with the specifications of Appendix 2, Figure A2-9 or A2-10 of ICAO Annex 14.

5.3.10 **Runway threshold and wing bar lights** (see Figure 5-22)

Application of runway threshold lights

5.3.10.1 Runway threshold lights shall be provided for a runway equipped with runway edge lights, except on a non-instrument or non-precision approach runway where the threshold is displaced and wing bar lights are provided.

Location of runway threshold lights

5.3.10.2 When a threshold is at the extremity of a runway, the threshold lights shall be placed in a row at right angles to the runway axis as near to the extremity of the runway as possible and, in any case, not more than 3 m outside the extremity.

5.3.10.3 When a threshold is displaced from the extremity of a runway, threshold lights shall be placed in a row at right angles to the runway axis at the displaced threshold.

5.3.10.4 Threshold lighting shall consist of:

(a) on a non-instrument or non-precision approach runway, at least six lights;

(b) on a precision approach runway category I, at least the number of lights that would be required if the lights were uniformly spaced at intervals of 3 m between the rows of runway edge lights; and

(c) on a precision approach runway category II or III, lights uniformly spaced between the rows of runway edge lights at intervals of not more than 3 m.

5.3.10.5 **Recommendation -** The lights prescribed in 5.3.10.4 a) and b) should be either:

(a) equally spaced between the rows of runway edge lights; or

(b) symmetrically disposed about the runway centre line in two groups, with the lights uniformly spaced in each group and with a gap between the groups equal to the gauge of the touchdown zone marking or lighting, where such is provided, or otherwise not more than half the distance between the rows of runway edge lights.

Application of wing bar lights

5.3.10.6 **Recommendation -** Wing bar lights should be provided on a precision approach runway when additional conspicuity is considered desirable.

5.3.10.7 Wing bar lights shall be provided on a non-instrument or non-precision approach runway where the threshold is displaced and runway threshold lights are required, but are not provided.

Location of wing bar lights

5.3.10.8 Wing bar lights shall be symmetrically disposed about the runway centre line at the threshold in two groups, i.e. wing bars. Each wing bar shall be formed by at least five lights extending at least 10 m outward from, and at right angles to, the line of the runway edge lights, with the innermost light of each wing bar in the line of the runway edge lights.

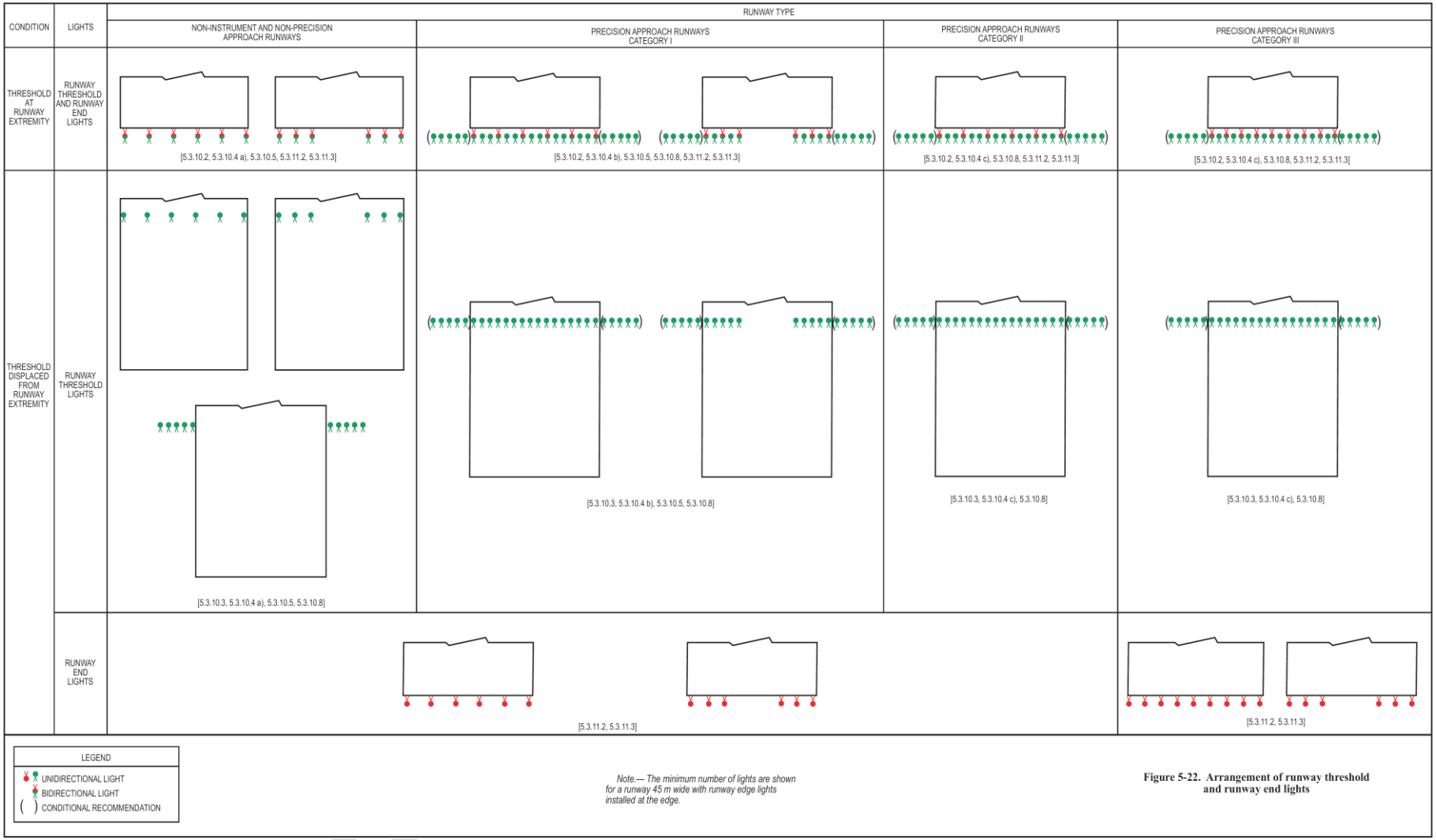


Figure 5-22. Arrangement of runway threshold and runway end light

Characteristics of runway threshold and wing bar lights

5.3.10.9 Runway threshold and wing bar lights shall be fixed unidirectional lights showing green in the direction of approach to the runway. The intensity and beam spread of the lights shall be adequate for the conditions of visibility and ambient light in which use of the runway is intended.

5.3.10.10 Runway threshold lights on a precision approach runway shall be in accordance with the specifications of Appendix 2, Figure A2-3 of ICAO Annex 14.

5.3.10.11 Threshold wing bar lights on a precision approach runway shall be in accordance with the specifications of Appendix 2, Figure A2-4 of ICAO Annex 14.

5.3.11 **Runway end lights** (see Figure 5-22)

Application

5.3.11.1 Runway end lights shall be provided for a runway equipped with runway edge lights.

Location

5.3.11.2 Runway end lights shall be placed on a line at right angles to the runway axis as near to the end of the runway as possible and, in any case, not more than 3 m outside the end.

5.3.11.3 **Recommendation -** Runway end lighting should consist of at least six lights. The lights should be either:

(a) equally spaced between the rows of runway edge lights; or

(b) symmetrically disposed about the runway centre line in two groups with the lights uniformly spaced in each group and with a gap between the groups of not more than half the distance between the rows of runway edge lights.

For a precision approach runway category III, the spacing between runway end lights, except between the two innermost lights if a gap is used, should not exceed 6 m.

Characteristics

5.3.11.4 Runway end lights shall be fixed unidirectional lights showing red in the direction of the runway. The intensity and beam spread of the lights shall be adequate for the conditions of visibility and ambient light in which use of the runway is intended.

5.3.11.5 Runway end lights on a precision approach runway shall be in accordance with the specifications of Appendix 2, Figure A2-8 of ICAO Annex 14.

5.3.12 Runway centre line lights

Application

5.3.12.1 Runway centre line lights shall be provided on a precision approach runway category II or III.

5.3.12.2 **Recommendation -** Runway centre line lights should be provided on a precision approach runway category I, particularly when the runway is used by aircraft with

high landing speeds or where the width between the runway edge lights is greater than 50 m.

5.3.12.3 Runway centre line lights shall be provided on a runway intended to be used for take-off with an operating minimum below an RVR of the order of 400 m.

5.3.12.4 Reserved

Location

5.3.12.5 Runway centre line lights shall be located along the centre line of the runway, except that the lights may be uniformly offset to the same side of the runway centre line by not more than 60 cm where it is not practicable to locate them along the centre line. The lights shall be located from the threshold to the end at longitudinal spacing of approximately 15 m. Where the serviceability level of the runway centre line lights specified as maintenance objectives in 10.5.7 or 10.5.11, as appropriate, can be demonstrated and the runway is intended for use in runway visual range conditions of 300 m or greater, the longitudinal spacing may be approximately 30 m.

Note.— Existing centre line lighting where lights are spaced at 7.5 m need not be replaced.

5.3.12.6 **Recommendation -** Centre line guidance for take-off from the beginning of a runway to a displaced threshold should be provided by:

(a) an approach lighting system if its characteristics and intensity settings afford the guidance required during take-off and it does not dazzle the pilot of an aircraft taking off; or

(b) runway centre line lights; or

(c) barrettes of at least 3 m in length and spaced at uniform intervals of 30 m, as shown in Figure 5-23, designed so that their photometric characteristics and intensity setting afford the guidance required during take-off without dazzling the pilot of an aircraft taking off.

Where necessary, provision should be made to extinguish those centre line lights specified in b) or reset the intensity of the approach lighting system or barrettes when the runway is being used for landing. In no case should only the single source runway centre line lights show from the beginning of the runway to a displaced threshold when the runway is being used for landing.

Characteristics

5.3.12.7 Runway centre line lights shall be fixed lights showing variable white from the threshold to the point 900 m from the runway end; alternate red and variable white from 900 m to 300 m from the runway end; and red from 300 m to the runway end, except that for runways less than 1 800 m in length, the alternate red and variable white lights shall extend from the midpoint of the runway usable for landing to 300 m from the runway end.

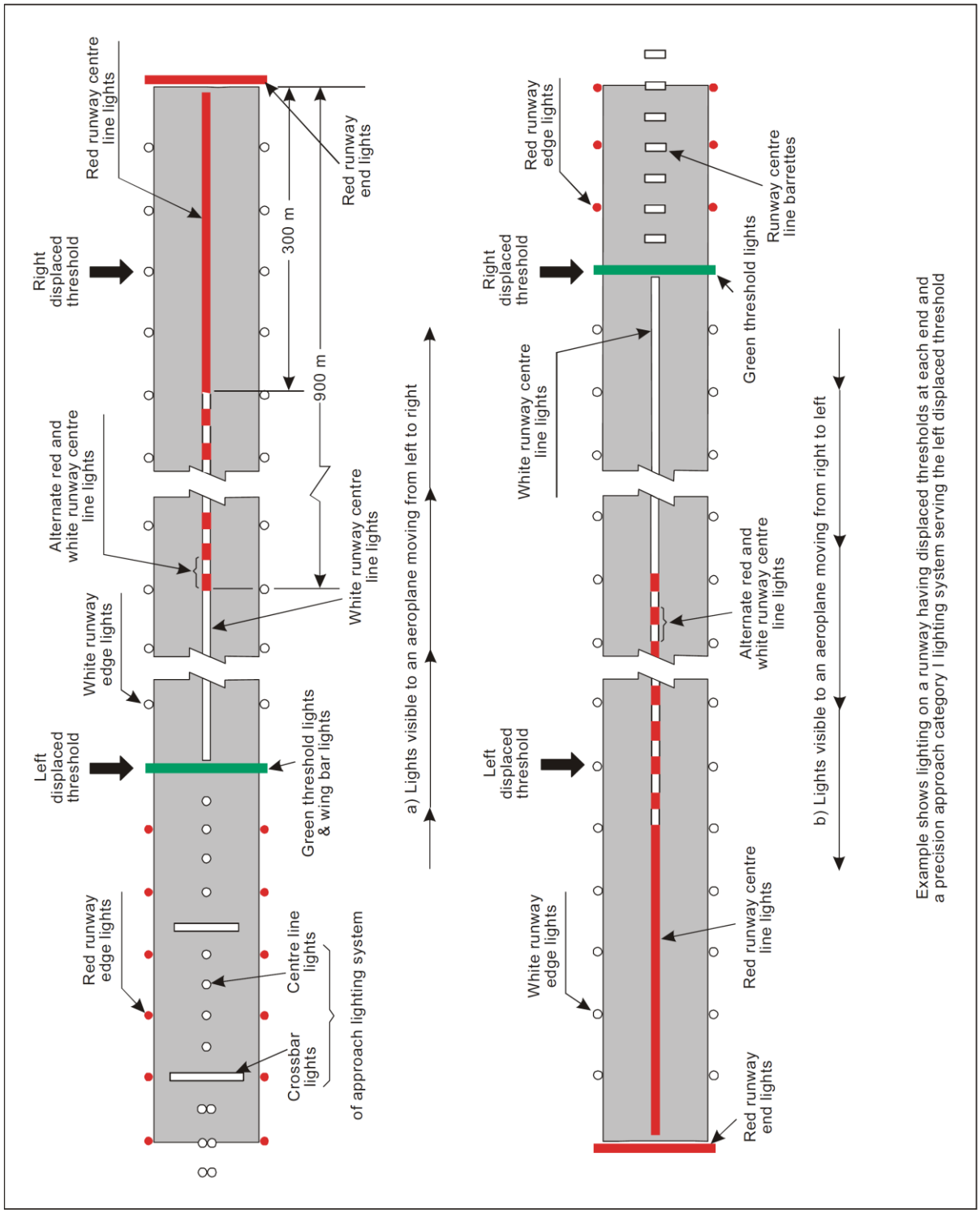


Figure 5-23. Example of approach and runway lighting for runway with displayed thresholds

5.3.12.8 Runway centre line lights shall be in accordance with the specifications of Appendix 2, Figure A2-6 or A2-7 of ICAO Annex 14.

5.3.13 Runway touchdown zone lights

Application

5.3.13.1 Touchdown zone (TDZ) lights shall be provided in the touchdown zone of a precision approach runway category II or III.

Location

5.3.13.2 Touchdown zone lights shall extend from the threshold for a longitudinal distance of 900 m, except that, on runways less than 1 800 m in length, the system shall be shortened so that it does not extend beyond the midpoint of the runway. The pattern shall be formed by pairs of barrettes symmetrically located about the runway centre line. The lateral spacing between the innermost lights of a pair of barrettes shall be equal to the lateral spacing selected for the touchdown zone marking. The longitudinal spacing between pairs of barrettes shall be either 30 m or 60 m.

Characteristics

5.3.13.3 A barrette shall be composed of at least three lights with a spacing between the lights of not more than 1.5 m.

5.3.13.4 **Recommendation -** A barrette should be not less than 3 m nor more than 4.5 m in length.

5.3.13.5 Touchdown zone lights shall be fixed unidirectional lights showing variable white.

5.3.13.6 Touchdown zone lights shall be in accordance with the specifications of Appendix 2, Figure A2-5 of ICAO Annex 14.

5.3.14 Simple touchdown zone lights

Application

5.3.14.1 **Recommendation -** Except where TDZ lights are provided in accordance with paragraph 5.3.13, at an aerodrome where the approach angle is greater than 3.5 degrees and/or the Landing Distance Available combined with other factors increases the risk of an overrun, simple touchdown zone lights should be provided.

Location

5.3.14.2 Simple touchdown zone lights shall be a pair of lights located on each side of the runway centreline 0.3 m beyond the upwind edge of the final touchdown zone marking. The lateral spacing between the inner lights of the two pairs of lights shall be equal to the lateral spacing selected for the touchdown zone marking. The spacing between the lights of the same pair shall not be more than 1.5 m or half the width of the touchdown zone marking, whichever is greater. (See Figure 5-24.)

5.3.14.3 **Recommendation -** Where provided on a runway without TDZ markings, simple touchdown zone lights should be installed in such a position that provides the equivalent TDZ information.

Characteristics

5.3.14.4 Simple touchdown zone lights shall be fixed unidirectional lights showing variable white, aligned so as to be visible to the pilot of a landing aeroplane in the direction of approach to the runway.

5.3.14.5 Simple touchdown zone lights shall be in accordance with the specifications in Appendix 2, Figure A2-5 of ICAO Annex 14.

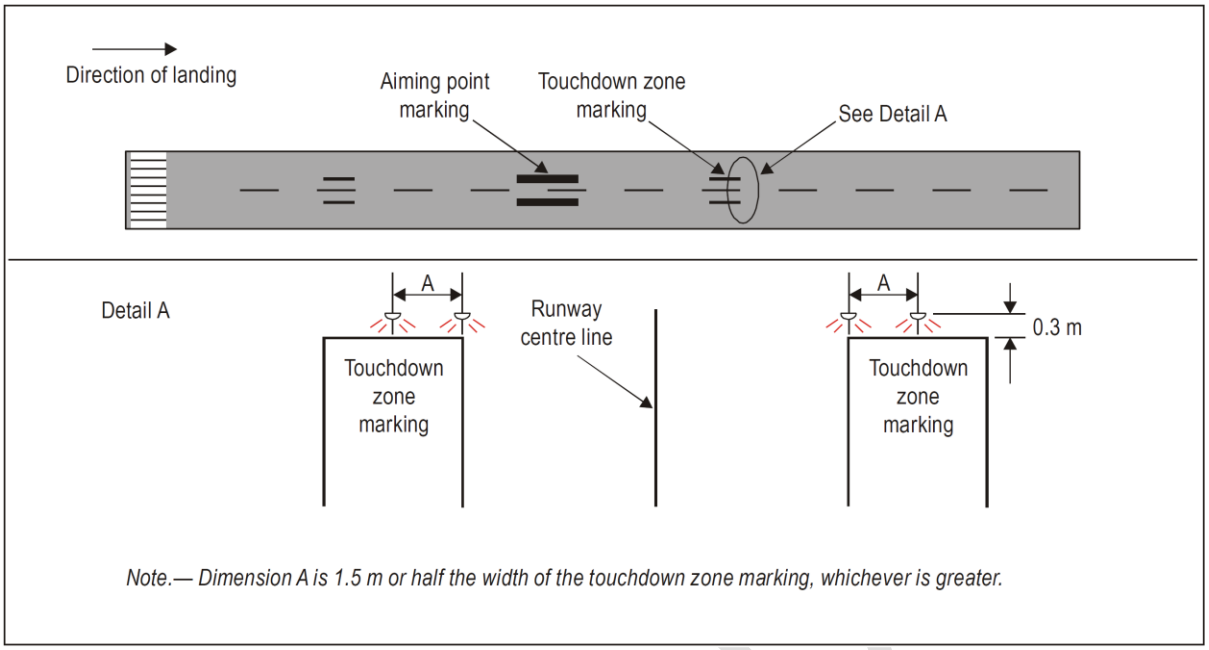


Figure 5-24. Single touchdown zone lighting

5.3.15 Rapid exit taxiway indicator lights

Note.— The purpose of rapid exit taxiway indicator lights (RETILs) is to provide pilots with distance-to-go information to the nearest rapid exit taxiway on the runway, to enhance situational awareness in low visibility conditions and enable pilots to apply braking action for more efficient roll-out and runway exit speeds. It is essential that pilots operating at aerodromes with runway(s) displaying rapid exit taxiway indicator lights be familiar with the purpose of these lights.

Application

5.3.15.1 **Recommendation -** Rapid exit taxiway indicator lights should be provided on a runway intended for use in runway visual range conditions less than a value of 300 m and/or where the traffic density is heavy.

Note.— See 15.1, Attachment A, Section 15.

5.3.15.2 Rapid exit taxiway indicator lights shall not be displayed in the event of any lamp failure or other failure that prevents the display of the light pattern depicted in Figure 5-25, in full.

Location

5.3.15.3 A set of rapid exit taxiway indicator lights shall be located on the runway on the same side of the runway centre line as the associated rapid exit taxiway, in the configuration shown in Figure 5-25. In each set, the lights shall be located 2 m apart and the light nearest to the runway centre line shall be displaced 2 m from the runway centre line.

5.3.15.4 Where more than one rapid exit taxiway exists on a runway, the set of rapid exit taxiway indicator lights for each exit shall not overlap when displayed.

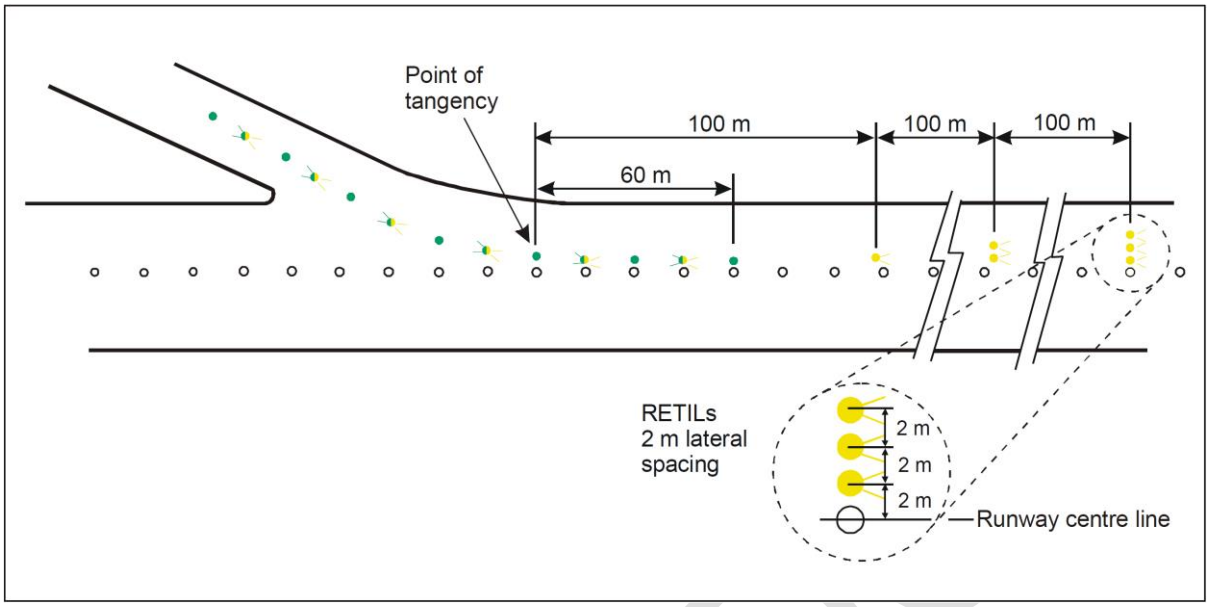


Figure 5-25. Rapid Exit Indicator Lights (RETILs)

Characteristics

5.3.15.5 Rapid exit taxiway indicator lights shall be fixed unidirectional yellow lights, aligned so as to be visible to the pilot of a landing aeroplane in the direction of approach to the runway.

5.3.15.6 Rapid exit taxiway indicator lights shall be in accordance with the specifications in Appendix 2, Figure A2-6 or Figure A2-7 of ICAO Annex 14, as appropriate.

5.3.15.7 **Recommendation -** Rapid exit taxiway indicator lights should be supplied with power on a separate circuit to other runway lighting so that they may be used when other lighting is switched off.

5.3.16 Stopway lights

Application

5.3.16.1 Stopway lights shall be provided for a stopway intended for use at night.

Location

5.3.16.2 Stopway lights shall be placed along the full length of the stopway and shall be in two parallel rows that are equidistant from the centre line and coincident with the rows of the runway edge lights. Stopway lights shall also be provided across the end of a stopway on a line at right angles to the stopway axis as near to the end of the stopway as possible and, in any case, not more than 3 m outside the end.

Characteristics

5.3.16.3 Stopway lights shall be fixed unidirectional lights showing red in the direction of the runway.

5.3.17 Taxiway centre line lights

Application

5.3.17.1 Taxiway centre line lights shall be provided on an exit taxiway, taxiway and apron intended for use in runway visual range conditions less than a value of 300 m in such a manner as to provide continuous guidance between the runway centre line and aircraft stands, except that these lights need not be provided where the traffic density is light and taxiway edge lights and centre line marking provide adequate guidance.

5.3.17.2 **Recommendation -** Taxiway centre line lights should be provided on a taxiway intended for use at night in runway visual range conditions of 300 m or greater, and particularly on complex taxiway intersections and exit taxiways, except that these lights need not be provided where the traffic density is light and taxiway edge lights and centre line marking provide adequate guidance.

5.3.17.3 **Recommendation -** Taxiway centre line lights should be provided on an exit taxiway, taxiway and apron in all visibility conditions where specified as components of an advanced surface movement guidance and control system in such a manner as to provide continuous guidance between the runway centre line and aircraft stands.

5.3.17.4 Taxiway centre line lights shall be provided on a runway forming part of a standard taxi-route and intended for taxiing in runway visual range conditions less than a value of 300 m, except that these lights need not be provided where the traffic density is light and taxiway edge lights and centre line marking provide adequate guidance.

Note.— See 8.2.3 for provisions concerning the interlocking of runway and taxiway lighting systems.

5.3.17.5 **Recommendation -** Taxiway centre line lights should be provided in all visibility conditions on a runway forming part of a standard taxi-route where specified as components of an advanced surface movement guidance and control system.

Characteristics

5.3.17.6 Except as provided for in 5.3.17.8, taxiway centre line lights on a taxiway other than an exit taxiway and on a runway forming part of a standard taxi-route shall be fixed lights showing green with beam dimensions such that the light is visible only from aeroplanes on or in the vicinity of the taxiway.

5.3.17.7 Taxiway centre line lights on an exit taxiway shall be fixed lights. Alternate taxiway centre line lights shall show green and yellow from their beginning near the runway centre line to the perimeter of the ILS/MLS critical/sensitive area or the lower edge of the inner transitional surface, whichever is farthest from the runway; and thereafter all lights shall show green (Figure 5-26). The first light in the exit centre line shall always show green, and the light nearest to the perimeter shall always show yellow.

5.3.17.8 **Recommendation -** Where it is necessary to denote the proximity to a runway, taxiway centre line lights should be fixed lights showing alternating green and yellow from the perimeter of the ILS/MLS critical/sensitive area or the lower edge of the inner transitional surface, whichever is farthest from the runway, to the runway and continue alternating green and yellow until:

(a) their end point near the runway centre line; or

(b) in the case of the taxiway centre line lights crossing the runway, to the opposite perimeter of the ILS/MLS critical/sensitive area or the lower edge of the inner transitional surface, whichever is farthest from the runway.

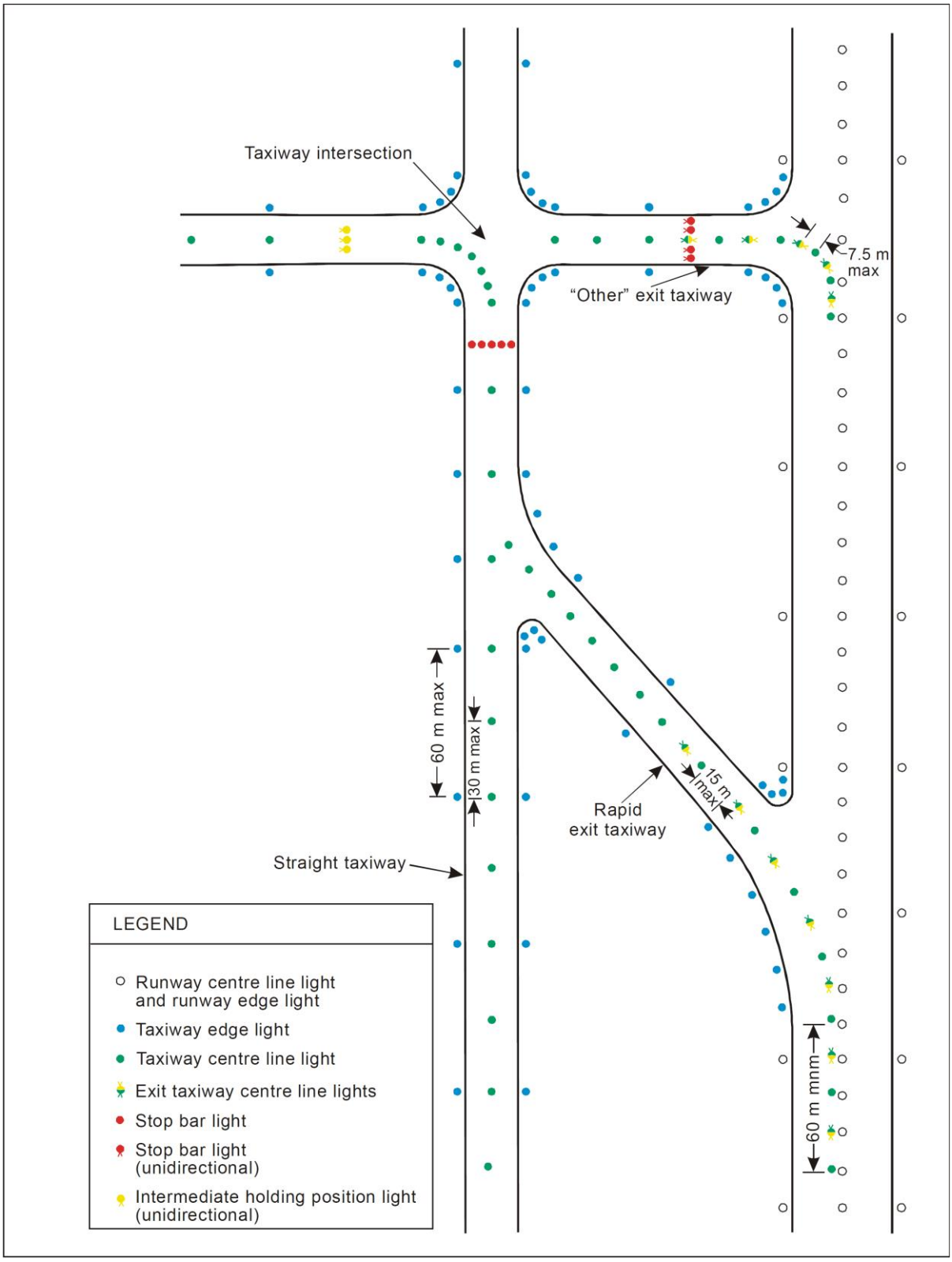


Figure 5-26. Taxiway Lighting

5.3.17.9 Taxiway centre line lights shall be in accordance with the specifications of:

(a) Appendix 2, Figure A2-12, A2-13, or A2-14 of ICAO Annex 14, for taxiways intended for use in runway visual range conditions of less than a value of 300 m; and

(b) Appendix 2, Figure A2-15 or A2-16 of ICAO Annex 14, for other taxiways.

5.3.17.10 **Recommendation -** Where higher intensities are required, from an operational point of view, taxiway centre line lights on rapid exit taxiways intended for use in runway visual range conditions less than a value of 300 m should be in accordance with the specifications of Appendix 2, Figure A2-12 of ICAO Annex 14. The number of levels of brilliancy settings for these lights should be the same as that for the runway centre line lights.

5.3.17.11 **Recommendation -** Where taxiway centre line lights are specified as components of an advanced surface movement guidance and control system and where, from an operational point of view, higher intensities are required to maintain ground movements at a certain speed in very low visibilities or in bright daytime conditions, taxiway centre line lights should be in accordance with the specifications of Appendix 2, Figure A2-17, A2-18 or A2-19 of ICAO Annex 14.

Location

5.3.17.12 **Recommendation -** Taxiway centre line lights should normally be located on the taxiway centre line marking, except that they may be offset by not more than 30 cm where it is not practicable to locate them on the marking.

Taxiway centre line lights on taxiways

Location

5.3.17.13 **Recommendation -** Taxiway centre line lights on a straight section of a taxiway should be spaced at longitudinal intervals of not more than 30 m, except that:

(a) larger intervals not exceeding 60 m may be used where, because of the prevailing meteorological conditions, adequate guidance is provided by such spacing;

(b) intervals less than 30 m should be provided on short straight sections; and

(c) on a taxiway intended for use in RVR conditions of less than a value of 300 m, the longitudinal spacing should not exceed 15 m.

5.3.17.14 **Recommendation -** Taxiway centre line lights on a taxiway curve should continue from the straight portion of the taxiway at a constant distance from the outside edge of the taxiway curve. The lights should be spaced at intervals such that a clear indication of the curve is provided.

5.3.17.15 **Recommendation -** On a taxiway intended for use in RVR conditions of less than a value of 300 m, the lights on a curve should not exceed a spacing of 15 m, and on a curve of less than 400 m radius the lights should be spaced at intervals of not greater than 7.5 m. This spacing should extend for 60 m before and after the curve.

Note 1. – Spacings on curves that have been found suitable for a taxiway intended for use in RVR conditions of 300 m or greater are:

Curve radius	Light spacing

Up to 400 m	7.5 m
401 m to 899 m	15 m
900 m or greater	30 m

Note 2.— See 3.9.5 and Figure 3-2.

Taxiway centre line lights on rapid exit taxiways

Location

5.3.17.16 **Recommendation -** Taxiway centre line lights on a rapid exit taxiway should commence at a point at least 60 m before the beginning of the taxiway centre line curve and continue beyond the end of the curve to a point on the centre line of the taxiway where an aeroplane can be expected to reach normal taxiing speed. The lights on that portion parallel to the runway centre line should always be at least 60 cm from any row of runway centre line lights, as shown in Figure 5-27.

5.3.17.17 **Recommendation -** The lights should be spaced at longitudinal intervals of not more than 15 m, except that, where runway centre line lights are not provided, a greater interval not exceeding 30 m may be used.

Taxiway centre line lights on other exit taxiways

Location

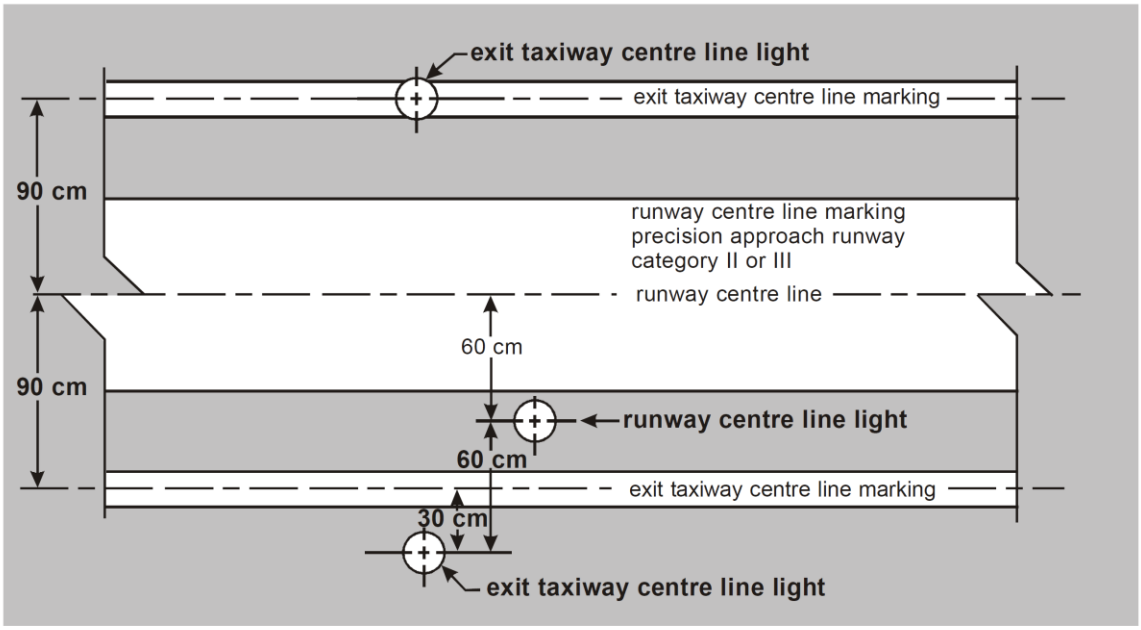
5.3.17.18 **Recommendation -** Taxiway centre line lights on exit taxiways other than rapid exit taxiways should commence at the point where the taxiway centre line marking begins to curve from the runway centre line, and follow the curved taxiway centre line marking at least to the point where the marking leaves the runway. The first light should be at least 60 cm from any row of runway centre line lights, as shown in Figure 5-27.

5.3.17.19 **Recommendation -** The lights should be spaced at longitudinal intervals of not more than 7.5 m.

Taxiway centre line lights on runways

Location

5.3.17.20 **Recommendation -** Taxiway centre line lights on a runway forming part of a standard taxi-route and intended for taxiing in runway visual range conditions less than a value of 300 m should be spaced at longitudinal intervals not exceeding 15 m.



Tolerances for offset runway centre line lights and taxiway centre line lights to maintain 60 cm separation.

Figure 5-27. Offset Runway and Taxiway Centre Line Lights

5.3.18 Taxiway edge lights

Application

5.3.18.1 Taxiway edge lights shall be provided at the edges of a runway turn pad, holding bay, apron, etc., intended for use at night and on a taxiway not provided with taxiway centre line lights and intended for use at night, except that taxiway edge lights need not be provided where, considering the nature of the operations, adequate guidance can be achieved by surface illumination or other means.

5.3.18.2 Taxiway edge lights shall be provided on a runway forming part of a standard taxi-route and intended for taxiing at night where the runway is not provided with taxiway centre line lights.

Location

5.3.18.3 **Recommendation -** Taxiway edge lights on a straight section of a taxiway and on a runway forming part of a standard taxi-route should be spaced at uniform longitudinal intervals of not more than 60 m. The lights on a curve should be spaced at intervals less than 60 m so that a clear indication of the curve is provided.

Note.— Guidance on the spacing of taxiway edge lights on curves is given in the ICAO Aerodrome Design Manual (Doc 9157), Part 4.

5.3.18.4 **Recommendation -** Taxiway edge lights on a holding bay, apron, etc., should be spaced at uniform longitudinal intervals of not more than 60 m.

5.3.18.5 **Recommendation -** Taxiway edge lights on a runway turn pad should be spaced at uniform longitudinal intervals of not more than 30 m.

5.3.18.6 **Recommendation -** The lights should be located as near as practicable to the edges of the taxiway, runway turn pad, holding bay, apron or runway, etc., or outside the edges at a distance of not more than 3 m.

Characteristics

5.3.18.7 Taxiway edge lights shall be fixed lights showing blue. The lights shall show up to at least 75° above the horizontal and at all angles in azimuth necessary to provide guidance to a pilot taxiing in either direction. At an intersection, exit or curve the lights shall be shielded as far as practicable so that they cannot be seen in angles of azimuth in which they may be confused with other lights.

5.3.18.8 The intensity of taxiway edge lights shall be at least 2 cd from 0° to 6° vertical, and 0.2 cd at any vertical angles between 6° and 75°.

5.3.19 Runway turn pad lights

Application

5.3.19.1 Runway turn pad lights shall be provided for continuous guidance on a runway turn pad intended for use in runway visual range conditions less than a value of 300 m, to enable an aeroplane to complete a 180-degree turn and align with the runway centre line.

5.3.19.2 **Recommendation -** Runway turn pad lights should be provided on a runway turn pad intended for use at night.

Location

5.3.19.3 **Recommendation -** Runway turn pad lights should normally be located on the runway turn pad marking, except that they may be offset by not more than 30 cm where it is not practicable to locate them on the marking.

5.3.19.4 **Recommendation -** Runway turn pad lights on a straight section of the runway turn pad marking should be spaced at longitudinal intervals of not more than 15 m.

5.3.19.5 **Recommendation -** Runway turn pad lights on a curved section of the runway turn pad marking should not exceed a spacing of 7.5 m.

Characteristics

5.3.19.6 Runway turn pad lights shall be unidirectional fixed lights showing green with beam dimensions such that the light is visible only from aeroplanes on or approaching the runway turn pad.

5.3.19.7 Runway turn pad lights shall be in accordance with the specifications of Appendix 2, Figure A2-13, A2-14 or A2-15 of ICAO Annex 14, as appropriate.

5.3.20 Stop bars

Application

Note 1.— A stop bar is intended to be controlled either manually or automatically by air traffic services.

Note 2.— Runway incursions may take place in all visibility or weather conditions. The provision of stop bars at runway-holding positions and their use at night and in visibility

conditions greater than 550 m runway visual range can form part of effective runway incursion prevention measures.

5.3.20.1 A stop bar shall be provided at every runway-holding position serving a runway when it is intended that the runway will be used in runway visual range conditions less than a value of 550 m, except where:

(a) appropriate aids and procedures are available to assist in preventing inadvertent incursions of traffic onto the runway; or

(b) operational procedures exist to limit, in runway visual range conditions less than a value of 550 m, the number of:

(1) aircraft on the manoeuvring area to one at a time; and

(2) vehicles on the manoeuvring area to the essential minimum.

5.3.20.2 Where there is more than one stop bar associated with a taxiway/runway intersection, only one shall be illuminated at any given time.

5.3.20.3 **Recommendation -** A stop bar should be provided at an intermediate holding position when it is desired to supplement markings with lights and to provide traffic control by visual means.

Location

5.3.20.4 Stop bars shall be located across the taxiway at the point where it is desired that traffic stop. Where the additional lights specified in 5.3.20.7 are provided, these lights shall be located not less than 3 m from the taxiway edge.

Characteristics

5.3.20.5 Stop bars shall consist of lights spaced at uniform intervals of no more than 3 m across the taxiway, showing red in the intended direction(s) of approach to the intersection or runway-holding position.

5.3.20.6 **Recommendation -** A pair of elevated lights should be added to each end of the stop bar where the in-pavement stop bar lights might be obscured from a pilot's view, for example, by rain, or where a pilot may be required to stop the aircraft in a position so close to the lights that they are blocked from view by the structure of the aircraft.

5.3.20.7 Stop bars installed at a runway-holding position shall be unidirectional and shall show red in the direction of approach to the runway.

5.3.20.8 Where the additional lights specified in 5.3.20.7 are provided, these lights shall have the same characteristics as the lights in the stop bar, but shall be visible to approaching aircraft up to the stop bar position.

5.3.20.9 The intensity in red light and beam spreads of stop bar lights shall be in accordance with the specifications in Appendix 2, Figures A2-12 through A2-16 of ICAO Annex 14, as appropriate.

5.3.20.10 **Recommendation -** Where stop bars are specified as components of an advanced surface movement guidance and control system and where, from an operational point of view, higher intensities are required to maintain ground movements at a certain speed in very low visibilities or in bright daytime conditions, the intensity in red light and beam spreads of stop bar lights should be in accordance with the specifications of Appendix 2, Figure A2-17, A2-18 or A2-19 of ICAO Annex 14.

5.3.20.11 **Recommendation -** Where a wide beam fixture is required, the intensity in red light and beam spreads of stop bar lights should be in accordance with the specifications of Appendix 2, Figure A2-17 or A2-19 of ICAO Annex 14.

5.3.20.12 The lighting circuit shall be designed so that:

(a) stop bars located across entrance taxiways are selectively switchable;

(b) stop bars located across taxiways intended to be used only as exit taxiways are switchable selectively or in groups;

(c) when a stop bar is illuminated, any taxiway centre line lights installed beyond the stop bar shall be extinguished for a distance of at least 90 m; and

(d) stop bars are interlocked with the taxiway centre line lights so that when the centre line lights beyond the stop bar are illuminated the stop bar is extinguished and vice versa.

5.3.21 Intermediate holding position lights

Application

5.3.21.1 Except where a stop bar has been installed, intermediate holding position lights shall be provided at an intermediate holding position intended for use in runway visual range conditions less than a value of 300 m.

5.3.21.2 **Recommendation -** Intermediate holding position lights should be provided at an intermediate holding position where there is no need for stop-and-go signals as provided by a stop bar.

Location

5.3.21.3 Intermediate holding position lights shall be located along the intermediate holding position marking at a distance of 0.3 m prior to the marking.

Characteristics

5.3.21.4 Intermediate holding position lights shall consist of three fixed unidirectional lights showing yellow in the direction of approach to the intermediate holding position with a light distribution similar to taxiway centre line lights if provided. The lights shall be disposed symmetrically about and at right angle to the taxiway centre line, with individual lights spaced 1.5 m apart.

5.3.22 De-icing/anti-icing facility exit lights

Application

5.3.22.1 Reserved

Location

5.3.22.2 Reserved

Characteristics

5.3.22.3 Reserved

5.3.23 Runway guard lights

Note.— Runway incursions may take place in all visibility or weather conditions. The use of runway guard lights at runway-holding positions can form part of effective runway

incursion prevention measures. Runway guard lights warn pilots and drivers of vehicles when operating on taxiways, that they are about to enter a runway. There are two standard configurations of runway guard lights as illustrated in Figure 5-29.

Application

5.3.23.1 Runway guard lights, Configuration A, shall be provided at each taxiway/runway intersection associated with a runway intended for use in:

(a) runway visual range conditions less than a value of 550 m where a stop bar is not installed; and

(b) runway visual range conditions of values between 550 m and 1 200 m where the traffic density is heavy.

Note 1.— Runway guard lights, Configuration B may supplement Configuration A when deemed necessary.

Note 2.— Guidance on the design, operation and the location of runway guard lights Configuration B is given in the Aerodrome Design Manual (Doc 9157), Part 4.

5.3.23.2 **Recommendation -** As part of runway incursion prevention measures, runway guard lights, Configuration A or B, should be provided at each taxiway/runway intersection where runway incursion hot spots have been identified, and used under all weather conditions during day and night.

5.3.23.3 **Recommendation -** Configuration B runway guard lights should not be collocated with a stop bar.

5.3.23.4 Where more than one runway-holding positions exist at a runway/taxiway intersection, only the set of runway guard lights associated with the operational runway-holding position shall be illuminated.

Location

5.3.23.5 Runway guard lights, Configuration A, shall be located at each side of the taxiway on the holding side of the runway-holding position marking.

5.3.23.6 Runway guard lights, Configuration B, shall be located across the taxiway on the holding side of the runway-holding position marking.

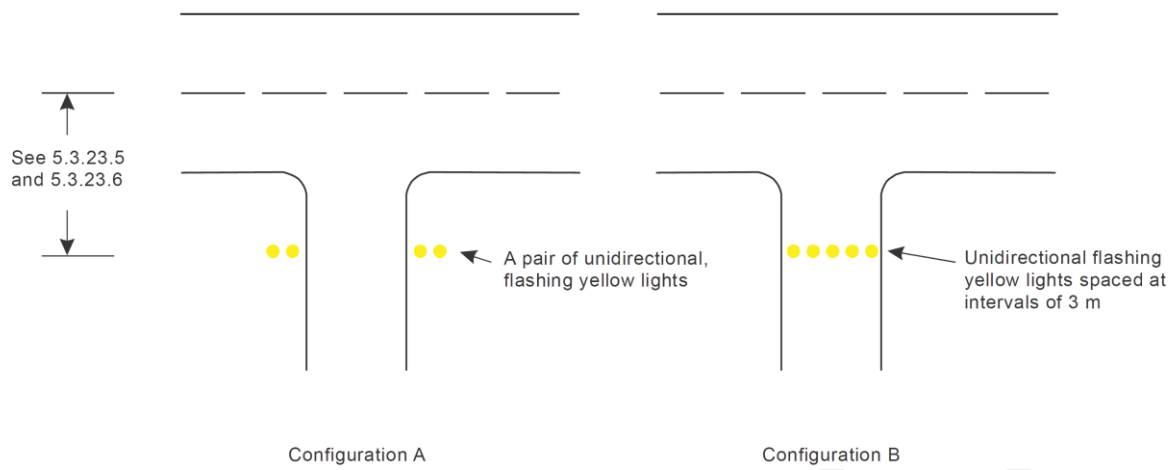


Figure 5-29. Runway guard lights

Characteristics

5.3.23.7 Runway guard lights, Configuration A, shall consist of two pairs of yellow lights.

5.3.23.8 **Recommendation -** Where there is a need to enhance the contrast between the on and off state of runway guard lights, Configuration A, intended for use during the day, a visor of sufficient size to prevent sunlight from entering the lens without interfering with the function of the fixture should be located above each lamp.

5.3.23.9 Runway guard lights, Configuration B, shall consist of yellow lights spaced at intervals of 3 m across the taxiway.

5.3.23.10 The light beam shall be unidirectional and shall show yellow in the direction of approach to the runway-holding position.

Note.— For guidance on orientation and aiming of runway guard lights, see the Aerodrome Design Manual (Doc 9157) Part 4.

5.3.23.11 **Recommendation -** The intensity in yellow light and beam spreads of lights of Configuration A should be in accordance with the specifications in Appendix 2, Figure A2-24 of ICAO Annex 14.

5.3.23.12 **Recommendation -** Where runway guard lights are intended for use during the day, the intensity in yellow light and beam spreads of lights of Configuration A should be in accordance with the specifications in Appendix 2, Figure A2-25 of ICAO Annex 14.

5.3.23.13 **Recommendation -** Where runway guard lights are specified as components of an advanced surface movement guidance and control system where higher light intensities are required, the intensity in yellow light and beam spreads of lights of Configuration A should be in accordance with the specifications in Appendix 2, Figure A2-25 of ICAO Annex 14.

5.3.23.14 **Recommendation -** The intensity in yellow light and beam spreads of lights of Configuration B should be in accordance with the specifications in Appendix 2, Figure A2-12 of ICAO Annex 14.

5.3.23.15 **Recommendation -** Where runway guard lights are intended for use during the day, the intensity in yellow light and beam spreads of lights of Configuration

B should be in accordance with the specifications in Appendix 2, Figure A2-20 of ICAO Annex 14.

5.3.23.16 **Recommendation -** Where runway guard lights are specified as components of an advanced surface movement guidance and control system where higher light intensities are required, the intensity in yellow light and beam spreads of lights of Configuration B should be in accordance with the specifications in Appendix 2, Figure A2-20 of ICAO Annex 14.

5.3.23.17 The lights in each unit of Configuration A shall be illuminated alternately.

5.3.23.18 For Configuration B, adjacent lights shall be alternately illuminated and alternative lights shall be illuminated in unison.

5.3.23.19 The lights shall be illuminated between 30 and 60 cycles per minute and the light suppression and illumination periods shall be equal and opposite in each light.

5.3.24 **Apron floodlighting** (see also 5.3.17.1 and 5.3.18.1)

Application

5.3.24.1 **Recommendation -** Apron floodlighting should be provided on an apron and on a designated isolated aircraft parking position intended to be used at night.

Location

5.3.24.2 **Recommendation -** Apron floodlights should be located so as to provide adequate illumination on all apron service areas, with a minimum of glare to pilots of aircraft in flight and on the ground, aerodrome and apron controllers, and personnel on the apron. The arrangement and aiming of floodlights should be such that an aircraft stand receives light from two or more directions to minimize shadows.

Characteristics

5.3.24.3 The spectral distribution of apron floodlights shall be such that the colours used for aircraft marking connected with routine servicing, and for surface and obstacle marking, can be correctly identified.

5.3.24.4 **Recommendation -** The average illuminance should be at least the following:

Aircraft stand:

- horizontal illuminance — 20 lux with a uniformity ratio (average to minimum) of not more than 4 to 1; and
- vertical illuminance — 20 lux at a height of 2 m above the apron in relevant directions.

Other apron areas:

- horizontal illuminance — 50 per cent of the average illuminance on the aircraft stands with a uniformity ratio (average to minimum) of not more than 4 to 1.

5.3.25 Visual docking guidance system

Application

5.3.25.1 A visual docking guidance system shall be provided when it is intended to indicate, by a visual aid, the precise positioning of an aircraft on an aircraft stand and other alternative means, such as marshallers, are not practicable.

Characteristics

5.3.25.2 The system shall provide both azimuth and stopping guidance.

5.3.25.3 The azimuth guidance unit and the stopping position indicator shall be adequate for use in all weather, visibility, background lighting and pavement conditions for which the system is intended, both by day and night, but shall not dazzle the pilot.

5.3.25.4 The azimuth guidance unit and the stopping position indicator shall be of a design such that:

(a) a clear indication of malfunction of either or both is available to the pilot; and

(b) they can be turned off.

5.3.25.5 The azimuth guidance unit and the stopping position indicator shall be located in such a way that there is continuity of guidance between the aircraft stand markings, the aircraft stand manoeuvring guidance lights, if present, and the visual docking guidance system.

5.3.25.6 The accuracy of the system shall be adequate for the type of passenger bridge and fixed aircraft servicing installations with which it is to be used.

5.3.25.7 **Recommendation -** The system should be usable by all types of aircraft for which the aircraft stand is intended, preferably without selective operation.

5.3.25.8 If selective operation is required to prepare the system for use by a particular type of aircraft, then the system shall provide an identification of the selected aircraft type to both the pilot and the system operator as a means of ensuring that the system has been set properly.

Azimuth guidance unit

Location

5.3.25.9 The azimuth guidance unit shall be located on or close to the extension of the stand centre line ahead of the aircraft so that its signals are visible from the cockpit of an aircraft throughout the docking manoeuvre and aligned for use at least by the pilot occupying the left seat.

5.3.25.10 **Recommendation -** The azimuth guidance unit should be aligned for use by the pilots occupying both the left and right seats.

Characteristics

5.3.25.11 The azimuth guidance unit shall provide unambiguous left/right guidance which enables the pilot to acquire and maintain the lead-in line without over-controlling.

5.3.25.12 When azimuth guidance is indicated by colour change, green shall be used to identify the centre line and red for deviations from the centre line.

Stopping position indicator

Location

5.3.25.13 The stopping position indicator shall be located in conjunction with, or sufficiently close to, the azimuth guidance unit so that a pilot can observe both the azimuth and stop signals without turning the head.

5.3.25.14 The stopping position indicator shall be usable at least by the pilot occupying the left seat.

5.3.25.15 **Recommendation -** The stopping position indicator should be usable by the pilots occupying both the left and right seats.

Characteristics

5.3.25.16 The stopping position information provided by the indicator for a particular aircraft type shall account for the anticipated range of variations in pilot eye height and/or viewing angle.

5.3.25.17 The stopping position indicator shall show the stopping position for the aircraft for which guidance is being provided and shall provide closing rate information to enable the pilot to gradually decelerate the aircraft to a full stop at the intended stopping position.

5.3.25.18 **Recommendation -** The stopping position indicator should provide closing rate information over a distance of at least 10 m.

5.3.25.19 When stopping guidance is indicated by colour change, green shall be used to show that the aircraft can proceed and red to show that the stop point has been reached ,except that for a short distance prior to the stop point a third colour may be used to warn that the stopping point is close.

5.3.26 Advanced visual docking guidance system

Application

5.3.26.1 **Recommendation -** An A-VDGS should be provided where it is operationally desirable to confirm the correct aircraft type for which guidance is being provided and/or to indicate the stand centre line in use, where more than one is provided for.

5.3.26.2 The A-VDGS shall be suitable for use by all types of aircraft for which the aircraft stand is intended.

5.3.26.3 The A-VDGS shall be used only in conditions in which its operational performance is specified.

5.3.26.4 The docking guidance information provided by an A-VDGS shall not conflict with that provided by a conventional visual docking guidance system on an aircraft stand if both types are provided and are in operational use. A method of indicating that the A-VDGS is not in operational use or is unserviceable shall be provided.

Location

5.3.26.5 The A-VDGS shall be located such that unobstructed and unambiguous guidance is provided to the person responsible for, and persons assisting, the docking of the aircraft throughout the docking manoeuvre.

Characteristics

5.3.26.6 The A-VDGS shall provide, at minimum, the following guidance information at the appropriate stage of the docking manoeuvre:

(a) an emergency stop indication;

(b) the aircraft type and model for which the guidance is provided;

(c) an indication of the lateral displacement of the aircraft relative to the stand centre line;

(d) the direction of azimuth correction needed to correct a displacement from the stand centre line;

(e) an indication of the distance to the stop position;

(f) an indication when the aircraft has reached the correct stopping position; and

(g) a warning indication if the aircraft goes beyond the appropriate stop position.

5.3.26.7 The A-VDGS shall be capable of providing docking guidance information for all aircraft taxi speeds encountered during the docking manoeuvre.

5.3.26.8 The time taken from the determination of the lateral displacement to its display shall not result in a deviation of the aircraft, when operated in normal conditions, from the stand centre line greater than 1 m.

5.3.26.9 **Recommendation -** The information on displacement of the aircraft relative to the stand centre line and distance to the stopping position, when displayed, should be provided with the accuracy specified in Table 5-4.

5.3.26.10 Symbols and graphics used to depict guidance information shall be intuitively representative of the type of information provided.

5.3.26.11 Information on the lateral displacement of the aircraft relative to the stand centre line shall be provided at least 25 m prior to the stop position.

5.3.26.12 Continuous closure distance and closure rate shall be provided from at least 15 m prior to the stop position.

5.3.26.13 **Recommendation -** Where provided, closure distance displayed in numerals should be provided in metre integers to the stop position and displayed to 1 decimal place at least 3 m prior to the stop position.

Table 5-4. A-VDGS recommended displacement accuracy

Guidance information	Maximum deviation at stop position (stop area)	Maximum deviation at 9 m from stop position	Maximum deviation at 15 m from stop position	Maximum deviation at 25 m from stop position
Azimuth	±250 mm	±340 mm	±400 mm	±500 mm
Distance	±500 mm	±1 000 mm	±1 300 mm	Not specified

5.3.26.14 Throughout the docking manoeuvre, an appropriate means shall be provided on the A-VDGS to indicate the need to bring the aircraft to an immediate halt. In such an event, which includes a failure of the A-VDGS, no other information shall be displayed.

5.3.26.15 Provision to initiate an immediate halt to the docking procedure shall be made available to personnel responsible for the operational safety of the stand.

5.3.26.16 **Recommendation -** The word “stop” in red characters should be displayed when an immediate cessation of the docking manoeuvre is required.

5.3.27 Aircraft stand manoeuvring guidance lights

Application

5.3.27.1 **Recommendation -** Aircraft stand manoeuvring guidance lights should be provided to facilitate the positioning of an aircraft on an aircraft stand on a paved apron intended for use in poor visibility conditions, unless adequate guidance is provided by other means.

Location

5.3.27.2 Aircraft stand manoeuvring guidance lights shall be collocated with the aircraft stand markings.

Characteristics

5.3.27.3 Aircraft stand manoeuvring guidance lights, other than those indicating a stop position, shall be fixed yellow lights, visible throughout the segments within which they are intended to provide guidance.

5.3.27.4 **Recommendation -** The lights used to delineate lead-in, turning and lead-out lines should be spaced at intervals of not more than 7.5 m on curves and 15 m on straight sections.

5.3.27.5 The lights indicating a stop position shall be fixed unidirectional lights showing red.

5.3.27.6 **Recommendation -** The intensity of the lights should be adequate for the condition of visibility and ambient light in which the use of the aircraft stand is intended.

5.3.27.7 **Recommendation -** The lighting circuit should be designed so that the lights may be switched on to indicate that an aircraft stand is to be used and switched off to indicate that it is not to be used.

5.3.28 Road-holding position light

Application

5.3.28.1 A road-holding position light shall be provided at each road-holding position serving a runway when it is intended that the runway will be used in runway visual range conditions less than a value of 300 m.

5.3.28.2 **Recommendation -** A road-holding position light should be provided at each road-holding position serving a runway when it is intended that the runway will be used in runway visual range conditions of values between 300 m and 550 m.

Location

5.3.28.3 A road-holding position light shall be located adjacent to the holding position marking 1.5 m (±0.5 m) from one edge of the road, i.e. left or right as appropriate to the local traffic requirements.

Characteristics

5.3.28.4 The road-holding position light shall comprise:

(a) a controllable red (stop)/green (go) traffic light; or

(b) a flashing-red light.

5.3.28.5 The road-holding position light beam shall be unidirectional and aligned so as to be visible to the driver of a vehicle approaching the holding position.

5.3.28.6 The intensity of the light beam shall be adequate for the conditions of visibility and ambient light in which the use of the holding position is intended, but shall not dazzle the driver.

5.3.28.7 The flash frequency of the flashing-red light shall be between 30 and 60 flashes per minute.

5.3.29 No-entry bar

Note.— Runway incursions may take place in all visibility or weather conditions. The use of no-entry bars can form part of effective runway incursion prevention measures.

Application

5.3.29.1 **Recommendation -** A no-entry bar should be provided across a taxiway which is intended to be used as an exit only taxiway to assist in preventing inadvertent access of traffic to that taxiway.

Location

5.3.29.2 **Recommendation -** A no-entry bar should be located across the taxiway at the end of an exit only taxiway where it is desired to prevent traffic from entering the taxiway in the wrong direction.

5.3.29.3 **Recommendation -** A no-entry bar should be co-located with a no-entry sign and/or a no-entry marking.

Characteristics

5.3.29.4 **Recommendation -** A no-entry bar should consist of unidirectional lights spaced at uniform intervals of no more than 3 m showing red in the intended direction(s) of approach to the runway.

5.3.29.5 **Recommendation -** A pair of elevated lights should be added to each end of the no-entry bar where the in- pavement no entry bar lights might be obscured from a pilot's view, for example, by rain, or where a pilot may be required to stop the aircraft in a position so close to the lights that they are blocked from view by the structure of the aircraft.

5.3.29.6 The intensity in red light and beam spreads of no-entry bar lights shall be in accordance with the specifications in Appendix 2, Figures A2-12 through A2-16 of ICAO Annex 14, as appropriate.

5.3.29.7 **Recommendation -** Where no-entry bars are specified as components of an advanced surface movement guidance and control system and where, from an operational point of view, higher intensities are required to maintain ground movements at a certain speed in very low visibilities or in bright daytime conditions, the intensity in red light and beam spreads of no-entry bar lights should be in accordance with the specifications of Appendix 2, Figure A2-17, A2-18 or A2-19 of ICAO Annex 14.

5.3.29.8 **Recommendation -** Where a wide beam fixture is required, the intensity in red light and beam spreads of no-entry bar lights should be in accordance with the specifications of Appendix 2, Figure A2-17 or A2-19 of ICAO Annex 14.

5.3.29.9 Taxiway centre line lights installed beyond the no-entry bar, looking in the direction of the runway, shall not be visible when viewed from the taxiway.

5.3.30 Runway status lights

Introductory Note.— Runway status lights (RWSL) is a type of autonomous runway incursion warning system (ARIWS).The two basic visual components of RWSL are runway entrance lights (RELs) and take-off hold lights (THLs). Either component may be installed by itself, but the two components are designed to be complementary to each other.

Location

5.3.30.1 Where provided, RELs shall be offset 0.6 m from the taxiway centre line on the opposite side to the taxiway centre line lights and begin 0.6 m before the runway-holding position extending to the edge of the runway. An additional single light shall be placed on the runway 0.6 m from the runway centre line and aligned with the last two taxiway RELs.

Note.— Where two or more runway-holding positions are provided, the runway-holding position referred is that closest to the runway.

5.3.30.2 RELs shall consist of at least five light units and shall be spaced at a minimum of 3.8 m and a maximum of 15.2 m longitudinally, depending upon the taxiway length involved, except for a single light installed near the runway centre line.

5.3.30.3 Where provided, THLs shall be offset 1.8 m on each side of the runway centre line lights and extend, in pairs, starting at a point 115 m from the beginning of the runway and, thereafter, every 30 m for at least 450 m.

Note.— Additional THLs may be similarly provided at the starting point of the take-off roll.

Characteristics

5.3.30.4 Where provided, RELs shall consist of a single line of fixed in pavement lights showing red in the direction of aircraft approaching the runway.

5.3.30.5 RELs shall illuminate as an array at each taxiway/runway intersection where they are installed less than two seconds after the system determines a warning is needed.

5.3.30.6 Intensity and beam spread of RELs shall be in accordance with the specifications of Appendix 2, Figures A2-12 and A2-14 of Annex 14 Volume I

Note.— Consideration for reduced beam width may be required for some REL lights at acute angled runway/taxiway intersections to ensure the RELs are not visible to aircraft on the runway.

5.3.30.7 Where provided, THLs shall consist of two rows of fixed in pavement lights showing red facing the aircraft taking off.

5.3.30.8 THLs shall illuminate as an array on the runway less than two seconds after the system determines a warning is needed.

5.3.30.9 Intensity and beam spread of THLs shall be in accordance with the specifications of Appendix 2, Figure A2-26 of ICAO Annex 14 Vol.I.

5.3.30.10 **Recommendation -** RELs and THLs should be automated to the extent that the only control over each system will be to disable one or both systems.

5.4 Signs

5.4.1 General Application

5.4.1.1 Signs shall be provided to convey a mandatory instruction, information on a specific location or destination on a movement area or to provide other information to meet the requirements of 9.8.1.

5.4.1.2 **Recommendation -** A variable message sign should be provided where:

(a) the instruction or information displayed on the sign is relevant only during a certain period of time; and/or

(b) there is a need for variable predetermined information to be displayed on the sign to meet the requirements of 9.8.1.

Characteristics

5.4.1.3 Signs shall be frangible. Those located near a runway or taxiway shall be sufficiently low to preserve clearance for propellers and the engine pods of jet aircraft. The installed height of the sign shall not exceed the dimension shown in the appropriate column of Table 5-5, except for runway distance remaining signs (see 5.4.8)

5.4.1.4 Mandatory instruction signs and information signs shall be rectangular, as shown in Figures 5-30 and 5-31 with the longer side horizontal.

5.4.1.5 The only signs on the movement area utilizing red shall be mandatory instruction signs.

5.4.1.6 The inscriptions on a sign shall be in accordance with the provisions of Appendix 4 of ICAO Annex 14 Volume I.

Table 5-5. Location distances for taxiing guidance signs including runway exit signs

Sign height (mm)				Perpendicular distance from defined taxiway pavement edge to near side of sign	Perpendicular distance from defined runway pavement edge to near side of sign
Code number	Legend	Face (min.)	Installed (max.)		
1 or 2	200	300	700	5–11 m	3–10 m
1 or 2	300	450	900	5–11 m	3–10 m
3 or 4	300	450	900	11–21 m	8–15 m
3 or 4	400	600	1 100	11–21 m	8–15 m

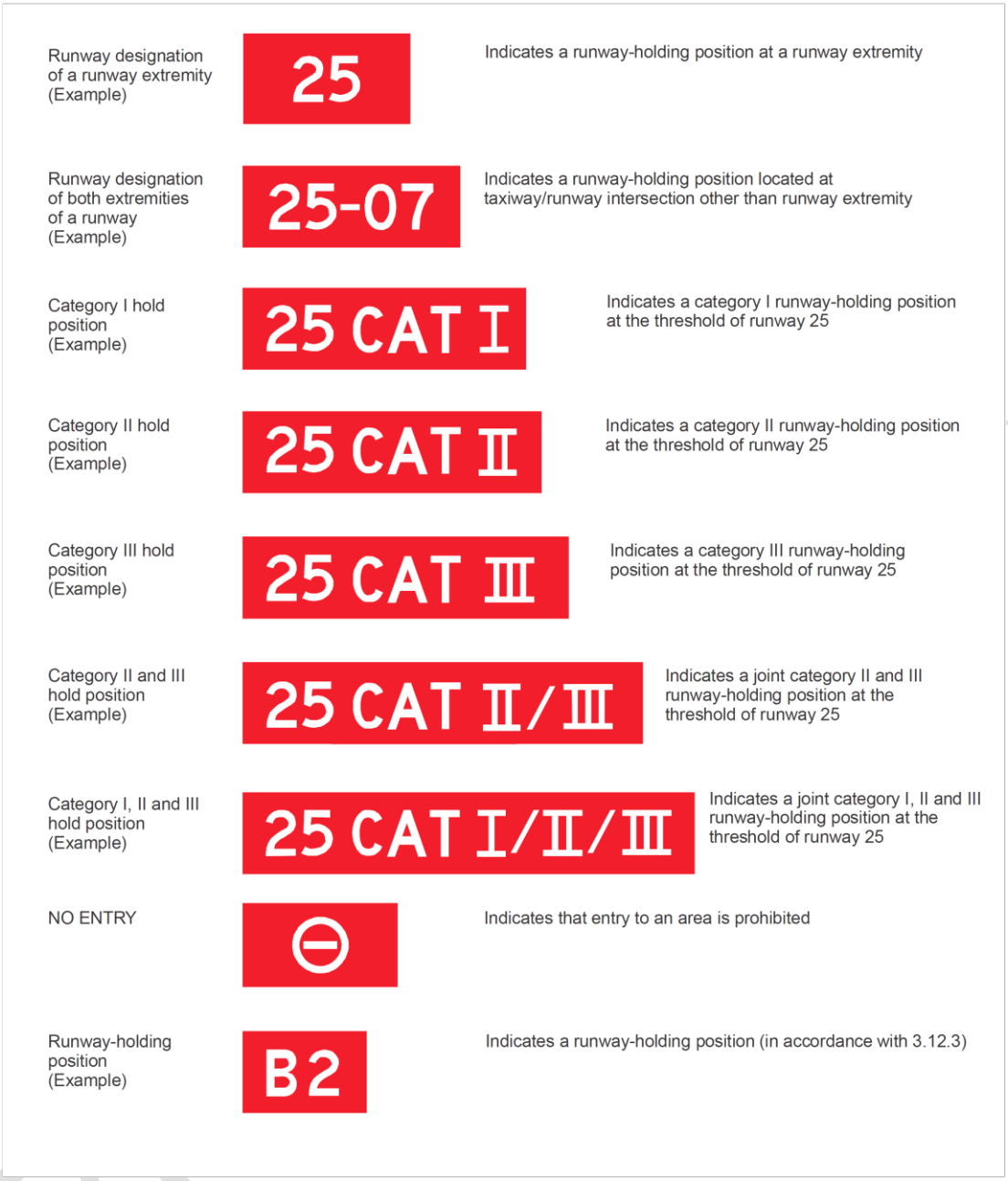


Figure 5-30. Mandatory instruction signs

5.4.1.7 Signs shall be illuminated in accordance with the provisions of Appendix 4 of Annex 14 Volume I when intended for use:

(a) in runway visual range conditions less than a value of 800 m; or

(b) at night in association with instrument runways; or

(c) at night in association with non-instrument runways where the code number is 3 or 4.

5.4.1.8 Signs shall be retroreflective and/or illuminated in accordance with the provisions of Appendix 4 of ICAO Annex 14 Volume I when intended for use at night in association with non-instrument runways where the code number is 1 or 2.

5.4.1.9 A variable message sign shall show a blank face when not in use.

5.4.1.10 In case of failure, a variable message sign shall not provide information that could lead to unsafe action from a pilot or a vehicle driver.

5.4.1.11 **Recommendation -** The time interval to change from one message to another on a variable message sign should be as short as practicable and should not exceed 5 seconds.

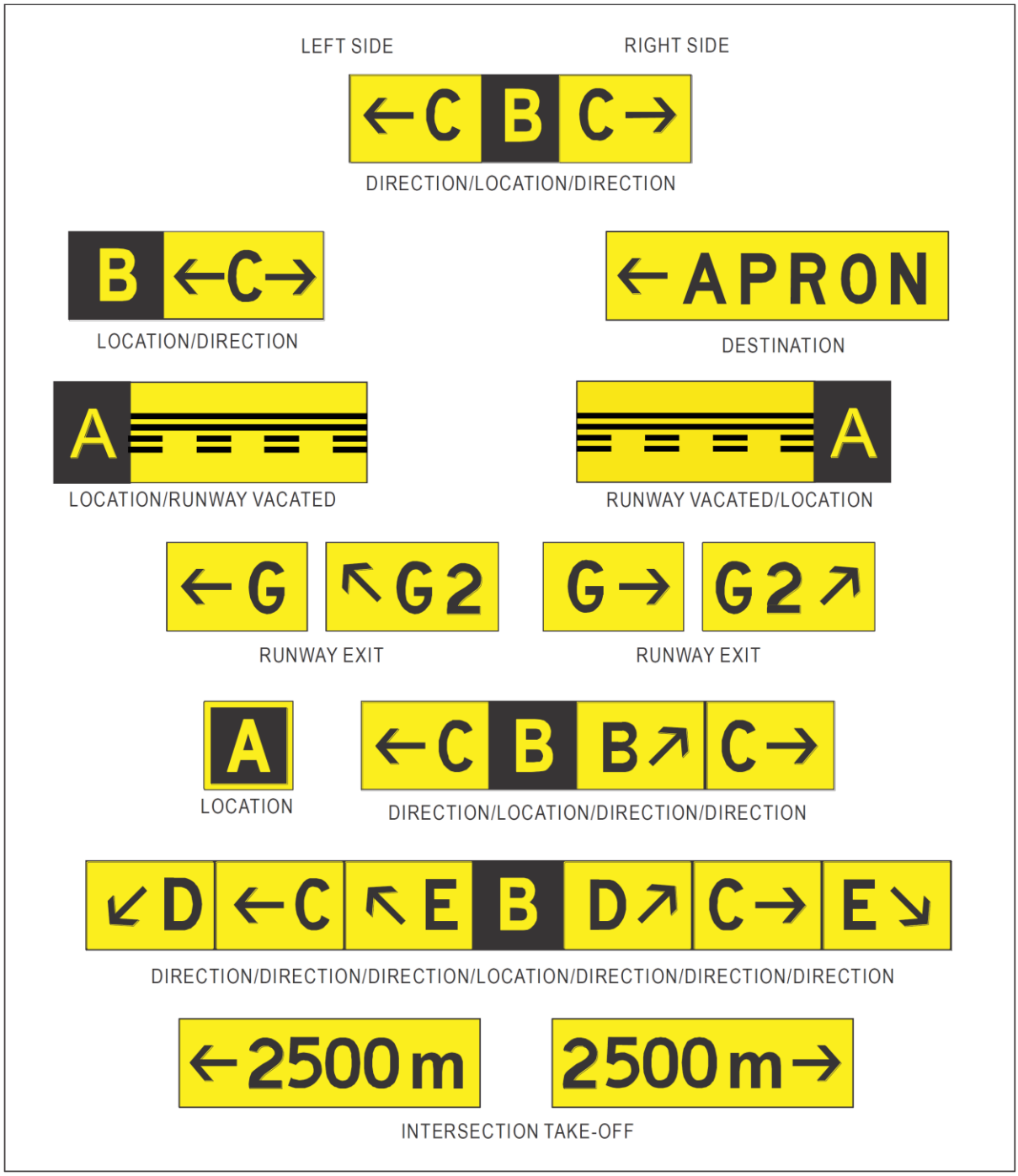


Figure 5-31. Information signs

5.4.2 Mandatory instruction signs

Note.— See Figure 5-30 for pictorial representation of mandatory instruction signs and Figure 5-32 for examples of locating signs at taxiway/runway intersections.

Application

5.4.2.1 A mandatory instruction sign shall be provided to identify a location beyond which an aircraft taxiing or vehicle shall not proceed unless authorized by the aerodrome control tower.

5.4.2.2 Mandatory instruction signs shall include runway designation signs, category I, II or III holding position signs, runway-holding position signs, road-holding position signs and NO ENTRY signs.

5.4.2.3 A pattern “A” runway-holding position marking shall be supplemented at a taxiway/runway intersection or a runway/runway intersection with a runway designation sign.

5.4.2.4 A pattern “B” runway-holding position marking shall be supplemented with a category I, II or III holding position sign.

5.4.2.5 A pattern “A” runway-holding position marking at a runway-holding position established in accordance with 3.12.3 shall be supplemented with a runway-holding position sign.

5.4.2.6 **Recommendation -** A runway designation sign at a taxiway/runway intersection should be supplemented with a location sign in the outboard (farthest from the taxiway) position, as appropriate.

5.4.2.7 A NO ENTRY sign shall be provided when entry into an area is prohibited.

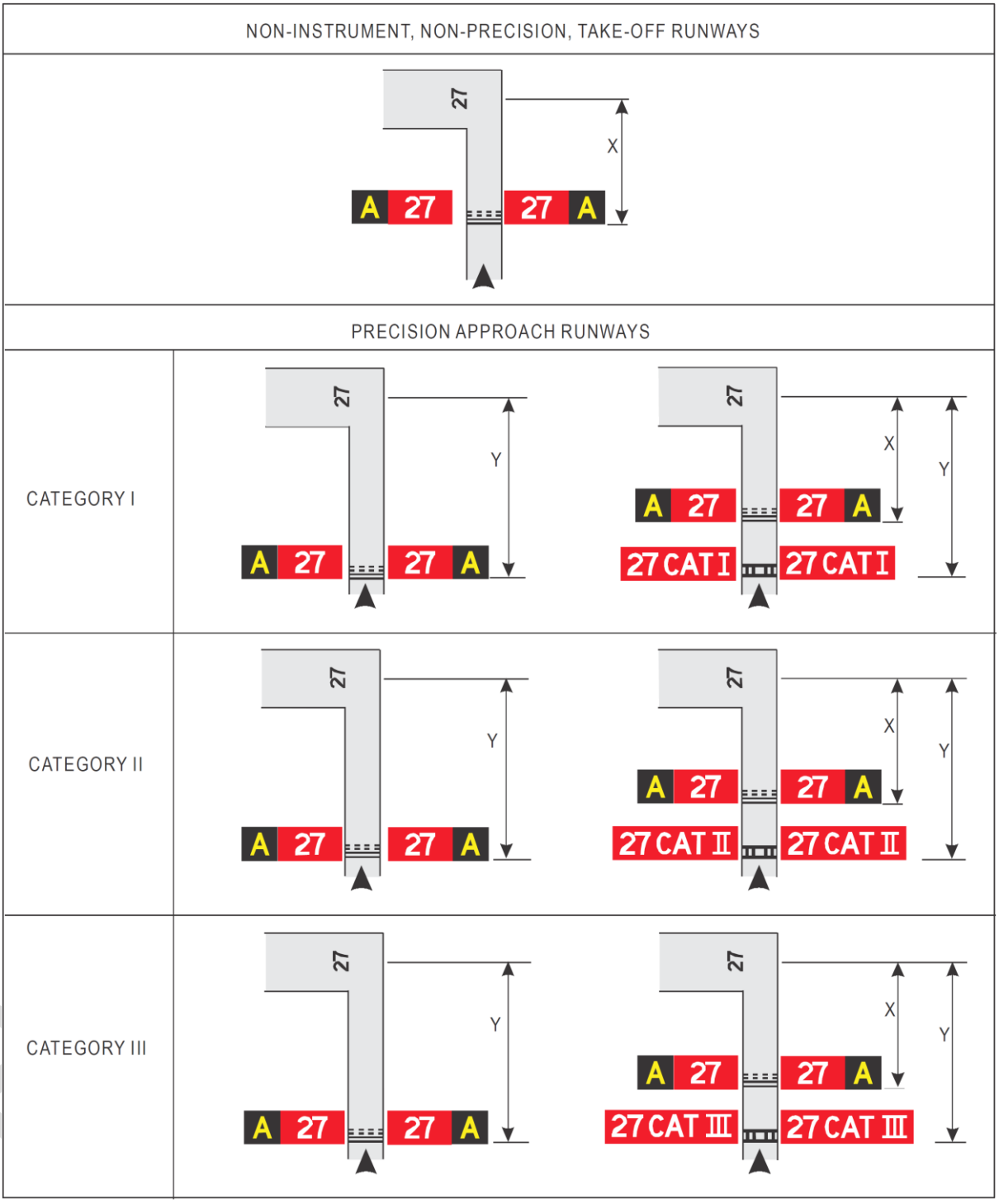
Location

5.4.2.8 A runway designation sign at a taxiway/runway intersection or a runway/runway intersection shall be located on each side of the runway-holding position marking facing the direction of approach to the runway.

5.4.2.9 A category I, II or III holding position sign shall be located on each side of the runway-holding position marking facing the direction of the approach to the critical area.

5.4.2.10 A NO ENTRY sign shall be located at the beginning of the area to which entrance is prohibited on each side of the taxiway as viewed by the pilot.

5.4.2.11 A runway-holding position sign shall be located on each side of the runway-holding position established in accordance with 3.12.3, facing the approach to the obstacle limitation surface or ILS/MLS critical/sensitive area, as appropriate.



Note.— Distance X is established in accordance with Table 3-2. Distance Y is established at the edge of the ILS/MLS critical/sensitive area.

Figure 5-32. Examples of sign position at taxiway/runway intersections

Characteristics

5.4.2.12 A mandatory instruction sign shall consist of an inscription in white on a red background.

5.4.2.13 **Recommendation -** Where, owing to environmental or other factors, the conspicuity of the inscription on a mandatory instruction sign needs to be enhanced, the outside edge of the white inscription should be supplemented by a black outline measuring 10 mm in width for runway code numbers 1 and 2, and 20 mm in width for runway code numbers 3 and 4.

5.4.2.14 The inscription on a runway designation sign shall consist of the runway designations of the intersecting runway properly oriented with respect to the viewing position of the sign, except that a runway designation sign installed in the vicinity of a runway extremity may show the runway designation of the concerned runway extremity only.

5.4.2.15 The inscription on a category I, II, III or joint II/III holding position sign shall consist of the runway designator followed by CAT I, CAT II, CAT III or CAT II/III, as appropriate.

5.4.2.16 The inscription on a NO ENTRY sign shall be in accordance with Figure 5-30.

5.4.2.17 The inscription on a runway-holding position sign at a runway-holding position established in accordance with 3.12.3 shall consist of the taxiway designation and a number.

5.4.2.18 Where installed, the inscriptions/symbol of Figure 5-30 shall be used.

5.4.3 Information signs

Note.— See Figure 5-31 for pictorial representations of information signs.

Application

5.4.3.1 An information sign shall be provided where there is an operational need to identify by a sign, a specific location, or routing (direction or destination) information.

5.4.3.2 Information signs shall include: direction signs, location signs, destination signs, runway exit signs, runway vacated signs and intersection take-off signs.

5.4.3.3 A runway exit sign shall be provided where there is an operational need to identify a runway exit.

5.4.3.4 A runway vacated sign shall be provided where the exit taxiway is not provided with taxiway centre line lights and there is a need to indicate to a pilot leaving a runway the perimeter of the ILS/MLS critical/sensitive area or the lower edge of the inner transitional surface, whichever is farther from the runway centre line.

5.4.3.5 **Recommendation -** An intersection take-off sign should be provided when there is an operational need to indicate the remaining take-off run available (TORA) for intersection take-offs.

5.4.3.6 **Recommendation -** Where necessary, a destination sign should be provided to indicate the direction to a specific destination on the aerodrome, such as cargo area, general aviation, etc.

5.4.3.7 A combined location and direction sign shall be provided when it is intended to indicate routing information prior to a taxiway intersection.

5.4.3.8 A direction sign shall be provided when there is an operational need to identify the designation and direction of taxiways at an intersection.

5.4.3.9 **Recommendation -** A location sign should be provided at an intermediate holding position.

5.4.3.10 A location sign shall be provided in conjunction with a runway designation sign except at a runway/runway intersection.

5.4.3.11 A location sign shall be provided in conjunction with a direction sign, except that it may be omitted where an aeronautical study indicates that it is not needed.

5.4.3.12 **Recommendation -** Where necessary, a location sign should be provided to identify taxiways exiting an apron or taxiways beyond an intersection.

5.4.3.13 **Recommendation -** Where a taxiway ends at an intersection such as a ‘‘T’’ and it is necessary to identify this, a barricade, direction sign and/or other appropriate visual aid should be used.

Location

5.4.3.14 Except as specified in 5.4.3.16 and 5.4.3.24 information signs shall, wherever practicable, be located on the left-hand side of the taxiway in accordance with Table 5-5.

5.4.3.15 At a taxiway intersection, information signs shall be located prior to the intersection and in line with the taxiway intersection marking. Where there is no taxiway intersection marking, the signs shall be installed at least 60 m from the centre line of the intersecting taxiway where the code number is 3 or 4, and at least 40 m where the code number is 1 or 2.

5.4.3.16 A runway exit sign shall be located on the same side of the runway as the exit is located (i.e. left or right) and positioned in accordance with Table 5-5.

5.4.3.17 A runway exit sign shall be located prior to the runway exit point in line with a position at least 60 m prior to the point of tangency where the code number is 3 or 4, and at least 30 m where the code number is 1 or 2.

5.4.3.18 A runway vacated sign shall be located at least on one side of the taxiway. The distance between the sign and the centre line of a runway shall be not less than the greater of the following:

(a) the distance between the centre line of the runway and the perimeter of the ILS/MLS critical/sensitive area; or

(b) the distance between the centre line of the runway and the lower edge of the inner transitional surface.

5.4.3.19 Where provided in conjunction with a runway vacated sign, the taxiway location sign shall be positioned outboard of the runway vacated sign.

5.4.3.20 An intersection take-off sign shall be located at the left-hand side of the entry taxiway. The distance between the sign and the centre line of the runway shall be not less than 60 m where the code number is 3 or 4, and not less than 45 m where the code number is 1 or 2.

5.4.3.21 A taxiway location sign installed in conjunction with a runway designation sign shall be positioned outboard of the runway designation sign.

5.4.3.22 **Recommendation -** A destination sign should not normally be collocated with a location or direction sign.

5.4.3.23 An information sign other than a location sign shall not be collocated with a mandatory instruction sign.

5.4.3.24 **Recommendation -** A direction sign, barricade and/or other appropriate visual aid used to identify a ‘‘T’’ intersection should be located on the opposite side of the intersection facing the taxiway.

Characteristics

5.4.3.25 An information sign other than a location sign shall consist of an inscription in black on a yellow background.

5.4.3.26 A location sign shall consist of an inscription in yellow on a black background and where it is a stand-alone sign shall have a yellow border.

5.4.3.27 The inscription on a runway exit sign shall consist of the designator of the exit taxiway and an arrow indicating the direction to follow.

5.4.3.28 The inscription on a runway vacated sign shall depict the pattern A runway-holding position marking as shown in Figure 5-31.

5.4.3.29 The inscription on an intersection take-off sign shall consist of a numerical message indicating the remaining take-off run available in metres plus an arrow, appropriately located and oriented, indicating the direction of the take-off as shown in Figure 5-31.

5.4.3.30 The inscription on a destination sign shall comprise an alpha, alphanumerical or numerical message identifying the destination plus an arrow indicating the direction to proceed as shown in Figure 5-31.

5.4.3.31 The inscription on a direction sign shall comprise an alpha or alphanumerical message identifying the taxiway(s) plus an arrow or arrows appropriately oriented as shown in Figure 5-31.

5.4.3.32 The inscription on a location sign shall comprise the designation of the location taxiway, runway or other pavement the aircraft is on or is entering and shall not contain arrows.

5.4.3.33 **Recommendation -** Where it is necessary to identify each of a series of intermediate holding positions on the same taxiway, the location sign should consist of the taxiway designation and a number.

5.4.3.34 Where a location sign and direction signs are used in combination:

(a) all direction signs related to left turns shall be placed on the left side of the location sign, and all direction signs related to right turns shall be placed on the right side of the location sign, except that where the junction consists of one intersecting taxiway, the location sign may alternatively be placed on the left-hand side;

(b) the direction signs shall be placed such that the direction of the arrows departs increasingly from the vertical with increasing deviation of the corresponding taxiway;

(c) an appropriate direction sign shall be placed next to the location sign where the direction of the location taxiway changes significantly beyond the intersection; and

(d) adjacent direction signs shall be delineated by a vertical black line as shown in Figure 5-31.

5.4.3.35 A taxiway shall be identified by a designator that is used only once on an aerodrome comprising a single letter, two letters or a combination of a letter or letters followed by a number.

5.4.3.36 **Recommendation -** When designating taxiways, the use of words such as inner and outer should be avoided wherever possible.

5.4.3.37 When designating taxiways, the use of the letters I, O or X shall not be used to avoid confusion with the numerals 1, 0 and closed marking.

5.4.3.38 The use of numbers alone on the manoeuvring area shall be reserved for the designation of runways.

5.4.3.39 **Recommendation -** Apron stand designators should not be the same as taxiway designators.

5.4.4 VOR aerodrome checkpoint sign

Application

5.4.4.1 When a VOR aerodrome checkpoint is established, it shall be indicated by a VOR aerodrome checkpoint marking and sign.

Location

5.4.4.2 A VOR aerodrome checkpoint sign shall be located as near as possible to the checkpoint and so that the inscriptions are visible from the cockpit of an aircraft properly positioned on the VOR aerodrome checkpoint marking.

Characteristics

5.4.4.3 A VOR aerodrome checkpoint sign shall consist of an inscription in black on a yellow background.

5.4.4.4 **Recommendation -** The inscriptions on a VOR checkpoint sign should be in accordance with one of the alternatives shown in Figure 5-33 in which:

VOR	is an abbreviation identifying this as a VOR checkpoint;
116.3	is an example of the radio frequency of the VOR concerned;
147°	is an example of the VOR bearing, to the nearest degree, which shall be indicated at the VOR checkpoint; and
4.3 NM	is an example of the distance in nautical miles to a DME collocated with the VOR concerned.

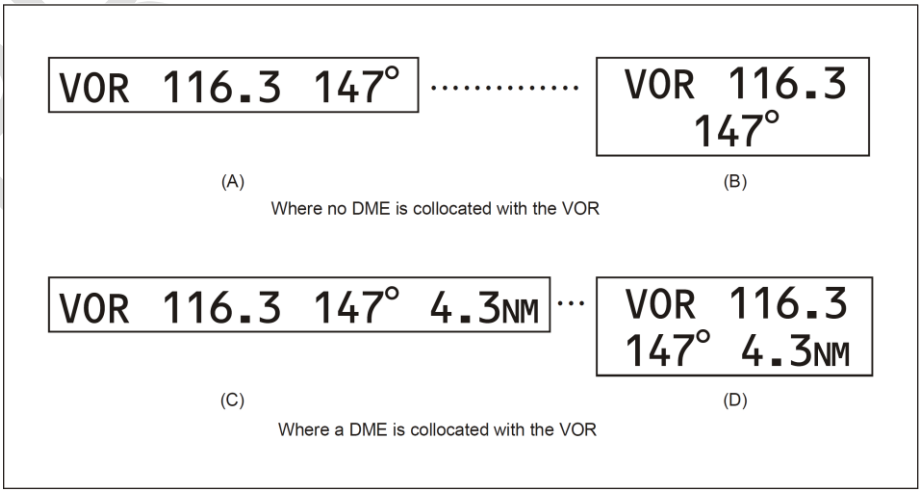


Figure 5-33. VOR aerodrome checkpoint sign

5.4.5 Aerodrome identification sign

Application

5.4.5.1 **Recommendation -** An aerodrome identification sign should be provided at an aerodrome where there is insufficient alternative means of visual identification.

Location

5.4.5.2 **Recommendation -** The aerodrome identification sign should be placed on the aerodrome so as to be legible, in so far as is practicable, at all angles above the horizontal.

Characteristics

5.4.5.3 The aerodrome identification sign shall consist of the name of the aerodrome.

5.4.5.4 **Recommendation -** The colour selected for the sign should give adequate conspicuity when viewed against its background.

5.4.5.5 **Recommendation -** The characters should have a height of not less than 3 m.

5.4.6 Aircraft stand identification signs

Application

5.4.6.1 **Recommendation -** An aircraft stand identification marking should be supplemented with an aircraft stand identification sign where feasible.

Location

5.4.6.2 **Recommendation -** An aircraft stand identification sign should be located so as to be clearly visible from the cockpit of an aircraft prior to entering the aircraft stand.

Characteristics

5.4.6.3 **Recommendation -** An aircraft stand identification sign should consist of an inscription in black on a yellow background.

5.4.7 Road-holding position sign

5.4.7.1 A road-holding position sign shall be provided at all road entrances to a runway.

Location

5.4.7.2 The road-holding position sign shall be located 1.5 m from one edge of the road (left or right as appropriate to the local traffic requirements) at the holding position.

Characteristics

5.4.7.3 A road-holding position sign shall consist of an inscription in white on a red background.

5.4.7.4 The inscription on a road-holding position sign shall be in the national language, be in conformity with the local traffic requirements and include the following:

(a) a requirement to stop; and

(b) where appropriate:

(1) a requirement to obtain ATC clearance; and

(2) location designator.

5.4.7.5 A road-holding position sign intended for night use shall be retroreflective or illuminated.

5.4.8 Runway distance remaining signs

Note 1.— The inclusion of detailed specifications for runway distance remaining signs (RDRS) in this section is not intended to imply that an RDRS has to be provided. Attachment A, Section 23, provides guidance on the need to provide RDRSs. Guidance on installing RDRSs is given in the Aerodrome Design Manual (Doc 9157), Part 4.

Note 2.— Runway excursions may take place in all visibility or weather conditions. The use of RDRS can form part of effective runway excursion prevention measures. The purpose of RDRSs is to provide pilots with distance-to-go information to the extremity of the runway, to enhance situational awareness and enable pilots to decide whether to commence a go-around or to apply braking action for more efficient rollout and runway exit speeds. It is essential that pilots operating at aerodromes with RDRS be familiar with the purpose of these signs.

Note 3.— Provisions related to the identification of hazards and management of safety risks, including the need for safety risk assessment related to runway safety, is available in PANS-Aerodromes (Doc 9981), Chapter 8.

Location

5.4.8.1 Where provided, runway distance remaining signs (RDRS) shall be placed along the full length of the runway at longitudinal spacing of approximately 300 m, parallel and equidistant from the runway centre line.

Note.— Displaced threshold areas that are used for take-off and/or roll-out are treated as part of the runway for purposes of locating the signs.

5.4.8.2 Runway distance remaining signs shall be placed outside the edges of the runway at a distance shown in Table 5-6.

Characteristics

5.4.8.3 Where provided, an RDRS shall consist of an inscription in white on a black background.

5.4.8.4 The installed height of the RDRS shall not exceed the dimension shown in the appropriate column of Table 5-6. All RDRSs on one runway shall be the same size.

Table 5-6. Location distances for taxiing guidance signs including runway exit signs

Sign height (mm)				Perpendicular distance from defined runway pavement edge to near side of sign
Code number	Legend	Face (min.)	Installed (max.)	
1 or 2	640	760	1070	6 – 10.5 m
3 or 4	1000	1200	1520	15 – 22.5 m
3 or 4	1200	1500	1600	25 m or more

5.5 Markers

5.5.1 General

Markers shall be frangible. Those located near a runway or taxiway shall be sufficiently low to preserve clearance for propellers and for the engine pods of jet aircraft.

5.5.2 Unpaved runway edge markers

Application

5.5.2.1 **Recommendation -** Markers should be provided when the extent of an unpaved runway is not clearly indicated by the appearance of its surface compared with that of the surrounding ground.

Location

5.5.2.2 **Recommendation -** Where runway lights are provided, the markers should be incorporated in the light fixtures. Where there are no lights, markers of flat rectangular or conical shape should be placed so as to delimit the runway clearly.

Characteristics

5.5.2.3 **Recommendation -** The flat rectangular markers should have a minimum size of 1 m by 3 m and should be placed with their long dimension parallel to the runway centre line. The conical markers should have a height not exceeding 50 cm.

5.5.3 Stopway edge markers

Application

5.5.3.1 **Recommendation -** Stopway edge markers should be provided when the extent of a stopway is not clearly indicated by its appearance compared with that of the surrounding ground.

Characteristics

5.5.3.2 The stopway edge markers shall be sufficiently different from any runway edge markers used to ensure that the two types of markers cannot be confused.

5.5.4 Edge markers for snow-covered runways

Application

5.5.4.1 Reserved

Location

5.5.4.2 Reserved

Characteristics

5.5.4.3 Reserved

5.5.5 Taxiway edge markers

Application

5.5.5.1 **Recommendation -** Taxiway edge markers should be provided on a taxiway where the code number is 1 or 2 and taxiway centre line or edge lights or taxiway centre line markers are not provided.

Location

5.5.5.2 **Recommendation -** Taxiway edge markers should be installed at least at the same locations as would the taxiway edge lights had they been used.

Characteristics

5.5.5.3 A taxiway edge marker shall be retroreflective blue.

5.5.5.4 **Recommendation -** The marked surface as viewed by the pilot should be a rectangle and should have a minimum viewing area of 150 cm^2.

5.5.5.5 Taxiway edge markers shall be frangible. Their height shall be sufficiently low to preserve clearance for propellers and for the engine pods of jet aircraft.

5.5.6 Taxiway centre line markers

Application

5.5.6.1 **Recommendation -** Taxiway centre line markers should be provided on a taxiway where the code number is 1 or 2 and taxiway centre line or edge lights or taxiway edge markers are not provided.

5.5.6.2 **Recommendation -** Taxiway centre line markers should be provided on a taxiway where the code number is 3 or 4 and taxiway centre line lights are not provided if there is a need to improve the guidance provided by the taxiway centre line marking.

Location

5.5.6.3 **Recommendation -** Taxiway centre line markers should be installed at least at the same location as would taxiway centre line lights had they been used.

Note. – See 5.3.17.12 for the spacing of taxiway centre line lights.

5.5.6.4 **Recommendation -** Taxiway centre line markers should normally be located on the taxiway centre line marking except that they may be offset by not more than 30 cm where it is not practicable to locate them on the marking.

Characteristics

5.5.6.5 A taxiway centre line marker shall be retroreflective green.

5.5.6.6 **Recommendation -** The marked surface as viewed by the pilot should be a rectangle and should have a minimum viewing area of 20 cm^2.

5.5.6.7 Taxiway centre line markers shall be so designed and fitted as to withstand being run over by the wheels of an aircraft without damage either to the aircraft or to the markers themselves.

5.5.7 Unpaved taxiway edge markers

Application

5.5.7.1 **Recommendation -** Where the extent of an unpaved taxiway is not clearly indicated by its appearance compared with that of the surrounding ground, markers should be provided.

Location

5.5.7.2 **Recommendation -** Where taxiway lights are provided, the markers should be incorporated in the light fixtures. Where there are no lights, markers of conical shape should be placed so as to delimit the taxiway clearly.

5.5.8 Boundary markers

Application

5.5.8.1 Boundary markers shall be provided at an aerodrome where the landing area has no runway.

Location

5.5.8.2 Boundary markers shall be spaced along the boundary of the landing area at intervals of not more than 200 m, if the type shown in Figure 5-34 is used, or approximately 90 m, if the conical type is used with a marker at any corner.

Characteristics

5.5.8.3 **Recommendation -** Boundary markers should be of a form similar to that shown in Figure 5-34, or in the form of a cone not less than 50 cm high and not less than 75 cm in diameter at the base. The markers should be coloured to contrast with the background against which they will be seen. A single colour, orange or red, or two contrasting colours, orange and white or alternatively red and white, should be used, except where such colours merge with the background.

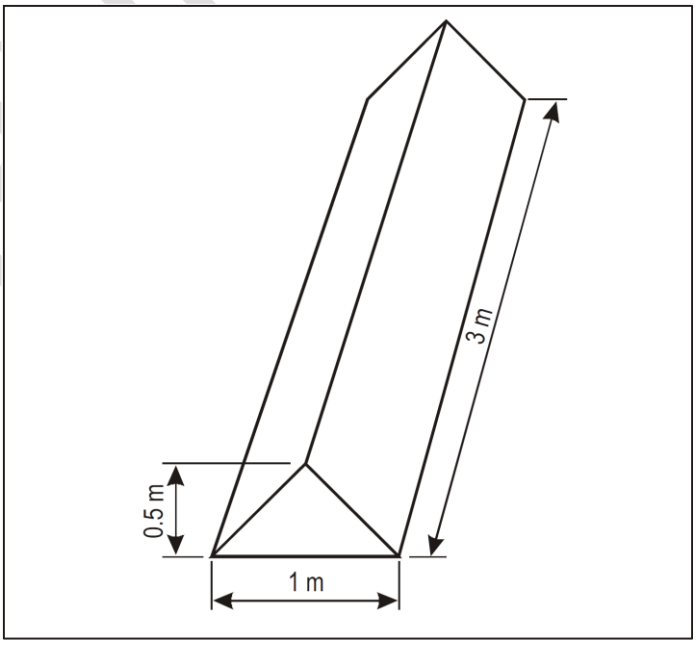


Figure 5-34. Boundary Markers

Chapter 6. Visual Aids For Denoting Obstacles

Note 1.— The marking and/or lighting of obstacles is intended to reduce hazards to aircraft by indicating the presence of the obstacles. It does not necessarily reduce operating limitations which may be imposed by an obstacle.

Note 2.— An autonomous aircraft detection system may be installed on or near an obstacle (or group of obstacles such as wind farms), designed to operate the lighting only when the system detects an aircraft approaching the obstacle, in order to reduce light exposure to local residents. Guidance on the design and installation of an autonomous aircraft detection system is available in the Aerodrome Design Manual (Doc 9157), Part 4. The availability of such guidance is not intended to imply that such a system has to be provided.

6.1 Objects to be marked and/or lighted

6.1.1 Objects within the lateral boundaries of the obstacle limitation surfaces

6.1.1.1 Vehicles and other mobile objects, excluding aircraft, on the movement area of an aerodrome are obstacles and shall be marked and, if the vehicles and aerodrome are used at night or in conditions of low visibility, lighted, except that aircraft servicing equipment and vehicles used only on aprons may be exempt.

6.1.1.2 Elevated aeronautical ground lights within the movement area shall be marked so as to be conspicuous by day. Obstacle lights shall not be installed on elevated ground lights or signs in the movement area.

6.1.1.3 All obstacles within the distance specified in Table 3-1, column 11 or 12, from the centre line of a taxiway, an apron taxiway or aircraft stand taxilane shall be marked and, if the taxiway, apron taxiway or aircraft stand taxilane is used at night, lighted.

6.1.1.4 **Recommendation -** A fixed obstacle that extends above a take-off climb surface within 3 000 m of the inner edge of the take-off climb surface should be marked and, if the runway is used at night, lighted, except that:

(a) such marking and lighting may be omitted when the obstacle is shielded by another fixed obstacle;

(b) the marking may be omitted when the obstacle is lighted by medium-intensity obstacle lights, Type A, by day and its height above the level of the surrounding ground does not exceed 150 m;

(c) the marking may be omitted when the obstacle is lighted by high-intensity obstacle lights by day; and

(d) the lighting may be omitted where the obstacle is a lighthouse and an aeronautical study indicates the lighthouse light to be sufficient.

6.1.1.5 **Recommendation -** A fixed object, other than an obstacle, adjacent to a take-off climb surface should be marked and, if the runway is used at night, lighted, if such marking and lighting is considered necessary to ensure its avoidance, except that the marking may be omitted when:

(a) the object is lighted by medium-intensity obstacle lights, Type A, by day and its height above the level of the surrounding ground does not exceed 150 m; or

(b) the object is lighted by high-intensity obstacle lights by day.

6.1.1.6 A fixed obstacle that extends above an approach surface within 3 000 m of the inner edge or above a transitional surface shall be marked and, if the runway is used at night, lighted, except that:

(a) such marking and lighting may be omitted when the obstacle is shielded by another fixed obstacle;

(b) the marking may be omitted when the obstacle is lighted by medium-intensity obstacle lights, Type A, by day and its height above the level of the surrounding ground does not exceed 150 m;

(c) the marking may be omitted when the obstacle is lighted by high-intensity obstacle lights by day; and

(d) the lighting may be omitted where the obstacle is a lighthouse and an aeronautical study indicates the lighthouse light to be sufficient.

6.1.1.7 **Recommendation -** A fixed obstacle that extends above a horizontal surface should be marked and, if the aerodrome is used at night, lighted, except that:

(a) such marking and lighting may be omitted when:

(1) the obstacle is shielded by another fixed obstacle; or

(2) for a circuit extensively obstructed by immovable objects or terrain, procedures have been established to ensure safe vertical clearance below prescribed flight paths; or

(3) an aeronautical study shows the obstacle not to be of operational significance;

(b) the marking may be omitted when the obstacle is lighted by medium-intensity obstacle lights, Type A, by day and its height above the level of the surrounding ground does not exceed 150 m;

(c) the marking may be omitted when the obstacle is lighted by high-intensity obstacle lights by day; and

(d) the lighting may be omitted where the obstacle is a lighthouse and an aeronautical study indicates the lighthouse light to be sufficient.

6.1.1.8 A fixed object that extends above an obstacle protection surface shall be marked and, if the runway is used at night, lighted.

6.1.1.9 **Recommendation -** Other objects inside the obstacle limitation surfaces should be marked and/or lighted if an aeronautical study indicates that the object could constitute a hazard to aircraft (this includes objects adjacent to visual routes e.g. waterway or highway).

6.1.1.10 **Recommendation -** Overhead wires, cables, etc., crossing a river, waterway, valley or highway should be marked and their supporting towers marked and lighted if an aeronautical study indicates that the wires or cables could constitute a hazard to aircraft.

6.1.2 Objects outside the lateral boundaries of the obstacle limitation surfaces

6.1.2.1 **Recommendation -** Obstacles in accordance with 4.3.2 should be marked and lighted, except that the marking may be omitted when the obstacle is lighted by high-intensity obstacle lights by day.

6.1.2.2 **Recommendation -** Other objects outside the obstacle limitation surfaces should be marked and/or lighted if an aeronautical study indicates that the

object could constitute a hazard to aircraft (this includes objects adjacent to visual routes e.g. waterway, highway).

6.1.2.3 **Recommendation -** Overhead wires, cables, etc., crossing a river, waterway, valley or highway should be marked and their supporting towers marked and lighted if an aeronautical study indicates that the wires or cables could constitute a hazard to aircraft.

6.2 Marking and/or lighting of objects

6.2.1 General

6.2.1.1 The presence of objects which must be lighted, as specified in 6.1, shall be indicated by low-, medium- or high- intensity obstacle lights, or a combination of such lights.

6.2.1.2 Low-intensity obstacle lights, Types A B, C and D, medium-intensity obstacle lights, Types A, B and C, high- intensity obstacle lights Type A and B, shall be in accordance with the specifications in Table 6-1 and Appendix 1 of ICAO Annex 14 Vol I.

6.2.1.3 The number and arrangement of low-, medium- or high-intensity obstacle lights at each level to be marked shall be such that the object is indicated from every angle in azimuth. Where a light is shielded in any direction by another part of the object, or by an adjacent object, additional lights shall be provided on that adjacent object or the part of the object that is shielding the light, in such a way as to retain the general definition of the object to be lighted. If the shielded light does not contribute to the definition of the object to be lighted, it may be omitted.

6.2.2 Mobile objects

Marking

6.2.2.1 All mobile objects to be marked shall be coloured or display flags.

Marking by colour

6.2.2.2 **Recommendation -** When mobile objects are marked by colour, a single conspicuous colour, preferably red or yellowish green for emergency vehicles and yellow for service vehicles, should be used.

Marking by flags

6.2.2.3 Flags used to mark mobile objects shall be displayed around, on top of, or around the highest edge of the object. Flags shall not increase the hazard presented by the object they mark.

6.2.2.4 Flags used to mark mobile objects shall not be less than 0.9 m on each side and shall consist of a chequered pattern, each square having sides of not less than 0.3 m. The colours of the pattern shall contrast each with the other and with the background against which they will be seen. Orange and white or alternatively red and white shall be used, except where such colours merge with the background.

Table 6-1. Characteristics of obstacle lights

1	2	3	4	5	6	7
Light Type	Colour	Signal type/ (flash rate)	Peak intensity (cd) at given Background Luminance (b)			Light Distribution Table
			Day (Above 500 cd/m^2)	Twilight (50-500 cd/m^2)	Night (Below 50 cd/m^2)	
Low-intensity, Type A (fixed obstacle)	Red	Fixed	N/A	N/A	10	Table 6-2
Low-intensity, Type B (fixed obstacle)	Red	Fixed	N/A	N/A	32	Table 6-2
Low-intensity, Type C (mobile obstacle)	Yellow/Blue (a)	Flashing (60-90 fpm)	N/A	40	40	Table 6-2
Low-intensity, Type D (follow-me vehicle)	Yellow	Flashing (60–90 fpm)	N/A	200	200	Table 6-2
Low-intensity, Type E	Red	Flashing (c)	N/A	N/A	32	Table 6-2 (Type B)
Medium-intensity, Type A	White	Flashing (20–60 fpm)	20 000	20 000	2 000	Table 6-3
Medium-intensity, Type B	Red	Flashing (20–60 fpm)	N/A	N/A	2 000	Table 6-3
Medium-intensity, Type C	Red	Fixed	N/A	N/A	2 000	Table 6-3
High-intensity, Type A	White	Flashing (40–60 fpm)	200 000	20 000	2 000	Table 6-3
High-intensity, Type B	White	Flashing (40–60 fpm)	100 000	20 000	2 000	Table 6-3

a) See 6.2.2.6

b) For flashing lights, effective intensity as determined in accordance with the *Aerodrome Design Manual* (Doc 9157), Part 4.

c) For wind turbine application, to flash at the same rate as the lighting on the nacelle.

Table 6-2. Light distribution for low-intensity obstacle lights

	Minimum intensity (a)	Maximum intensity (a)	Vertical beam spread (f)	
			Minimum beam spread	Intensity
Type A	10 cd (b)	N/A	10°	5 cd
Type B	32 cd (b)	N/A	10°	16 cd
Type C	40 cd (b)	400 cd	12° (d)	20 cd
Type D	200 cd (c)	400 cd	N/A (e)	N/A

Note. This table does not include recommended horizontal beam spreads. 6.2.1.3 requires 360° coverage around an obstacle.

Therefore, the number of lights needed to meet this requirement will depend on the horizontal beam spreads of each light as well as the shape of the obstacle. Thus, with narrower beam spreads, more lights will be required.

(a) 360° horizontal. For flashing lights, the intensity is read into effective intensity, as determined in accordance with the Aerodrome Design Manual (Doc 9157), Part 4.

(b) Between 2 and 10° vertical. Elevation vertical angles are referenced to the horizontal when the light is levelled.

(c) Between 2 and 20° vertical. Elevation vertical angles are referenced to the horizontal when the light is levelled.

(d) Peak intensity shall be located at approximately 2.5° vertical.

(e) Peak intensity shall be located at approximately 17° vertical.

(f) Beam spread is defined as the angle between the horizontal plane and the directions for which the intensity exceeds that mentioned in the “intensity” column.

Table 6-3. Light distribution for medium- and high-intensity obstacle lights according to benchmark intensities of Table 6-1

Benchmark intensity	Minimum requirements					Recommendations				
	Vertical elevation angle (b)			Vertical beam spread (c)		Vertical elevation angle (b)			Vertical beam spread (c)	
	0°		-1°			0°	-1°	-10°		
	Minimum average intensity (a)	Minimum intensity (a)	Minimum intensity (a)	Minimum beam spread	Intensity (a)	Maximum intensity (a)	Maximum intensity (a)	Maximum intensity (a)	Maximum beam spread	Intensity (a)
200 000	200 000	150 000	75 000	3°	75 000	250 000	112 500	7 500	7°	75 000
100 000	100 000	75 000	37 500	3°	37 500	125 000	56 250	3 750	7°	37 500
20 000	20 000	15 000	7 500	3°	7 500	25 000	11 250	750	N/A	N/A
2 000	2 000	1 500	750	3°	750	2 500	1 125	75	N/A	N/A

Note.— This table does not include recommended horizontal beam spreads. 6.2.1.3 requires 360° coverage around an obstacle.

Therefore, the number of lights needed to meet this requirement will depend on the horizontal beam spreads of each light as well as the shape of the obstacle. Thus, with narrower beam spreads, more lights will be required.

(a) 360° horizontal. All intensities are expressed in Candela. For flashing lights, the intensity is read into effective intensity, as determined in accordance with the Aerodrome Design Manual (Doc 9157), Part 4.

(b) Elevation vertical angles are referenced to the horizontal when the light unit is levelled.

(c) Beam spread is defined as the angle between the horizontal plane and the directions for which the intensity exceeds that mentioned in the “intensity” column.

Note.— An extended beam spread may be necessary under specific configuration and justified by an aeronautical study.

Lighting

6.2.2.5 Low-intensity obstacle lights, Type C, shall be displayed on vehicles and other mobile objects excluding aircraft.

6.2.2.6 Low-intensity obstacle lights, Type C, displayed on vehicles associated with emergency or security shall be flashing-blue and those displayed on other vehicles shall be flashing-yellow.

6.2.2.7 Low-intensity obstacle lights, Type D, shall be displayed on follow-me vehicles.

6.2.2.8 Low-intensity obstacle lights on objects with limited mobility such as passenger boarding bridges shall be fixed-red, and as a minimum be in accordance with the specifications for low-intensity obstacle lights, Type A, in Table 6-1. The intensity of the lights shall be sufficient to ensure conspicuity considering the intensity of the adjacent lights and the general levels of illumination against which they would normally be viewed.

6.2.3 Fixed objects

Note.— The fixed objects of wind turbines are addressed separately in 6.2.4 and the fixed objects of overhead wires, cables, etc., and supporting towers are addressed separately in 6.2.5.

Marking

6.2.3.1 All fixed objects to be marked shall, whenever practicable, be coloured, but if this is not practicable, markers or flags shall be displayed on or above them, except that objects that are sufficiently conspicuous by their shape, size or colour need not be otherwise marked.

Marking by colour

6.2.3.2 **Recommendation -** An object should be coloured to show a chequered pattern if it has essentially unbroken surfaces and its projection on any vertical plane equals or exceeds 4.5 m in both dimensions. The pattern should consist of rectangles of not less than 1.5 m and not more than 3 m on a side, the corners being of the darker colour. The colours of the pattern should contrast each with the other and with the background against which they will be seen. Orange and white or alternatively red and white should be used, except where such colours merge with the background. (See Figure 6-1).

6.2.3.3 **Recommendation -** An object should be coloured to show alternating contrasting bands if:

(a) it has essentially unbroken surfaces and has one dimension, horizontal or vertical, greater than 1.5 m, and the other dimension, horizontal or vertical, less than 4.5 m; or

(b) it is of skeletal type with either a vertical or a horizontal dimension greater than 1.5 m.

The bands should be perpendicular to the longest dimension and have a width approximately 1/7 of the longest dimension or 30 m, whichever is less. The colours of the bands should contrast with the background against which they will be seen. Orange and white should be used, except where such colours are not conspicuous when viewed against the background. The bands on the extremities of the object should be of the darker colour. (See Figures 6-1 and 6-2.)

Note.— Table 6-4 shows a formula for determining band widths and for having an odd number of bands,hus permitting both the top and bottom bands to be of the darker colour.

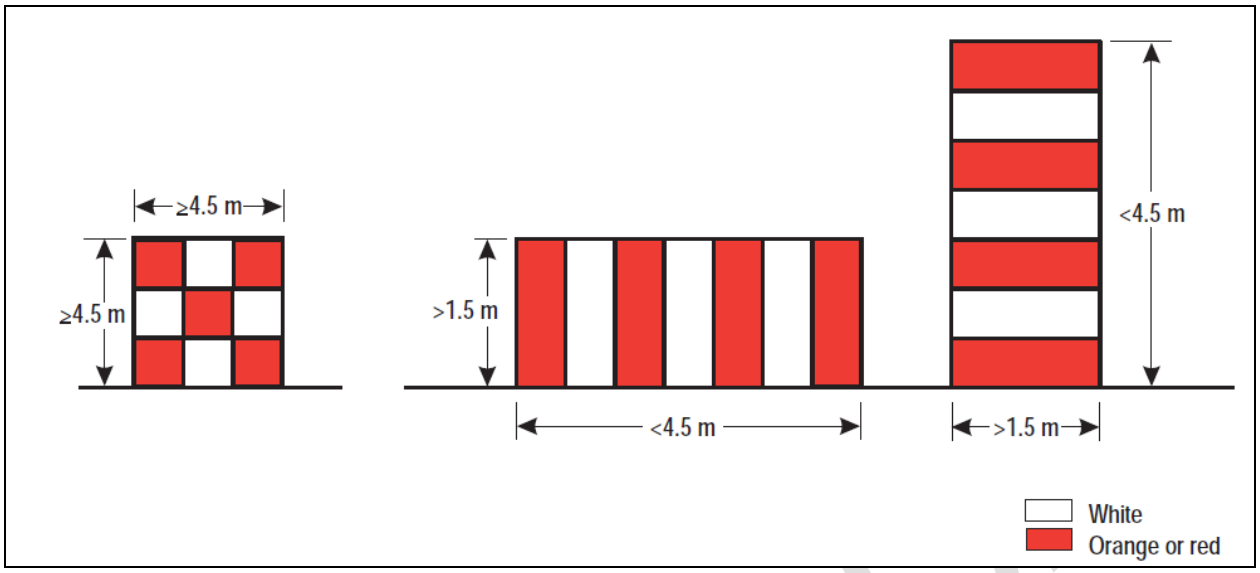


Figure 6-1. Basic marking patterns

Table 6-4. Marking band widths

Longest dimension		
Greater than	Not exceeding	Band width
1.5 m	210 m	1/7 of longest dimension
210 m	270 m	1/9 " " "
270 m	330 m	1/11 " " "
330 m	390 m	1/13 " " "
390 m	450 m	1/15 " " "
450 m	510 m	1/17 " " "
510 m	570 m	1/19 " " "
570 m	630 m	1/21 " " "

6.2.3.4 **Recommendation -** An object should be coloured in a single conspicuous colour if its projection on any vertical plane has both dimensions less than 1.5 m. Orange or red should be used, except where such colours merge with the background.

Note.— Against some backgrounds it may be found necessary to use a different colour from orange or red to obtain sufficient contrast.

Marking by flags

6.2.3.5 Flags used to mark fixed objects shall be displayed around, on top of, or around the highest edge of, the object. When flags are used to mark extensive objects or groups of closely spaced objects, they shall be displayed at least every 15 m. Flags shall not increase the hazard presented by the object they mark.

6.2.3.6 Flags used to mark fixed objects shall not be less than 0.6 m on each side.

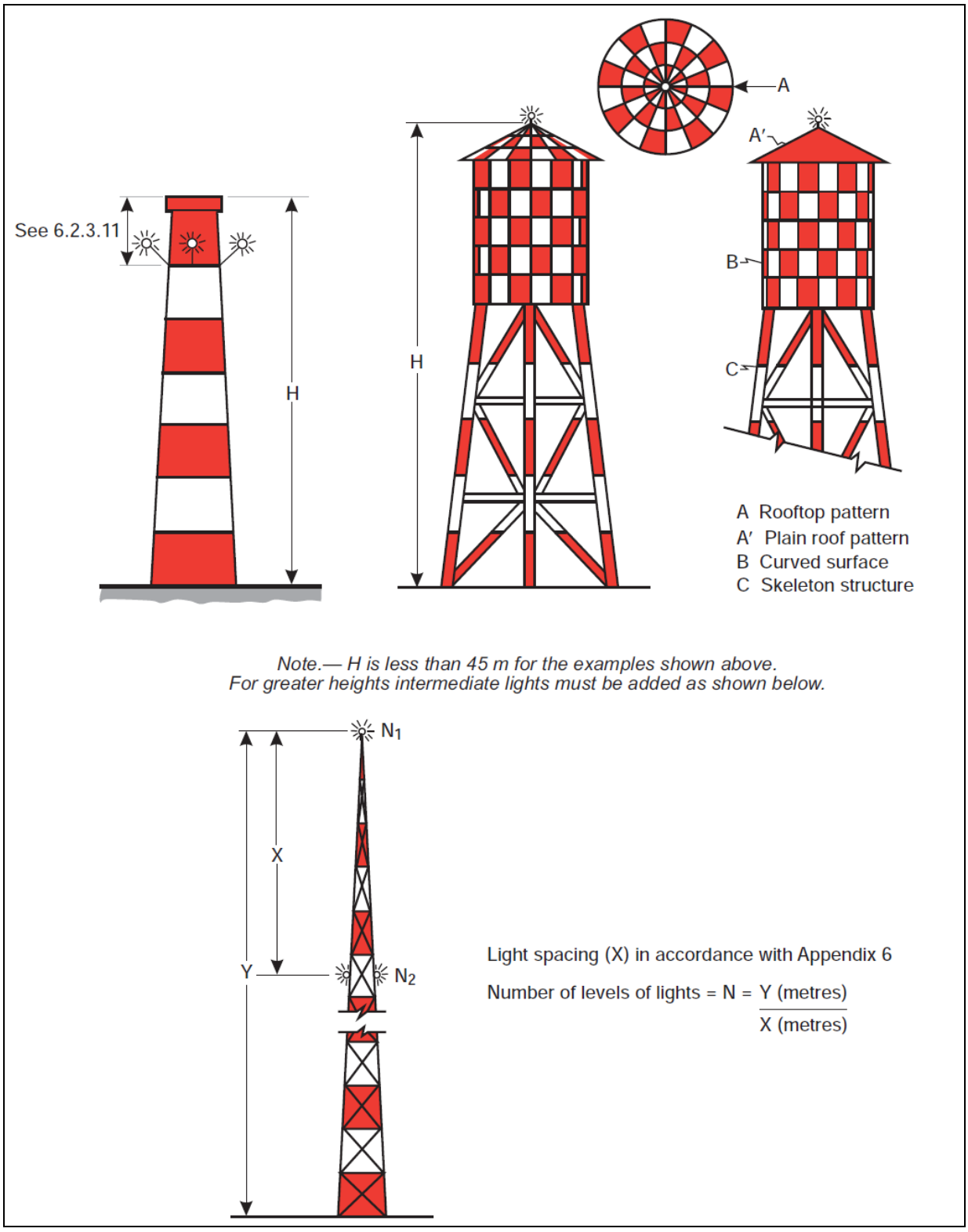


Figure 6-2. Examples of marking lighting of tall structures

6.2.3.7 **Recommendation -** Flags used to mark fixed objects should be orange in colour or a combination of two triangular sections, one orange and the other white, or one red and the other white, except that where such colours merge with the background, other conspicuous colours should be used.

Marking by markers

6.2.3.8 Markers displayed on or adjacent to objects shall be located in conspicuous positions so as to retain the general definition of the object and shall be recognizable in clear weather from a distance of at least 1 000 m for an object to be viewed from the air and 300 m for an object to be viewed from the ground in all directions in which an aircraft is likely to approach the object. The shape of markers shall be distinctive to the extent necessary to ensure that they are not mistaken for markers employed to convey other information, and they shall be such that the hazard presented by the object they mark is not increased.

6.2.3.9 **Recommendation -** A marker should be of one colour. When installed, white and red, or white and orange markers should be displayed alternately. The colour selected should contrast with the background against which it will be seen.

Lighting

6.2.3.10 In the case of an object to be lighted, one or more low-, medium- or high-intensity obstacle lights shall be located as close as practicable to the top of the object.

6.2.3.11 **Recommendation -** In the case of chimney or other structure of like function, the top lights should be placed sufficiently below the top so as to minimize contamination by smoke, etc. (See Figure 6-2).

6.2.3.12 In the case of a tower or antenna structure indicated by high-intensity obstacle lights by day with an appurtenance, such as a rod or an antenna, greater than 12 m where it is not practicable to locate a high-intensity obstacle light on the top of the appurtenance, such a light shall be located at the highest practicable point and, if practicable, a medium-intensity obstacle light, Type A, mounted on the top.

6.2.3.13 In the case of an extensive object or of a group of closely spaced objects to be lighted that are:

(a) penetrating a horizontal obstacle limitation surface (OLS) or located outside an OLS, the top lights shall be so arranged as to at least indicate the points or edges of the object highest in relation to the obstacle limitation surface or above the ground, and so as to indicate the general definition and the extent of the objects; and

(b) penetrating a sloping OLS, the top lights shall be so arranged as to at least indicate the points or edges of the object highest in relation to the OLS, and so as to indicate the general definition and the extent of the objects. If two or more edges are of the same height, the edge nearest the landing area shall be marked.

6.2.3.14 **Recommendation -** When the obstacle limitation surface concerned is sloping and the highest point above the OLS is not the highest point of the object, additional obstacle lights should be placed on the highest point of the object.

6.2.3.15 Where lights are applied to display the general definition of an extensive object or a group of closely spaced objects, and

(a) low-intensity lights are used, they shall be spaced at longitudinal intervals not exceeding 45 m; and

(b) medium-intensity lights are used, they shall be spaced at longitudinal intervals not exceeding 900 m.

6.2.3.16 High-intensity obstacle lights, Type A, and medium-intensity obstacle lights, Types A and B, located on an object shall flash simultaneously.

6.2.3.17 **Recommendation -** The installation setting angles for high-intensity obstacle lights, Type A, should be in accordance with Table 6-5.

6.2.3.18 **Recommendation -** Where, in the opinion of the Brunei DCA Regulatory, the use of high-intensity obstacle lights, Type A, or medium-intensity obstacle lights, Type A, at night may dazzle pilots in the vicinity of an aerodrome (within approximately 10 000 m radius) or cause significant environmental concerns, a dual obstacle lighting system should be provided. This system should be composed of high-intensity obstacle lights, Type A, or medium-intensity obstacle lights, Type A, as appropriate, for daytime and twilight use and medium-intensity obstacle lights, Type B or C, for night-time use.

Lighting of objects with a height less than 45 m above ground level

6.2.3.19 **Recommendation -** Low-intensity obstacle lights, Type A or B, should be used where the object is a less extensive one and its height above the surrounding ground is less than 45 m.

6.2.3.20 **Recommendation -** Where the use of low-intensity obstacle lights, Type A or B, would be inadequate or an early special warning is required, then medium- or high-intensity obstacle lights should be used.

6.2.3.21 **Recommendation -** Low-intensity obstacle lights, Type B, should be used either alone or in combination with medium-intensity obstacle lights, Type B, in accordance with 6.2.3.22.

6.2.3.22 **Recommendation -** Medium-intensity obstacle lights, Type A, B or C, should be used where the object is an extensive one. Medium-intensity obstacle lights, Types A and C, should be used alone, whereas medium-intensity obstacle lights, Type B, should be used either alone or in combination with low-intensity obstacle lights, Type B.

Lighting of objects with a height 45 m to a height less than 150 m above ground level

6.2.3.23 **Recommendation -** Medium-intensity obstacle lights, Type A, B or C, should be used. Medium-intensity obstacle lights, Types A and C, should be used alone, whereas medium-intensity obstacle lights, Type B, should be used either alone or in combination with low-intensity obstacle lights, Type B.

6.2.3.24 Where an object is indicated by medium-intensity obstacle lights, Type A, and the top of the object is more than 105 m above the level of the surrounding ground or the elevation of tops of nearby buildings (when the object to be marked is surrounded by buildings), additional lights shall be provided at intermediate levels. These additional intermediate lights shall be spaced as equally as practicable, between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 105 m.

6.2.3.25 Where an object is indicated by medium-intensity obstacle lights, Type B, and the top of the object is more than 45 m above the level of the surrounding ground or the elevation of tops of nearby buildings (when the object to be marked is surrounded by buildings), additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-

intensity obstacle lights, Type B, and medium-intensity obstacle lights, Type B, and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52 m.

6.2.3.26 Where an object is indicated by medium-intensity obstacle lights, Type C, and the top of the object is more than 45 m above the level of the surrounding ground or the elevation of tops of nearby buildings (when the object to be marked is surrounded by buildings), additional lights shall be provided at intermediate levels. These additional intermediate lights shall be spaced as equally as practicable, between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52 m.

6.2.3.27 Where high-intensity obstacle lights, Type A, are used, they shall be spaced at uniform intervals not exceeding 105 m between the ground level and the top light(s) specified in 6.2.3.10, except that where an object to be marked is surrounded by buildings, the elevation of the tops of the buildings may be used as the equivalent of the ground level when determining the number of light levels.

Lighting of objects with a height 150 m or more above ground level

6.2.3.28 **Recommendation -** High-intensity obstacle lights, Type A, should be used to indicate the presence of an object if its height above the level of the surrounding ground exceeds 150 m and an aeronautical study indicates such lights to be essential for the recognition of the object by day.

6.2.3.29 Where high-intensity obstacle lights, Type A, are used, they shall be spaced at uniform intervals not exceeding 105 m between the ground level and the top light(s) specified in 6.2.3.10, except that where an object to be marked is surrounded by buildings, the elevation of the tops of the buildings may be used as the equivalent of the ground level when determining the number of light levels.

6.2.3.30 **Recommendation -** Where, in the opinion of the Brunei DCA, the use of high-intensity obstacle lights, Type A, at night may dazzle pilots in the vicinity of an aerodrome (within approximately 10 000 m radius) or cause significant environmental concerns, medium-intensity obstacle lights, Type C, should be used alone, whereas medium- intensity obstacle lights, Type B, should be used either alone or in combination with low-intensity obstacle lights, Type B.

6.2.3.31 Where an object is indicated by medium-intensity obstacle lights, Type A, additional lights shall be provided at intermediate levels. These additional intermediate lights shall be spaced as equally as practicable, between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 105 m.

6.2.3.32 Where an object is indicated by medium-intensity obstacle lights, Type B, additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B, and medium-intensity obstacle lights, Type B, and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52 m.

6.2.3.33 Where an object is indicated by medium-intensity obstacle lights, Type C, additional lights shall be provided at intermediate levels. These additional intermediate lights shall be spaced as equally as practicable, between the top

lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52 m.

6.2.4 Wind turbines

6.2.4.1 A wind turbine shall be marked and/or lighted if it is determined to be an obstacle.

Markings

6.2.4.2 **Recommendation -** The rotor blades, nacelle and upper 2/3 of the supporting mast of wind turbines should be painted white, unless otherwise indicated by an aeronautical study.

Lighting

6.2.4.3 When lighting is deemed necessary, in the case of a wind farm, i.e. a group of two or more wind turbines, it shall be regarded as an extensive object and the lights shall be installed:

(a) to identify the perimeter of the wind farm;

(b) respecting the maximum spacing, in accordance with 6.2.3.15, between the lights along the perimeter, unless a dedicated assessment shows that a greater spacing can be used;

(c) so that, where flashing lights are used, they flash simultaneously throughout the wind farm; and

(d) so that, within a wind farm, any wind turbines of significantly higher elevation are also identified wherever they are located.

(e) at locations prescribed in a), b) and d), respecting the following criteria:

i) for wind turbines of less than 150 m in overall height (hub height plus vertical blade height), medium-intensity lighting on the nacelle shall be provided;

ii) for wind turbines from 150 m to 315 m in overall height, in addition to the medium-intensity light installed on the nacelle, a second light serving as an alternate shall be provided in case of failure of the operating light. The lights shall be installed to assure that the output of either light is not blocked by the other; and

iii) in addition, for wind turbines from 150 m to 315 m in overall height, an intermediate level at half the nacelle height of at least three low-intensity Type E lights, as specified in 6.2.1.3, shall be provided. If an aeronautical study shows that low-intensity Type E lights are not suitable, low-intensity Type A or B lights may be used.

Note.— The above 6.2.4.3 e) does not address wind turbines of more than 315 m of overall height. For such wind turbines, additional marking and lighting may be required as determined by an aeronautical study.

6.2.4.4 The obstacle lights shall be installed on the nacelle in such a manner as to provide an unobstructed view for aircraft approaching from any direction.

6.2.4.5 Where lighting is deemed necessary for a single wind turbine or short line of wind turbines, the installation shall be in accordance with 6.2.4.3 e) or as determined by an aeronautical study.

6.2.5 Overhead wires, cables, etc., and supporting towers

Marking

6.2.5.1 **Recommendation -** The wires, cables, etc., to be marked should be equipped with markers; the supporting tower should be coloured.

Marking by colours

6.2.5.2 **Recommendation -** The supporting towers of overhead wires, cables, etc., that require marking should be marked in accordance with 6.2.3.1 to 6.2.3.4, except that the marking of the supporting towers may be omitted when they are lighted by high-intensity obstacle lights by day.

Marking by markers

6.2.5.3 Markers displayed on or adjacent to objects shall be located in conspicuous positions so as to retain the general definition of the object and shall be recognizable in clear weather from a distance of at least 1 000 m for an object to be viewed from the air and 300 m for an object to be viewed from the ground in all directions in which an aircraft is likely to approach the object. The shape of markers shall be distinctive to the extent necessary to ensure that they are not mistaken for markers employed to convey other information, and they shall be such that the hazard presented by the object they mark is not increased.

6.2.5.4 **Recommendation -** A marker displayed on an overhead wire, cable, etc., should be spherical and have a diameter of not less than 60 cm.

6.2.5.5 **Recommendation -** The spacing between two consecutive markers or between a marker and a supporting tower should be appropriate to the diameter of the marker, but in no case should the spacing exceed:

(a) 30 m where the marker diameter is 60 cm progressively increasing with the diameter of the marker to

(b) 35 m where the marker diameter is 80 cm and further progressively increasing to a maximum of

(c) 40 m where the marker diameter is of at least 130 cm.

Where multiple wires, cables, etc., are involved, a marker should be located not lower than the level of the highest wire at the point marked.

6.2.5.6 **Recommendation -** A marker should be of one colour. When installed, white and red, or white and orange markers should be displayed alternately. The colour selected should contrast with the background against which it will be seen.

6.2.5.7 **Recommendation -** When it has been determined that an overhead wire, cable, etc., needs to be marked but it is not practicable to install markers on the wire, cable, etc., then high-intensity obstacle lights, Type B, should be provided on their supporting towers.

Lighting

6.2.5.8 **Recommendation -** High-intensity obstacle lights, Type B, should be used to indicate the presence of a tower supporting overhead wires, cables, etc., where:

(a) an aeronautical study indicates such lights to be essential for the recognition of the presence of wires, cables, etc.; or

(b) it has not been found practicable to install markers on the wires, cables, etc.

6.2.5.9 Where high-intensity obstacle lights, Type B, are used, they shall be located at three levels:

- at the top of the tower;
- at the lowest level of the catenary of the wires or cables; and
- at approximately midway between these two levels.

6.2.5.10 **Recommendation -** High-intensity obstacle lights, Type B, indicating the presence of a tower supporting overhead wires, cables, etc., should flash sequentially; first the middle light, second the top light and last, the bottom light. The intervals between flashes of the lights should approximate the following ratios:

Flash interval between	**Ratio of cycle time**
middle and top light	1/13
top and bottom light	2/13
bottom and middle light	10/13.

6.2.5.11 **Recommendation -** Where, in the opinion of the Brunei DCA, the use of high-intensity obstacle lights, Type B, at night may dazzle pilots in the vicinity of an aerodrome (within approximately 10 000 m radius) or cause significant environmental concerns, a dual obstacle lighting system should be provided. This system should be composed of high-intensity obstacle lights, Type B, for daytime and twilight use and medium-intensity obstacle lights, Type B, for night- time use. Where medium-intensity lights are used they should be installed at the same level as the high-intensity obstacle light Type B.

6.2.5.12 **Recommendation -** The installation setting angles for high-intensity obstacle lights, Type B, should be in accordance with Table 6-5.

Table 6-5. Installation setting angles for high-intensity obstacle lights

Height of light unit above terrain (AGL)		Angle of the peak of the beam above the horizontal
Greater than	Not exceeding	
151 m		0°
122 m	151 m	1°
92 m	122 m	2°
	92 m	3°

Chapter 7. Visual Aids For Denoting Restricted Use Areas

7.1 Closed runways and taxiways, or parts thereof

7.1.1 General

7.1.1.1 When a runway or taxiway or portion thereof is permanently closed, all normal runway and taxiway markings shall be obliterated.

7.1.1.2 Lighting systems provided for a closed runway or taxiway or portion thereof shall not be operated, except as required for maintenance purposes.

Note.— Lighting systems provided for a runway include both approach and runway lighting systems.

7.1.1.3 In addition to closed markings, as specified in 7.1.2 and 7.1.3, when a closed runway or taxiway or portion thereof closed is intercepted by a runway or taxiway which can be used at night, unserviceability lights shall be placed across the entrance to the closed area at intervals not exceeding 3 m (see 7.4.2).

7.1.2 Closed runway marking

7.1.2.1 A closed runway marking shall be displayed on a runway or portion thereof which is permanently closed to the use of all aircraft.

7.1.2.2 **Recommendation -** A closed runway marking should be displayed on a temporarily closed runway or taxiway or portion thereof, except that such marking may be omitted when the closing is of short duration and adequate warning by air traffic services is provided.

Location

7.1.2.3 A closed runway marking shall be placed at each extremity of the runway, or portion thereof, declared closed, and additional markings shall be so placed that the maximum interval between markings does not exceed 300 m.

Characteristics

7.1.2.4 The closed runway marking shall be white and of the form and proportions as detailed in Figure 7-1, Illustration a).

Note 1.— When an area is temporarily closed, frangible barriers or markings utilizing materials other than paint or other suitable means may be used to identify the closed area.

Note 2.— Procedures pertaining to the planning, coordination, monitoring and safety management of works in progress on the movement area are specified in the PANS-Aerodromes (Doc 9981).

7.1.3 Closed taxiway marking

7.1.3.1 A closed taxiway marking shall be displayed on a taxiway or portion thereof which is permanently closed to the use of all aircraft.

7.1.3.2 A closed taxiway marking shall be displayed on a temporarily closed taxiway or portion thereof, except that such marking may be omitted when the

closing is of short duration and adequate warning by air traffic services is provided.

Location

7.1.3.3 A closed taxiway marking shall be placed at least at each extremity of the taxiway or portion thereof closed.

Characteristics

7.1.3.4 The closed taxiway marking shall be yellow and of the form and proportions as detailed in Figure 7-1, Illustration b).

Note 1.— When an area is temporarily closed, frangible barriers or markings utilizing materials other than paint or other suitable means may be used to identify the closed area.

Note 2.— Procedures pertaining to the planning, coordination, monitoring and safety management of works in progress on the movement area are specified in the PANS-Aerodromes (Doc 9981).

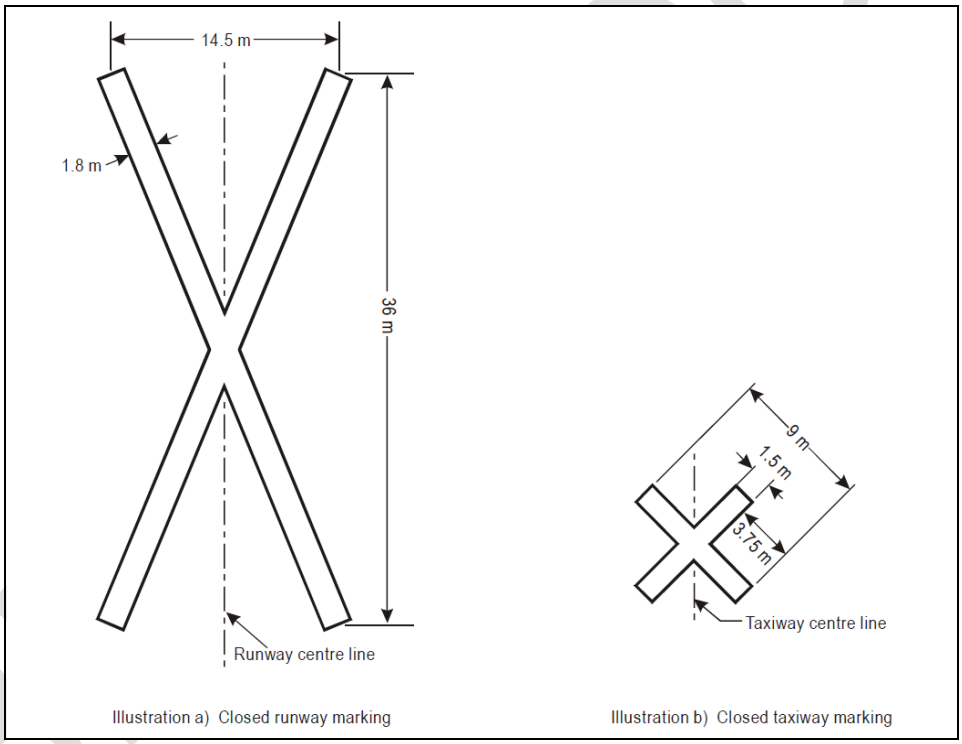


Figure 7-1. Closed runway and taxiway markings

7.1.4 Closed runway lighting

Application

7.1.4.1 Where operationally desirable, at an aerodrome provided with runway lighting, closed runway lighting shall be provided on runway(s) that are temporarily closed or temporarily restricted for take-off.

Note 1.— The purpose of the closed runway lighting is to reduce the likelihood of unintended landings during periods of poor visibility or at night whenever the runway lighting must be switched on for electrical maintenance.

Note 2.— In dusk or poor visibility conditions by day, lighting can be more effective than markings.

Note 3.— The closed runway lighting is intended to be controlled either automatically or manually by air traffic services or by the aerodrome operator.

Location

7.1.4.2 A closed runway lighting shall be placed on the centre line near each extremity of the runway temporarily declared closed.

Note.— Placement of a closed runway lighting would enhance the situational awareness of the runway closure to the pilot.

Characteristics

7.1.4.3 The closed runway lighting as viewed by the pilot shall be of the equivalent elevated form and proportions as detailed in Figure 7-2, showing a minimum of five lights uniformly spaced on each branch, with a minimum interval as specified by Table 7-1.

Table 7-1. Minimum interval between closed runway lights centres

Number of lights per branch	Minimum interval between lights centres
5	1.5 m
7	1.0 m
9	0.8 m

Note 1.— The closed runway lighting may be either fixed or mobile.

Note 2.— The fixed closed runway lighting may be formed as if shadowed (i.e. stretched) from the equivalent elevated structure (see Appendix 3, Note 3 of ICAO Annex 14 Vol.I). Guidance on the sizing of a fixed closed runway lighting is given in the Aerodrome Design Manual (Doc 9157), Part 4.

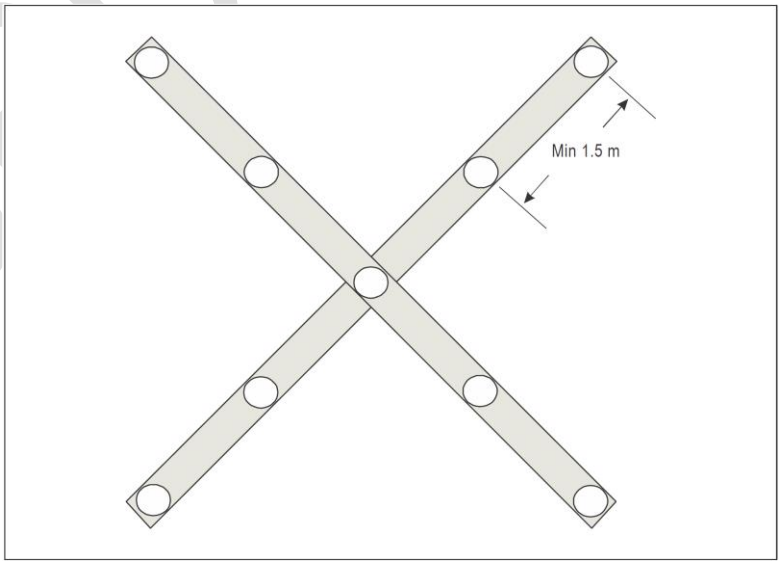


Figure 7-2. Example of equivalent elevated closed runway lighting with five lights per branch

7.1.4.4 Closed runway lights shall show flashing variable white in the direction of approach to the runway, at a rate of one second on and one second off.

7.1.4.5 Closed runway lights shall automatically revert to fixed lights in the event of the flashing system failure.

7.1.4.6 Closed runway lights shall be in accordance with the specifications in Appendix 2, Figure A2-27 ICAO Annex 14 Vol.I.

7.2 Non-load-bearing surfaces

Application

7.2.1 Shoulders for taxiways, runway turn pads, holding bays and aprons and other non-load-bearing surfaces which cannot readily be distinguished from load-bearing surfaces and which, if used by aircraft, might result in damage to the aircraft shall have the boundary between such areas and the load-bearing surface marked by a taxi side stripe marking.

Location

7.2.2 **Recommendation -** A taxi side stripe marking should be placed along the edge of the load-bearing pavement, with the outer edge of the marking approximately on the edge of the load-bearing pavement.

Characteristics

7.2.3 **Recommendation -** A taxi side stripe marking should consist of a pair of solid lines, each 15 cm wide and spaced 15 cm apart and the same colour as the taxiway centre line marking.

7.3 Pre-threshold area

Application

7.3.1 Recommendation - When the surface before a threshold is paved and exceeds 60 m in length and is not suitable for normal use by aircraft, the entire length before the threshold should be marked with a chevron marking.

Location

7.3.2 Recommendation - A chevron marking should point in the direction of the runway and be placed as shown in Figure 7-3.

Characteristics

7.3.3 Recommendation - A chevron marking should be of conspicuous colour and contrast with the colour used for the runway markings; it should preferably be yellow. It should have an overall width of at least 0.9 m.

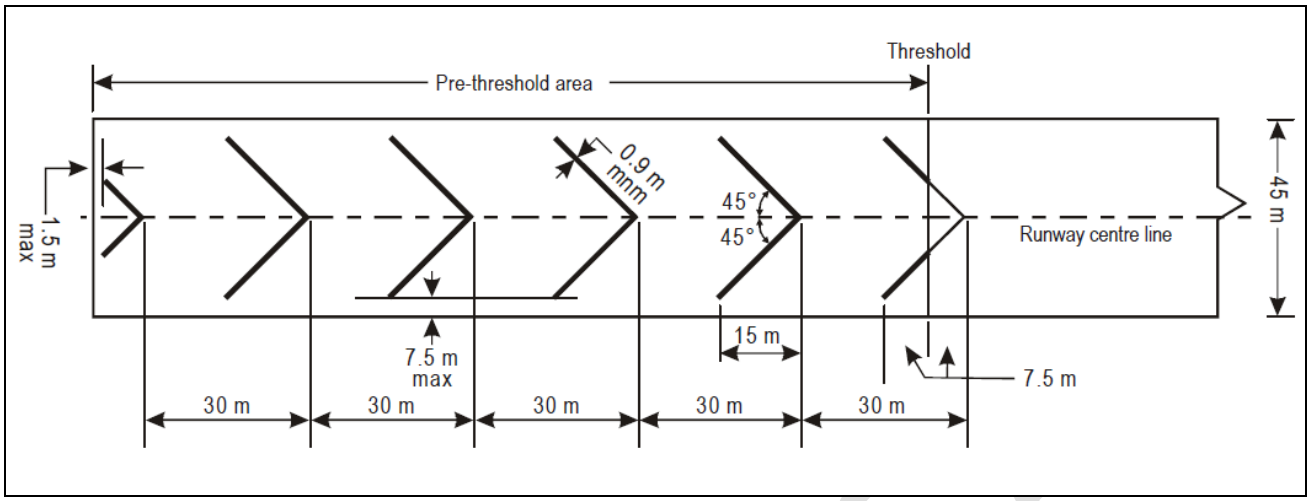


Figure 7-3. Pre-threshold marking

7.4 Unserviceable areas

7.4.1 Unserviceability markings

7.4.1.1 Where operationally required, unserviceability signs shall be supplemented by unserviceability markings on the surface of the pavement.

7.4.1.2 Where it is impracticable to install an unserviceability sign in accordance with 7.4.3.1, an unserviceability marking shall be provided on the surface of the pavement.

7.4.1.3 Unserviceability markings shall be displayed across the surface of the taxiway or apron where necessary and positioned so as to be legible from the cockpit of an approaching aircraft.

Characteristics

7.4.1.4 Unserviceability markings shall consist of an inscription in black upon an orange background.

7.4.1.5 The inscriptions shall be in the form and proportions shown in Appendix 3 of ICAO Annex 14 Vol.I.

7.4.1.6 The background shall be rectangular and extend a minimum of 0.5 m laterally and vertically beyond the extremities of the inscription.

7.4.2 Unserviceability lights

7.4.2.1 Unserviceability lights shall be provided on a movement area used at night, wherever any portion of the movement area is unfit for the movement of aircraft but it is still possible for aircraft to bypass the area safely.

Note 1.— Unserviceability lights are used for such purposes as warning pilots of a hole in a taxiway or apron pavement or outlining a portion of pavement, such as on an apron, that is under repair. They are not suitable for use when a portion of a runway becomes unserviceable, nor on a taxiway when a major portion of the width becomes unserviceable. In such instances, the runway or taxiway is normally closed.

Note 2.— Procedures pertaining to the planning, coordination, monitoring and safety

management of works in progress on the movement area are specified in the PANS-Aerodromes (Doc 9981).

Location

7.4.2.2 Unserviceability lights shall be placed at intervals sufficiently close so as to delineate the unserviceable area.

Note. - Guidance on the location of unserviceability lights is given in 15.1 Attachment A, Section 13.

Characteristics

7.4.2.3 An unserviceability light shall consist of a red fixed light. The light shall have an intensity sufficient to ensure conspicuity considering the intensity of the adjacent lights and the general level of illumination against which it would normally be viewed. In no case shall the intensity be less than 10 cd of red light.

7.4.3 Unserviceability signs

Note 1.— Temporary changes to the movement area may include, inter alia, reduction in the runway length, reduction in the maximum allowable wingspan, taxiway closure or any other closure to the movement area. Unserviceability signs provide relevant information to aerodrome users to maintain an acceptable level of safety during aircraft and vehicle operations, by reducing the risk of confusion and enhancing the awareness of such temporary changes.

Note 2.— Unserviceability signs can be used to indicate temporary closed or restricted areas, as well as to provide information on operational restrictions to aerodrome users.

Application

7.4.3.1 Unserviceability signs shall be provided where there is an operational need to indicate temporary changes to runway declared distances.

7.4.3.2 **Recommendation -** Unserviceability signs should be provided where there is an operational need to indicate temporary changes to taxiways and aprons.

7.4.3.3 Existing signs shall be removed or obscured at an aerodrome if they provide inadequate or misleading information regarding unserviceability areas.

7.4.3.4 The information provided by unserviceability signs shall not be in conflict with the information provided by the appropriate aeronautical information services.

Note. - The information provided by unserviceability signs supplements that which is provided by the appropriate aeronautical information services unit.

Location

7.4.3.5 Unserviceability signs shall be located where operationally needed on the movement area. The location distances on the manoeuvring area shall be as per taxiing guidance signs in Table 5-5.

7.4.3.6 The location of unserviceability signs shall not visually obscure or provide conflicting information with existing operationally required visual aids.

Characteristics

7.4.3.7 Unserviceability signs shall be frangible. Those located near a runway or taxiway shall be sufficiently low to preserve clearance for propellers and the engine pods of jet aircraft. The installed height of unserviceability signs shall not exceed the dimension for taxiing guidance signs shown in Table 5-5.

7.4.3.8 Unserviceability signs shall be rectangular, as shown in Figure 7-4, with the longer side horizontal.

7.4.3.9 The inscriptions on an unserviceability sign shall be in accordance with the provisions of Appendix 4 of ICAO Annex 14 Vol.I.

7.4.3.10 Unserviceability signs shall consist of an inscription in black on an orange background. Unserviceability signs shall be supplemented by a black outline measuring 10 mm in width for runways where the code number is 1 or 2, and 20 mm in width for runways where the code number is 3 or 4.

7.4.3.11 The inscription on an unserviceability sign shall consist of a legible, clear and simple message, only providing the useful and necessary information for the safety of the operation.

Note. - See Figure 7-4 for examples of unserviceability signs.

7.4.3.12 Unserviceability signs shall be retroreflective in accordance with the provisions of Appendix 4 of ICAO Annex 14 Vol.I.

7.4.3.13 **Recommendation -** Where there is a need to enhance the conspicuity of unserviceability signs, they should be supplemented by two red or yellow simultaneously flashing lights. The intensity and the beam spread of these lights should be in accordance with the specifications in Appendix 2, Figure A2-24 of ICAO Annex 14 Vol.I.

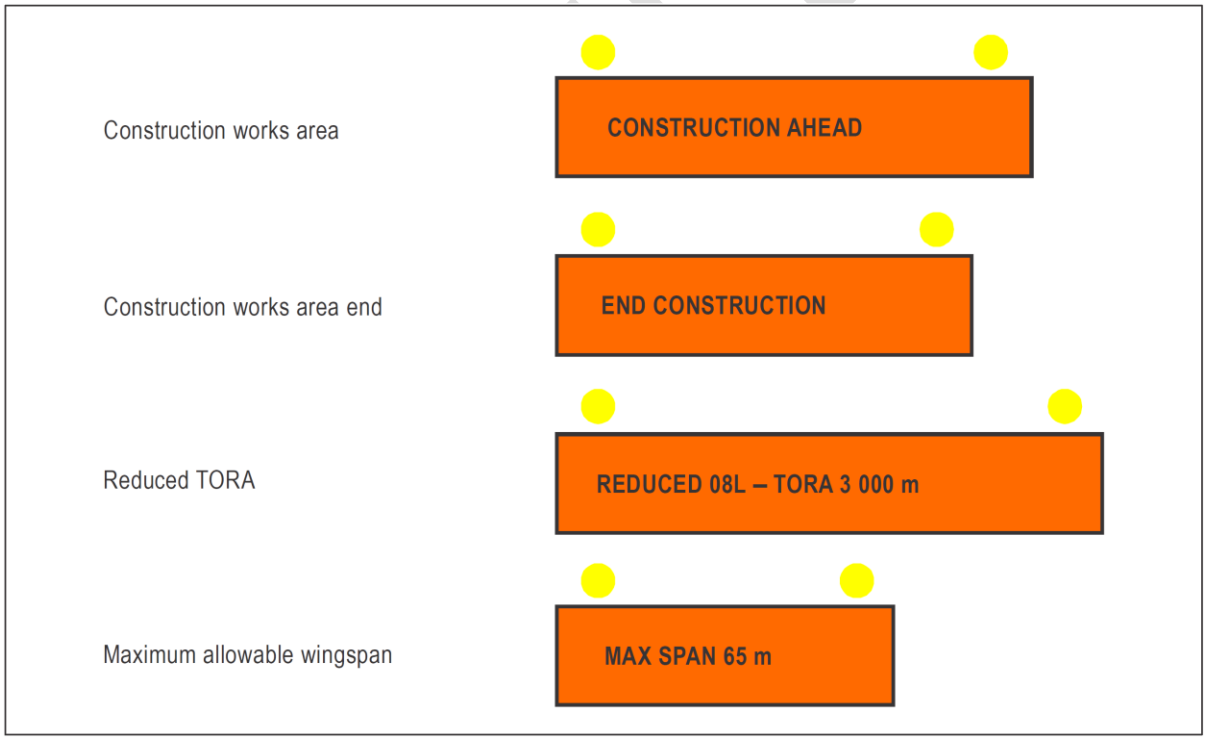


Figure 7-4. Examples of unserviceability signs

7.4.4 Unserviceability markers

Application

7.4.4.1 Unserviceability markers shall be displayed wherever any portion of a taxiway, apron or holding bay is unfit for the movement of aircraft but it is still possible for aircraft to bypass the area safely.

Note.— Unserviceability markers are used for such purposes as warning pilots of a hole in a taxiway or apron pavement or outlining a portion of pavement, such as on an apron, that is under repair. They are not suitable for use when a portion of a runway becomes unserviceable, nor on a taxiway when a major portion of the width becomes unserviceable. In such instances, the runway or taxiway is normally closed.

Location

7.4.4.2 Unserviceability markers shall be placed at intervals sufficiently close, so as to delineate the unserviceable area.

Characteristics

7.4.4.3 Unserviceability markers shall consist of conspicuous upstanding devices such as flags, cones or marker boards.

7.4.4.4 **Recommendation -** An unserviceability cone should be at least 0.5 m in height and red, orange or yellow or any one of these colours in combination with white.

7.4.4.5 **Recommendation -** An unserviceability flag should be at least 0.5 m square and red, orange or yellow or any one of these colours in combination with white.

7.4.4.6 **Recommendation -** An unserviceability marker board should be at least 0.5 m in height and 0.9 m in length, with alternate red and white or orange and white vertical stripes.

Chapter 8. Electrical systems

8.1 Electrical power supply systems for air navigation facilities

8.1.1 Adequate primary power supply shall be available at aerodromes for the safe functioning of air navigation facilities.

8.1.2 The design and provision of electrical power systems for aerodrome visual and radio navigation aids shall be such that an equipment failure will not leave the pilot with inadequate visual and non-visual guidance or misleading information.

8.1.3 **Recommendation -** Electric power supply connections to those facilities for which secondary power is required should be so arranged that the facilities are automatically connected to the secondary power supply on failure of the primary source of power.

8.1.4 **Recommendation -** The time interval between failure of the primary source of power and the complete restoration of the services required by 8.1.10 should be as short as practicable, except that for visual aids associated with non-precision, precision approach or take-off runways the requirements of Table 8-1 for maximum switch-over times should apply.

8.1.5 The provision of a definition of switch-over time shall not require the replacement of an existing secondary power supply before 1 January 2010. However, for a secondary power supply installed after 4 November 1999, the electric power supply connections to those facilities for which secondary power is required shall be so arranged that the facilities are capable of meeting the requirements of Table 8-1 for maximum switch-over times as defined in Chapter 1.

Visual aids

Application

8.1.6 For a precision approach runway, a secondary power supply capable of meeting the requirements of Table 8-1 for the appropriate category of precision approach runway shall be provided. Electric power supply connections to those facilities for which secondary power is required shall be so arranged that the facilities are automatically connected to the secondary power supply on failure of the primary source of power.

8.1.7 For a runway meant for take-off in runway visual range conditions less than a value of 800 m, a secondary power supply capable of meeting the relevant requirements of Table 8-1 shall be provided.

8.1.8 **Recommendation -** At an aerodrome where the primary runway is a non-precision approach runway, a secondary power supply capable of meeting the requirements of Table 8-1 should be provided except that a secondary power supply for visual aids need not be provided for more than one non-precision approach runway.

8.1.9 **Recommendation -** At an aerodrome where the primary runway is a non-instrument runway, a secondary power supply capable of meeting the requirements of 8.1.4 should be provided, except that a secondary power supply for visual aids need not be provided when an emergency lighting system in

accordance with the specification of 5.3.2 is provided and capable of being deployed in 15 minutes.

8.1.10 **Recommendation -** The following aerodrome facilities should be provided with a secondary power supply capable of supplying power when there is a failure of the primary power supply:

(a) the signalling lamp and the minimum lighting necessary to enable air traffic services personnel to carry out their duties;

(b) all obstacle lights which, in the opinion of the Brunei DCA Regulatory, are essential to ensure the safe operation of aircraft;

(c) approach, runway and taxiway lighting as specified in 8.1.6 to 8.1.9;

(d) closed runway lighting, if provided in accordance with 7.1.4.1 and connected to the primary power supply;

(e) meteorological equipment;

(f) essential security lighting, if provided in accordance with 9.11;

(g) essential equipment and facilities for the aerodrome responding emergency agencies;

(h) floodlighting on a designated isolated aircraft parking position if provided in accordance with 5.3.24.1; and

(i) illumination of apron areas over which passengers may walk.

Note.— Specifications for secondary power supply for radio navigation aids and ground elements of communications systems are given in Annex 10, Volume I, Chapter 2.

8.1.11 **Recommendation -** Requirements for a secondary power supply should be met by either of the following:

- independent public power, which is a source of power supplying the aerodrome service from a substation other than the normal substation through a transmission line following a route different from the normal power supply route and such that the possibility of a simultaneous failure of the normal and independent public power supplies is extremely remote; or
- standby power unit(s), which are engine generators, batteries, etc., from which electric power can be obtained.

Note.— Guidance on electrical systems is included in the ICAO Aerodrome Design Manual (Doc 9157), Part 5.

Table 8-1. Secondary power supply requirements

Runway	Lighting aids requiring power	Maximum switch-over time
Non-instrument	Visual approach slope indicators[a]	See 8.1.4 and 8.1.9
	Runway edge[b]	
	Runway threshold[b]	
	Runway end[b]	
	Obstacle[a]	
Non-precision approach	Approach lighting system	15 seconds
	Visual approach slope indicators[a, d]	15 seconds
	Runway edge[d]	15 seconds
	Runway threshold[d]	15 seconds
	Runway end	15 seconds
	Obstacle[a]	15 seconds
Precision approach category I	Approach lighting system	15 seconds
	Runway edge[d]	15 seconds
	Visual approach slope indicators[a, d]	15 seconds
	Runway threshold[d]	15 seconds
	Runway end	15 seconds
	Essential taxiway[a]	15 seconds
	Obstacle[a]	15 seconds
Precision approach category II/III	Inner 300 m of the approach lighting system	1 second
	Other parts of the approach lighting system	15 seconds
	Obstacle[a]	15 seconds
	Runway edge	15 seconds
	Runway threshold	1 second
	Runway end	1 second
	Runway centre line	1 second
	Runway touchdown zone	1 second
	All stop bars	1 second
	Essential taxiway	15 seconds
Runway meant for take-off in runway visual range conditions less than a value of 800 m	Runway edge	15 seconds[c]
	Runway end	1 second
	Runway centre line	1 second
	All stop bars	1 second
	Essential taxiway[a]	15 seconds
	Obstacle[a]	15 seconds

a. Supplied with secondary power when their operation is essential to the safety of flight operation.
b. See Chapter 5, 5.3.2, regarding the use of emergency lighting.
c. One second where no runway centre line lights are provided.
d. One second where approaches are over hazardous or precipitous terrain.

8.2 System design

8.2.1 For a runway meant for use in runway visual range conditions less than a value of 550 m, the electrical systems for the power supply, lighting and control of the lighting systems included in Table 8-1 shall be so designed that an equipment failure will not leave the pilot with inadequate visual guidance or misleading information.

8.2.2 Where the secondary power supply of an aerodrome is provided by the use of duplicate feeders, such supplies shall be physically and electrically separate so as to ensure the required level of availability and independence.

8.2.3 Where a runway forming part of a standard taxi-route is provided with runway lighting and taxiway lighting, the lighting systems shall be interlocked to preclude the possibility of simultaneous operation of both forms of lighting.

8.2.4 The electrical systems for the power supply and the control of the closed runway lighting shall be so designed that the closed runway lighting system is operated independently of runway lighting systems.

8.3 Monitoring

Note.— Guidance on this subject is given in the Aerodrome Design Manual (Doc 9157), Part 5.

8.3.1 A system of monitoring shall be employed to indicate the operational status of the lighting systems.

8.3.2 Where lighting systems are used for aircraft control purposes, such systems shall be monitored automatically so as to provide an indication of any fault which may affect the control functions. This information shall be automatically relayed to the air traffic services unit.

8.3.3 **Recommendation -** Where a change in the operational status of lights has occurred, an indication should be provided within two seconds for a stop bar at a runway-holding position and within five seconds for all other types of visual aids.

8.3.4 **Recommendation -** For a runway meant for use in runway visual range conditions less than a value of 550 m, the lighting systems detailed in Table 8-1 should be monitored automatically so as to provide an indication when the serviceability level of any element falls below the minimum serviceability level specified in 10.5.7 to 10.5.11, as appropriate. This information should be automatically relayed to the maintenance crew.

8.3.5 **Recommendation -** For a runway meant for use in runway visual range conditions less than a value of 550 m, the lighting systems detailed in Table 8-1 should be monitored automatically to provide an indication when the serviceability level of any element falls below the minimum level specified by the appropriate authority below which operations should not continue. This information should be automatically relayed to the air traffic services unit and displayed in a prominent position.

Note.— Guidance on air traffic control interface and visual aids monitoring is included in the Aerodrome Design Manual (Doc 9157), Part 5.

Chapter 9. Aerodrome Operational Services, Equipment and Installations

9.1 Aerodrome emergency planning

General

Introductory Note.— Aerodrome emergency planning is the process of preparing an aerodrome to cope with an emergency occurring at the aerodrome or in its vicinity. The objective of aerodrome emergency planning is to minimize the effects of an emergency, particularly in respect of saving lives and maintaining aircraft operations. The aerodrome emergency plan sets forth the procedures for coordinating the response of different aerodrome agencies (or services) and of those agencies in the surrounding community that could be of assistance in responding to the emergency. Guidance material to assist the appropriate authority in establishing aerodrome emergency planning is given in the Airport Services Manual (Doc 9137), Part 7.

9.1.1 An aerodrome emergency plan shall be established at an aerodrome, commensurate with the aircraft operations and other activities conducted at the aerodrome.

9.1.2 The aerodrome emergency plan shall provide for the coordination of the actions to be taken in an emergency occurring at an aerodrome or in its vicinity.

Note 1.— Examples of emergencies are: aircraft emergencies, sabotage including bomb threats, unlawfully seized aircraft, dangerous goods occurrences, building fires, natural disaster and public health emergencies.

Note 2.— Examples of public health emergencies are increased risk of travellers or cargo spreading a serious communicable disease internationally through air transport and severe outbreak of a communicable disease potentially affecting a large proportion of aerodrome staff.

9.1.3 The plan shall coordinate the response or participation of all existing agencies which, in the opinion of the aerodrome operator, could be of assistance in responding to an emergency.

Note 1.— Examples of agencies are:

— on the aerodrome: air traffic control units, rescue and firefighting services, aerodrome administration, airport medical and ambulance services, aircraft operators, ground handling service providers, security services, and police;
— off the aerodrome: fire departments, police, health authorities (including medical, ambulance, hospital and public health services), military, and harbour patrol or coast guard.

Note 2.— Public health services include planning to minimize adverse effects to the community from health-related events and deal with population health issues rather than provision of health services to individuals.

9.1.4 **Recommendation -** The plan should provide for cooperation and coordination with the rescue coordination centre, as necessary.

9.1.5 **Recommendation -** The aerodrome emergency plan document should include at least the following:

(a) types of emergencies planned for;

(b) agencies involved in the plan;

(c) responsibility and role of each agency, the emergency operations centre and the command post, for each type of emergency;

(d) information on names and telephone numbers of offices or people to be contacted in the case of a particular emergency; and

(e) a grid map of the aerodrome and its immediate vicinity.

9.1.6 The plan shall observe Human Factors principles to ensure optimum response by all existing agencies participating in emergency operations.

Note 1.— Guidance material on Human Factors principles can be found in the Human Factors Training Manual (Doc 9683).

Note 2.— General principles and procedures on the training of aerodrome personnel, including training programmes and competence checks, are specified in the PANS-Aerodromes (Doc 9981).

Emergency operations centre and command post

9.1.7 **Recommendation -** A fixed emergency operations centre and a mobile command post should be available for use during an emergency.

9.1.8 **Recommendation -** The emergency operations centre should be a part of the aerodrome facilities and should be responsible for the overall coordination and general direction of the response to an emergency.

9.1.9 **Recommendation -** The command post should be a facility capable of being moved rapidly to the site of an emergency, when required, and should undertake the local coordination of those agencies responding to the emergency.

9.1.10 **Recommendation -** A person should be assigned to assume control of the emergency operations centre and, when appropriate, another person the command post.

Communication system

9.1.11 **Recommendation -** Adequate communication systems linking the command post and the emergency operations centre with each other and with the participating agencies should be provided in accordance with the plan and consistent with the particular requirements of the aerodrome.

Aerodrome emergency exercise

9.1.12 The aerodrome operator's aerodrome emergency plan shall contain procedures for periodic testing of the adequacy of the plan and for reviewing the results in order to improve its effectiveness.

9.1.13 The plan shall be tested by conducting:

(a) a full-scale aerodrome emergency exercise at intervals not exceeding two years and partial emergency exercises in the intervening year to ensure that any deficiencies found during the full-scale aerodrome emergency exercise have been corrected; or

(b) a series of modular tests commencing in the first year and concluding in a full-scale aerodrome emergency exercise at intervals not exceeding three years;

and reviewed thereafter, or after an actual emergency, so as to correct any deficiency found during such exercises or actual emergency.

Note 1.— The purpose of a full-scale exercise is to ensure the adequacy of the plan to cope with different types of emergencies. The purpose of a partial exercise is to ensure the adequacy of the response to individual participating agencies and components of the plan, such as the communications system. The purpose of modular tests is to enable concentrated effort on specific components of established emergency plans.

Note 2.— Guidance material on airport emergency planning is available in the Airport Services Manual (Doc 9137), Part 7.

Emergencies in difficult environments

9.1.14 The plan shall include the ready availability of, and coordination with, appropriate specialist rescue services to be able to respond to emergencies where an aerodrome is located close to water and/or swampy areas and where a significant portion of approach or departure operations takes place over these areas.

9.1.15 **Recommendation -** At those aerodromes located close to water and/or swampy areas, or difficult terrain, the aerodrome emergency plan should include the establishment, testing and assessment at regular intervals of a predetermined response for the specialist rescue services.

9.1.16 **Recommendation -** An assessment of the approach and departure areas within 1 000 m of runway thresholds should be carried out to determine the options available for intervention.

Note.— Guidance material on assessing approach and departure areas within 1 000 m of runway thresholds can be found in Chapter 13 of the Airport Services Manual (Doc 9137), Part 1.

9.2 Rescue and fire fighting

General

Introductory Note.— The principal objective of a rescue and firefighting service is to save lives in the event of an aircraft accident or incident occurring at, or in the immediate vicinity of, an aerodrome. The rescue and firefighting service is provided to create and maintain survivable conditions, to provide egress routes for occupants and to initiate the rescue of those occupants unable to make their escape without direct aid. The rescue may require the use of equipment and personnel other than those assessed primarily for rescue and firefighting purposes.

The most important factors bearing on effective rescue in a survivable aircraft accident are: the training received, the effectiveness of the equipment and the speed with which personnel and equipment designated for rescue and firefighting purposes can be put into use.

Requirements to combat building and fuel farm fires, or to deal with foaming of runways, are not taken into account.

Application

9.2.1 Rescue and fire fighting equipment and services shall be provided at an aerodrome when serving commercial air transport operations.

9.2.2 Where an aerodrome is located close to water/swampy areas, or difficult terrain, and where a significant portion of approach or departure operations takes place over these areas, specialist rescue services and fire fighting equipment appropriate to the hazard and risk shall be available.

Note 1.— Special firefighting equipment need not be provided for water areas; this does not prevent the provision of such equipment if it would be of practical use, such as when the areas concerned include reefs or islands.

Note 2.— The objective is to plan and deploy the necessary life-saving flotation equipment as expeditiously as possible in a number commensurate with the largest aeroplane normally using the aerodrome.

Note 3.— Additional guidance is available in Chapter 13 of the Airport Services Manual (Doc 9137), Part 1.

Level of protection to be provided

9.2.3 The level of protection provided at an aerodrome for rescue and fire fighting shall be appropriate to the aerodrome category determined using the principles in paragraphs 9.2.5 and 9.2.6, except that, where the number of movements of the aeroplanes in the highest category normally using the aerodrome is less than 700 in the busiest consecutive three months, the level of protection provided shall be not less than one category below the determined category.

Note.— Either a take-off or a landing constitutes a movement.

9.2.4 **Recommendation -** The level of protection provided at an aerodrome for rescue and fire fighting should be equal to the aerodrome category determined using the principles in 9.2.5 and 9.2.6

9.2.5 The aerodrome category shall be determined from Table 9-1 and shall be based on the longest aeroplanes normally using the aerodrome and their fuselage width.

Note. – To categorise the aeroplanes using the aerodrome, first evaluate their overall length and second, their fuselage width.

9.2.6 If, after selecting the category appropriate to the longest aeroplane's overall length, that aeroplane's fuselage width is greater than the maximum width in Table 9-1, column 3, for that category, then the category for that aeroplane shall actually be one category higher.

Note 1.— See guidance in the Airport Services Manual (Doc 9137), Part 1, for categorizing aerodromes, including those or all-cargo aircraft operations, for rescue and firefighting purposes.

Note 2.— Principles and procedures on training, including training programmes and competence checks, are specified in the PANS-Aerodromes (Doc 9981). Further guidance on the training of personnel, rescue equipment for difficult environments and other facilities and services for rescue and firefighting is given in ICAO Annex 14 Vol.I, Attachment A, Section 18, and in the Airport Services Manual (Doc 9137),Part 1.

9.2.7 During anticipated periods of reduced activity, the level of protection available shall be no less than that needed for the highest category of aeroplane planned to use the aerodrome during that time irrespective of the number of movements.

Table 9-1. Aerodrome category for rescue and fire fighting

Aerodrome Category (1)	Aeroplane overall length (2)	Maximum fuselage width (3)
1	0 m up to but not including 9 m	2 m
2	9 m up to but not including 12 m	2 m

3	12 m up to but not including 18 m	3 m
4	18 m up to but not including 24 m	4 m
5	24 m up to but not including 28 m	4 m
6	28 m up to but not including 39 m	5 m
7	39 m up to but not including 49 m	5 m
8	49 m up to but not including 61 m	7 m
9	61 m up to but not including 76 m	7 m
10	76 m up to but not including 90 m	8 m

Extinguishing Agents

9.2.8 **Recommendation -** Both principal and complementary agents should normally be provided at an aerodrome.

Note. Descriptions of the agents may be found in the ICAO Airport Services Manual (Doc 9137), Part 1.

9.2.9 **Recommendation -** The principal extinguishing agent should be:

(a) a foam meeting the minimum performance level A; or

(b) a foam meeting the minimum performance level B; or

(c) a foam meeting the minimum performance level C; or

(d) a combination of these agents;

except that the principal extinguishing agent for aerodromes in categories 1 to 3 should preferably meet a performance level B or C foam.

9.2.10 **Recommendation -** The complementary extinguishing agent should be a dry chemical powder suitable for extinguishing hydrocarbon fires.

Note 1.— When selecting dry chemical powders for use with foam, care must be exercised to ensure compatibility.

Note 2.— Alternate complementary agents having equivalent firefighting capability may be utilized. Additional information on extinguishing agents is given in the Airport Services Manual (Doc 9137), Part 1.

9.2.11 The amounts of water for foam production and the complementary agents to be provided on the rescue and fire fighting vehicles shall be in accordance with the aerodrome category determined under 9.2.3, 9.2.4, 9.2.5, 9.2.6 and Table 9-2, except that for aerodrome categories 1 and 2 up to 100 per cent of the water may be substituted with complementary agent.

For the purpose of agent substitution, 1 kg of complementary agent shall be taken as equivalent to 1.0 L of water for production of a foam meeting performance level A.

Note 1.— The amounts of water specified for foam production are predicated on an application rate of 8.2 L/min/m2 for a foam meeting performance level A, 5.5 L/min/m2 for a foam meeting performance level B and 3.75 L/min/m2 for a foam meeting performance level C.

Note 2.— When any other complementary agent is used, the substitution ratios need to be checked.

9.2.12 At aerodromes where operations by aeroplanes larger than the average size in a given category are planned, the quantities of water shall be recalculated and the amount of water for foam production and the discharge rates for foam solution shall be increased accordingly.

Note.— Guidance on the determination of quantities of water and discharge rates based on the largest overall length of aeroplane in a given category is available in Chapter 2 of the Airport Services Manual (Doc 9137), Part 1.

Table 9-2. Minimum usable amounts of extinguishing agents

	Foam meeting performance level A		Foam meeting performance level B		Foam meeting performance level C		Complementary agents	
Aerodrome category	Water (L)	Discharge rate foam solution/ minute (L)	Water (L)	Discharge rate foam solution/ minute (L)	Water (L)	Discharge rate foam solution/ minute (L)	Dry chemical powders (kg)	Discharge Rate (kg/second)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	350	350	230	230	160	160	45	2.25
2	1 000	800	670	550	460	360	90	2.25
3	1 800	1 300	1 200	900	820	630	135	2.25
4	3 600	2 600	2 400	1 800	1 700	1 100	135	2.25
5	8 100	4 500	5 400	3 000	3 900	2 200	180	2.25
6	11 800	6 000	7 900	4 000	5 800	2 900	225	2.25
7	18 200	7 900	12 100	5 300	8 800	3 800	225	2.25
8	27 300	10 800	18 200	7 200	12 800	5 100	450	4.5
9	36 400	13 500	24 300	9 000	17 100	6 300	450	4.5
10	48 200	16 600	32 300	11 200	22 800	7 900	450	4.5

Note.— The quantities of water shown in columns 2, 4 and 6 are based on the average overall length of aeroplanes in a given category.

9.2.13 The quantity of foam concentrates separately provided on vehicles for foam production shall be in proportion to the quantity of water provided and the foam concentrate selected.

9.2.14 **Recommendation -** The amount of foam concentrate provided on a vehicle should be sufficient to produce at least two loads of foam solution.

9.2.15 **Recommendation -** Supplementary water supplies, for the expeditious replenishment of rescue and fire fighting vehicles at the scene of an aircraft accident, should be provided.

9.2.16 **Recommendation -** When a combination of different performance level foams are provided at an aerodrome, the total amount of water to be provided for foam production should be calculated for each foam type and the distribution of these quantities should be documented for each vehicle and applied to the overall rescue and fire fighting requirement.

9.2.17 The discharge rate of the foam solution shall not be less than the rates shown in Table 9-2.

9.2.18 The complementary agents shall comply with the appropriate specifications of the International Organization for Standardization (ISO).*

Note.- * See ISO Publication 7202 (Powder).

9.2.19 **Recommendation -** The discharge rate of complementary agents should be no less than the values shown in Table 9-2.

9.2.20 **Recommendation -** Dry chemical powders should only be substituted with an agent that has equivalent or better fire fighting capabilities for all types of fires where complementary agent is expected to be used.

Note.— Guidance on the use of complementary agents can be found in the Airport Services Manual (Doc 9137), Part 1.

9.2.21 **Recommendation -** A reserve supply of foam concentrate, equivalent to 200 per cent of the quantities identified in Table 9-2, should be maintained on the aerodrome for vehicle replenishment purposes.

Note.— Foam concentrate carried on fire vehicles in excess of the quantity identified in Table 9-2 can contribute to the reserve.

9.2.22 **Recommendation -** A reserve supply of complementary agent, equivalent to 100 per cent of the quantity identified in Table 9-2, should be maintained on the aerodrome for vehicle replenishment purposes. Sufficient propellant gas should be included to utilize this reserve complementary agent.

9.2.23 **Recommendation -** Category 1 and 2 aerodromes that have replaced up to 100 per cent of the water with complementary agent should hold a reserve supply of complementary agent of 200 per cent.

9.2.24 **Recommendation -** Where a major delay in the replenishment of the supplies is anticipated, the amount of reserve supply in 9.2.21, 9.2.22 and 9.2.23 should be increased as determined by a risk assessment.

Note.— See the Airport Services Manual (Doc 9137), Part 1 for guidance on the conduct of a risk analysis to determine the quantities of reserve extinguishing agents.

Rescue equipment

9.2.25 **Recommendation -** Rescue equipment commensurate with the level of aircraft operations should be provided on the rescue and fire fighting vehicle(s).

Response time

9.2.26 The operational objective of the rescue and fire fighting service shall be to achieve a response time not exceeding three minutes to any point of each operational runway, in optimum visibility and surface conditions.

9.2.27 **Recommendation -** The operational objective of the rescue and fire fighting service should be to achieve a response time not exceeding two minutes to any point of each operational runway, in optimum visibility and surface conditions.

9.2.28 **Recommendation -** The operational objective of the rescue and fire fighting service should be to achieve a response time not exceeding three minutes to any other part of the movement area, in optimum visibility and surface conditions.

Note 1.— Response time is considered to be the time between the initial call to the rescue and firefighting service, and the time when the first responding vehicle(s) is (are) in position to apply foam at a rate of at least 50 per cent of the discharge rate specified in Table 9-2.

Note 2.— Optimum visibility and surface conditions are defined as daytime, good visibility, no precipitation with normal response route free of surface contamination, e.g. water.

9.2.29 **Recommendation -** To meet the operational objective as nearly as possible in less than optimum conditions of visibility, especially during low visibility

operations, suitable guidance, equipment and/or procedures for rescue and fire fighting services should be provided.

9.2.30 Any vehicles, other than the first responding vehicle(s), required to deliver the amounts of extinguishing agents specified in Table 9-2 shall ensure continuous agent application and shall arrive no more than four minutes from the initial call.

9.2.31 **Recommendation -** Any vehicles, other than the first responding vehicles(s), required to deliver the amounts of extinguishing agents specified in Table 24 should ensure continuous agent application and should arrive no more than three minutes from the initial call.

9.2.32 **Recommendation -** A system of preventive maintenance of rescue and fire fighting vehicles should be employed to ensure effectiveness of the equipment and compliance with the specified response time throughout the life of the vehicle.

Emergency access roads

9.2.33 **Recommendation -** Emergency access roads should be provided on an aerodrome where terrain conditions permit their construction, for example an emergency access road direct to the runway, so as to facilitate achieving minimum response times. Particular attention should be given to the provision of ready access to approach areas up to 1 000 m from the threshold, or at least within the aerodrome boundary. Where a fence is provided, the need for convenient access to outside areas should be taken into account.

9.2.34 **Recommendation -** Emergency access roads should be capable of supporting the heaviest vehicles which will use them, and be usable in all weather conditions. Roads within 90 m of a runway should be surfaced to prevent surface erosion and the transfer of debris to the runway. Sufficient vertical clearance should be provided from overhead obstructions for the largest vehicles.

9.2.35 **Recommendation -** When the surface of the road is indistinguishable from the surrounding area, or in areas where snow may obscure the location of the roads, edge markers should be placed at intervals of about 10 m.

Facilities & Communications

Fire stations

9.2.36 **Recommendation -** All rescue and fire fighting vehicles should normally be housed in a fire station. Satellite fire stations should be provided whenever the response time cannot be achieved from a single fire station.

9.2.37 **Recommendation -** The fire station should be located so that the access for rescue and fire fighting vehicles into the runway area is direct and clear, requiring a minimum number of turns.

Communication and alerting systems

9.2.38 **Recommendation -** A discrete communication system should be provided linking a fire station with the control tower, any other fire station on the aerodrome and the rescue and fire fighting vehicles.

9.2.39 **Recommendation -** An alerting system for rescue and fire fighting personnel, capable of being operated from that station, should be provided at a fire station, any other fire station on the aerodrome and the aerodrome control tower.

Number of rescue and fire fighting vehicles

9.2.40 **Recommendation -** The minimum number of rescue and fire fighting vehicles provided at an aerodrome should be in accordance with the following tabulation:

Aerodrome Category	Rescue and fire fighting vehicles
1	1
2	1
3	1
4	1
5	1
6	2
7	2
8	3
9	3
10	3

Personnel & equipment.

Personnel

9.2.41 All rescue and fire fighting personnel shall be properly trained to perform their duties in an efficient manner and shall participate in live fire drills commensurate with the types of aircraft and type of rescue and fire fighting equipment in use at the aerodrome, including pressure-fed fuel fires.

Note.— Guidance to assist the appropriate authority in providing proper training is given in 15.1 Attachment A, Section 18, and the Airport Services Manual (Doc 9137), Part 1.

9.2.42 The rescue and fire fighting personnel training programme shall include training in human performance, including team coordination.

Note.— Guidance material to design training programmes on human performance and team coordination can be found in the Human Factors Training Manual (Doc 9683).

9.2.43 **Recommendation -** During flight operations, sufficient trained and competent personnel should be designated to be readily available to ride the rescue and fire fighting vehicles and to operate the equipment at maximum capacity. These personnel should be deployed in a way that ensures that minimum response times can be achieved and that continuous agent application at the appropriate rate can be fully maintained. Consideration should also be given for personnel to use hand lines, ladders and other rescue and fire fighting equipment normally associated with aircraft rescue and fire fighting operations.

9.2.44 **Recommendation -** In determining the minimum number of rescue and fire fighting personnel required, a task resource analysis should be completed and the level of staffing documented in the Aerodrome Manual.

Note.— Guidance on the use of a task resource analysis can be found in ADR 029 -Task Resource Analysis for RFF. Further information of task resource analysis is given in the Airport Services Manual (Doc 9137), Part 1.

9.2.45 All responding rescue and fire fighting personnel shall be provided with protective clothing and respiratory equipment to enable them to perform their duties in an effective manner.

9.3 Disabled aircraft removal

Note.— Guidance on removal of a disabled aircraft, including recovery equipment, is given in the Airport Services Manual (Doc 9137), Part 5. See also Annex 13 — Aircraft Accident and Incident Investigation concerning protection of evidence, custody and removal of aircraft.

9.3.1 **Recommendation -** A plan for the removal of an aircraft disabled on, or adjacent to, the movement area should be established for an aerodrome, and a coordinator designated to implement the plan, when necessary.

9.3.2 **Recommendation -** The disabled aircraft removal plan should be based on the characteristics of the aircraft that may normally be expected to operate at the aerodrome, and include among other things:

(a) a list of equipment and personnel on, or in the vicinity of, the aerodrome which would be available for such purpose; and

(b) arrangements for the rapid receipt of aircraft recovery equipment kits available from other aerodromes.

9.4 Wildlife strike hazard reduction

Note.—The presence of wildlife (birds and other animals) on and in the aerodrome vicinity poses a serious threat to aircraft operational safety.

9.4.1 The wildlife strike hazard on, or in the vicinity of, an aerodrome shall be assessed through:

(a) the establishment of a procedure by the aerodrome operator for recording and reporting wildlife strikes to aircraft;

(b) the collection of wildlife strikes information from aircraft operators, aerodrome personnel and other sources on the presence of wildlife on or around the aerodrome constituting a potential hazard to aircraft operations; and

(c) an ongoing evaluation (study or assessment) of the wildlife hazard by competent personnel.

Note 1.— See Annex 15, Chapter 5 for additional information on post flight information service.

Note 2.- Information of mandatory occurrence reporting is given in BAR 13 - Accident Prevention & Occurrence Reporting.

Note 3.- Assess to national safety data collection and processing systems (SDCPS) is given in BAR 19 - Safety Management, Chapter 5

Note 4.- A typical standard bird strike form in given in ADR 016 - wildlife strike reporting form.

9.4.2 Wildlife strike reports shall be collected and forwarded to ICAO by the Brunei DCA Regulatory for inclusion in ICAO Bird Strike Information System (IBIS) database.

Note. – The IBIS is designed to collect and disseminate information on wildlife strikes to aircraft. Information on the system is included in the Manual on the ICAO Bird Strike Information System (IBIS) (Doc 9332) (forthcoming).

9.4.3 Action shall be taken to decrease the risk to aircraft operations by adopting measures to minimize the likelihood of collisions between wildlife and aircraft.

Note 1.— Procedures on the management of wildlife hazards on and within the vicinity of aerodromes, including the establishment of a wildlife hazard management programme (WHMP), wildlife risk assessment, land-use management and personnel training, are specified in the ADR 003 Wildlife Hazard Management.

Note 2.- Further guidance is given in the PANS-Aerodromes (Doc 9981), Part II, Chapters 1 and 6 and in the Airport Services Manual (Doc 9137), Part 3.

9.4.4 The aerodrome operator shall take action to eliminate or to prevent the establishment of garbage disposal dumps or any other source which may attract wildlife to the aerodrome, or its vicinity, unless an appropriate wildlife assessment indicates that they are unlikely to create conditions conducive to a wildlife hazard problem. Where the elimination of existing sites is not possible, the appropriate authority shall ensure that any risk to aircraft posed by these sites is assessed and reduced to as low as reasonably practicable.

9.4.5 **Recommendation -** Aerodrome operator should gives due consideration to aviation safety concerns related to land developments in the vicinity of the aerodrome that may attract wildlife. A documented process should be established in managing potential conflicts between land use and aviation authorities to ensure aircraft safety is not compromised. The airport operator should establish process for the management of potential conflicts between environmental and aviation safety requirement.

Note.- See guidance material ADR 035 - Process for Management of Conflicts Between Land Use or Environmental Requirements and Aviation Safety for more information.

9.5 Apron management service

9.5.1 **Recommendation -** When warranted by the volume of traffic and operating conditions, an appropriate apron management service should be provided on an apron by an aerodrome ATS unit, by the aerodrome operator, or by a cooperative combination of these, in order to:

(a) regulate movement with the objective of preventing collisions between aircraft, and between aircraft and obstacles;

(b) regulate entry of aircraft into, and coordinate exit of aircraft from, the apron with the aerodrome control tower; and

(c) ensure safe and expeditious movement of vehicles and appropriate requirement of other activities.

9.5.2 **Recommendation -** When the aerodrome control tower does not participate in the apron management service, procedures should be established to facilitate the orderly transition of aircraft between the apron management unit and the aerodrome control tower.

Note.1 — Procedures on apron safety including guidance on orderly transition of aircraft between the apron management and the aerodrome control tower are given in ADR 032-Apron Safety Management.

Note.2 – Additional information on apron safety are specified in the PANS-Aerodromes (Doc 9981). Guidance on an apron management service is given in the Airport Services Manual (Doc 9137), Part 8, and in the Manual of Surface Movement Guidance and Control Systems (SMGCS) (Doc 9476).

9.5.3 An apron management service shall be provided with radiotelephony communications facilities.

9.5.4 Where low visibility procedures are in effect, persons and vehicles operating on an apron shall be restricted to the essential minimum.

Note.— Guidance on related special procedures is given in the Manual of Surface Movement Guidance and Control Systems (SMGCS) (Doc 9476).

9.5.5 **Recommendation -** Aircraft should be allocated to an aircraft stand or apron area appropriate to the aircraft characteristics.

9.5.6 **Recommendation -** A risk assessment should be carried out if there is a need to allocate aircraft parking to areas other than aircraft stands or apron areas.

Note .—The need to allocate aircraft to other areas could arise from situations such as mass diversions, special events, adverse weather conditions, contingency requirements, work in progress, etc..

9.5.7 **Recommendation -** When allocating an aircraft to an aircraft stand, the following parameters should be considered:

a) parking aids;

b) facilities serving the aircraft stand;

c) proximity of infrastructure;

d) other parked aircraft in the neighbouring aircraft stands;

e) aircraft stand dependencies; and

f) jet blast and propeller wash related protection.

Apron Safety

9.5.8 An emergency vehicle responding to an emergency shall be given priority over all other surface movement traffic.

9.5.9 A vehicle operating on an apron shall:

(a) give way to an emergency vehicle; an aircraft taxiing, about to taxi, or being pushed or towed; and

(b) give way to other vehicles in accordance with local requirements.

9.5.10 Aircraft shall be guided while arriving on or departing from the aircraft stand.

Note.— Means for guidance can be a visual docking guidance systems, personnel, lighting or markings.

9.5.11 An aircraft stand shall be visually monitored in-person or remotely to ensure that the recommended clearance distances are maintained.

Note.— Stand dependencies may occur when multiple centre lines are used on the same stand, creating possible variations in fixed or mobile obstacle separations with adjacent stands.

9.5.12 Emergency stop procedures shall be in place to stop an aircraft when entering the stand if the safety of operations on the aircraft stand is compromised.

Note.— Procedures on the training of operational personnel, and on apron safety and operations, are specified in the PANS-Aerodromes (Doc 9981), Part II, Chapters 1 and 7.

9.5.13 Personnel, other than those required to assist the initial arrival and departure of the aircraft, shall not be allowed to approach the aircraft when anti-collision lights are turned on and engines are running.

Note.— This does not apply to helicopter operations as per Annex 6, Part 3.

9.5.14 Parked aircraft shall be appropriately secured to prevent any unintended movement.

9.6 Aircraft fuelling – Safety considerations

9.6.1 Fire extinguishing equipment suitable for at least initial intervention in the event of a fuel fire and personnel trained in its use shall be readily available during fuelling operations, and there shall be a means of quickly summoning the rescue and fire fighting service in the event of a fire or major fuel spill.

9.6.2 When aircraft refuelling operations take place while passengers are embarking, on board or disembarking, ground equipment shall be positioned so as to allow:

a) the use of a sufficient number of exits for expeditious evacuation; and

b) a ready escape route from each of the exits to be used in an emergency.

9.7 Ground handling

(Applicable as of 26 November 2026)

Note 1.— Ground handling can be provided by an aircraft operator, an aerodrome operator or an independent organization. When provided by an aircraft operator or an aerodrome operator, this organization is also considered, as a ground handling service provider (GHSP).

Note 2.— A list of ground handling services is provided in the Manual on Ground Handling (Doc 10121), Appendix B.

9.7.1 The Brunei DCA shall regularly assess the impact of ground handling operations on aviation safety.

Note.— Guidance on the assessment of the impact of ground handling operations on aviation safety is provided in the Manual on Ground Handling (Doc 10121), Chapter 2.

9.7.2 **Recommendation –** The Brunei DCA should establish criteria for the safety oversight of ground handling as part of their State Safety Programme (SSP).

Note 1.— Guidance on the establishment of criteria for the safety oversight of ground handling, and approaches for safety oversight are contained in the Manual on Ground Handling (Doc 10121)

Note 2.— Provisions on periodically reviewing the need to extend SMS to additional aviation sectors are contained in BAR 19 – Safety Management. Examples of additional aviation sectors can include GHSP. See 2.3.4 (f) and Chapter 12 – Contracted Activities

9.8 Aerodrome vehicle operations

Note 1.— Procedures on the establishment of an airside driver permit (ADP) scheme and vehicle/equipment safety requirements, including detailed personnel training, are specified in the ADR 020 - Requirement for ADP scheme

Note.2 — Guidance on aerodrome vehicle operations is contained in 15.1 Attachment A, Section 18 and on traffic rules and regulations for vehicles is contained in the ICAO Manual of Surface Movement Guidance and Control Systems (SMGCS) (Doc 9476).

Note. 3 — It is intended that roads located on the movement area be restricted to the exclusive use of aerodrome personnel and other authorized persons, and that access to the public buildings by an unauthorized person will not require use of such roads.

9.8.1 A vehicle shall be operated:

(a) on a manoeuvring area only as authorized by the aerodrome control tower; and

(b) on an apron only as authorized by the appropriate designated authority.

9.8.2 The driver of a vehicle on the movement area shall comply with all mandatory instructions conveyed by markings and signs unless otherwise authorized by:

(a) the aerodrome control tower when on the manoeuvring area; or

(b) the appropriate designated authority when on the apron.

9.8.3 The driver of a vehicle on the movement area shall comply with all mandatory instructions conveyed by lights.

9.8.4 The driver of a vehicle on the movement area shall be appropriately trained for the tasks to be performed and shall comply with the instructions issued by:

(a) the aerodrome control tower, when on the manoeuvring area; and

(b) the appropriate designated authority, when on the apron.

9.8.5 The driver of a radio-equipped vehicle shall establish satisfactory two-way radio communication with the aerodrome control tower before entering the manoeuvring area and with the appropriate designated authority before entering the apron. The driver shall maintain a continuous listening watch on the assigned frequency when on the movement area.

9.9 Surface movement guidance and control systems (SMGCS)

Application

9.9.1 A surface movement guidance and control system (SMGCS) shall be provided at an aerodrome.

Note.— Guidance on surface movement guidance and control systems is contained in the Manual of Surface Movement Guidance and Control Systems (SMGCS) (Doc 9476).

Characteristics

9.9.2 **Recommendation -** The design of an SMGCS should take into account:

(a) the density of air traffic;

(b) the visibility conditions under which operations are intended;

(c) the need for pilot orientation;

(d) the complexity of the aerodrome layout; and

(e) movements of vehicles.

9.9.3 **Recommendation -** The visual aid components of an SMGCS, i.e. markings, lights and signs, should be designed to conform with the relevant specifications in 5.2, 5.3 and 5.4, respectively.

9.9.4 **Recommendation -** An SMGCS should be designed to assist in the prevention of inadvertent incursions of aircraft and vehicles onto an active runway.

9.9.5 **Recommendation -** The system should be designed to assist in the prevention of collisions between aircraft, and between aircraft and vehicles or objects, on any part of the movement area.

Note.— Guidance on control of stop bars through induction loops and on a visual taxiing guidance and control system is contained in the Aerodrome Design Manual (Doc 9157), Part 4.

9.9.6 Where an SMGCS is provided by selective switching of stop bars and taxiway centre line lights, the following requirements shall be met:

(a) taxiway routes which are indicated by illuminated taxiway centre line lights shall be capable of being terminated by an illuminated stop bar;

(b) the control circuits shall be so arranged that when a stop bar located ahead of an aircraft is illuminated, the appropriate section of taxiway centre line lights beyond it is suppressed; and

(c) the taxiway centre line lights are activated ahead of an aircraft when the stop bar is suppressed.

Note 1.— See Sections 5.3.17 and 5.3.20 for specifications on taxiway centre line lights and stop bars, respectively.

Note 2.— Guidance on installation of stop bars and taxiway centre line lights in SMGCSs is given in the Aerodrome Design Manual (Doc 9157), Part 4.

9.9.7 **Recommendation -** Surface movement radar for the manoeuvring area should be provided at an aerodrome intended for use in runway visual range conditions less than a value of 350 m.

9.9.8 **Recommendation -** Surface movement radar for the manoeuvring area should be provided at an aerodrome other than that in 9.9.7 when traffic density and operating conditions are such that regularity of traffic flow cannot be maintained by alternative procedures and facilities.

Note.— Guidance on the use of surface movement radar is given in the Manual of Surface Movement Guidance and Control Systems (SMGCS) (Doc 9476) and in the Air Traffic Services Planning Manual (Doc 9426).

9.10 Sitting of equipment and installations on operational areas

Note 1.— Requirements for obstacle limitation surfaces are specified in 4.2.

Note 2.— The design of light fixtures and their supporting structures, light units of visual approach slope indicators, signs, and markers, is specified in 5.3.1, 5.3.5, 5.4.1 and 5.5.1, respectively. Guidance on the frangible design of visual and non-visual aids for navigation is given in the Aerodrome Design Manual (Doc 9157), Part 6.

9.10.1 Unless its function requires it to be there for air navigation or for aircraft safety purposes, no equipment or installation shall be:

(a) on a runway strip, a runway end safety area, a taxiway strip or within the distances specified in Table 3-1, column 11, if it would endanger an aircraft; or

(b) on a clearway if it would endanger an aircraft in the air.

9.10.2 Any equipment or installation required for air navigation or for aircraft safety purposes which must be located:

(a) on that portion of a runway strip within:

(1) 75 m of the runway centre line where the code number is 3 or 4; or

(2) 45 m of the runway centre line where the code number is 1 or 2; or

(b) on a runway end safety area, a taxiway strip or within the distances specified in Table 3-1; or

(c) on a clearway and which would endanger an aircraft in the air;

shall be frangible and mounted as low as possible.

9.10.3 **Recommendation -** Any equipment or installation required for air navigation or for aircraft safety purposes which must be located on the non-graded portion of a runway strip should be regarded as an obstacle and should be frangible and mounted as low as possible.

9.10.4 Unless its function requires it to be there for air navigation or for aircraft safety purposes, no equipment or installation should be located within 240 m from the end of the strip and within:

(a) 60 m of the extended centre line where the code number is 3 or 4; or

(b) 45 m of the extended centre line where the code number is 1 or 2;

of a precision approach runway category I, II or III.

9.10.5 Any equipment or installation required for air navigation or for aircraft safety purposes which must be located on or near a strip of a precision approach runway category I, II or III and which:

(a) is situated within 240 m from the end of the strip and within:

(1) 60 m of the extended runway centre line where the code number is 3 or 4; or

(2) 45 m of the extended runway centre line where the code number is 1 or 2; or

(b) penetrates the inner approach surface, the inner transitional surface or the balked landing surface;

shall be frangible and mounted as low as possible.

9.10.6 **Recommendation -** Any equipment or installation required for air navigation or for aircraft safety purposes which is an obstacle of operational significance in accordance with 4.2.4, 4.2.11, 4.2.20 or 4.2.27 should be frangible and mounted as low as possible.

9.11 Fencing

Application

9.11.1 A fence or other suitable barrier shall be provided on an aerodrome to prevent the entrance to the movement area of animals large enough to be a hazard to aircraft.

9.11.2 A fence or other suitable barrier shall be provided on an aerodrome to deter the inadvertent or premeditated access of an unauthorized person onto a non-public area of the aerodrome including the barring of sewers, ducts, tunnels, etc., where necessary to prevent access.

9.11.3 Suitable means of protection shall be provided to deter the inadvertent or premeditated access of unauthorized persons into ground installations and facilities essential for the safety of civil aviation located off the aerodrome.

Location

9.11.4 The fence or barrier shall be located so as to separate the movement area and other facilities or zones on the aerodrome vital to the safe operation of aircraft from areas open to public access.

9.11.5 **Recommendation -** When greater security is thought necessary, a cleared area should be provided on both sides of the fence or barrier to facilitate the work of patrols and to make trespassing more difficult. Consideration should be given to the provision of a perimeter road inside the aerodrome fencing for the use of both maintenance personnel and security patrols.

9.12 Security lighting

9.12.1 **Recommendation -** At an aerodrome where it is deemed desirable for security reasons, a fence or other barrier provided for the protection of international civil aviation and its facilities should be illuminated at a minimum essential level. Consideration should be given to locating lights so that the ground area on both sides of the fence or barrier, particularly at access points, is illuminated.

9.12.2 A risk assessment shall be conducted and evaluated to determine portions of the fence to be lit.

9.13 Autonomous runway incursion warning system

Note 1.— The inclusion of detailed specifications for an autonomous runway incursion warning system (ARIWS) in this section is not intended to imply that an ARIWS has to be provided at an aerodrome.

Note 2.— The implementation of an ARIWS is a complex issue deserving careful consideration by aerodrome operators, air traffic services and States, and in coordination with the aircraft operators.

Note 3.— Attachment A, Section 21, provides a description of an ARIWS and information on its use.

Characteristics

9.13.1 Where an ARIWS is installed at an aerodrome:

a) it shall provide autonomous detection of a potential incursion or of the occupancy of an active runway and a direct warning to a flight crew or vehicle operator;

b) it shall function and be controlled independently of any other visual system on the aerodrome;

c) its visual aid components, i.e. lights, shall be designed to conform with the relevant specifications in 5.3; and

d) failure of part or all of it shall not interfere with normal aerodrome operations. To this end, provision shall be made to allow the ATC unit to partially or entirely shut down the system.

Note 1.— An ARIWS may be installed in conjunction with enhanced taxiway centre line markings, stop bars or runway guard lights.

Note 2.— It is intended that the system(s) be operational under all weather conditions, including low visibility.

Note 3.— An ARIWS may share common sensory components of an SMGCS or A-SMGCS, however, it operates independently of either system.

9.13.2 Where an ARIWS is installed at an aerodrome, information on its characteristics and status shall be provided to the appropriate aeronautical information services for promulgation in the AIP with the description of the aerodrome surface movement guidance and control system and markings as specified in Annex 15.

Note.— Detailed specifications concerning the AIP are contained in PANS-AIM (Doc 10066).

Chapter 10. Aerodrome Maintenance

10.1 General

10.1.1 A maintenance programme, including preventive maintenance where appropriate, shall be established at an aerodrome to maintain facilities in a condition which does not impair the safety, regularity or efficiency of air navigation.

Note 1.— Preventive maintenance is programmed maintenance work done in order to prevent a failure or degradation of facilities.

Note 2.— "Facilities" are intended to include such items as pavements, visual aids, fencing, drainage systems, electrical systems and buildings.

10.1.2 **Recommendation -** The design and application of the maintenance programme should observe Human Factors principles.

Note 1.— Guidance material on Human Factors principles can be found in the Human Factors Training Manual (Doc 9683) and in the Airport Services Manual (Doc 9137), Part 8 – Airport Operational Services.

Note 2.— General principles and procedures on the training of aerodrome personnel, including training programmes and competence checks, are specified in the PANS-Aerodromes (Doc 9981).

10.2 Pavements

10.2.1 The surfaces of all movement areas including pavements (runways, taxiways and aprons) and adjacent areas shall be inspected and their conditions monitored regularly as part of an aerodrome preventive and corrective maintenance programme with the objective of avoiding and eliminating any loose objects/debris that might cause damage to aircraft or impair the operation of aircraft systems.

Note 1.— See 1.19 for inspections of movement areas.

Note 2.— Guidance on carrying out daily inspections of the movement area is given in the Airport Services Manual (Doc 9137), Part 8, the Manual of Surface Movement Guidance and Control Systems (SMGCS) (Doc 9476) and the Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual (Doc 9830).

Note 3.— Additional guidance on sweeping/cleaning of surfaces is contained in the Airport Services Manual (Doc 9137), Part 9.

Note 4.— Guidance on precautions to be taken in regard to the surface of shoulders is given in Chapter 15 Attachment A, Section 9, and the Aerodrome Design Manual (Doc 9157), Part 2.

Note 5.— Where the pavement is used by large aircraft or aircraft with tire pressures in the upper categories referred to in 2.6.6 c) of Annex 14 Volume I, particular attention shall be given to the integrity of light fittings in the pavement and pavement joints.

10.2.2 The surface of a runway shall be maintained in a condition such as to prevent formation of harmful irregularities.

Note.— See 15.1 Attachment A, Section 5.

10.2.3 A paved runway shall be maintained in a condition so as to provide surface friction characteristics at or above the minimum friction level specified in Table 10-1.

Note.- Assessment, Measurement and Reporting of Runway Surface Conditions is given in ADR 002 Assessment of Runway Friction Characteristics. The (Cir 355) contains further information on this subject.

10.2.4 Runway surface friction characteristics for maintenance purposes shall be periodically measured with a continuous friction measuring device using self-wetting features and documented. The frequency of these measurements shall be sufficient to determine the trend of the surface friction characteristics of the runway.

Note 1.- Guidance on evaluating the runway surface friction characteristics is provided in Assessment, Measurement and Reporting of Runway Surface Conditions (Cir 355).

Note 2.- The objective of 10.2.3 to 10.2.8 is to ensure that the surface friction characteristics for the entire runway remain at or above a minimum friction level specified in Table 10-1.

10.2.5 When runway surface friction measurements are made or maintenance purposes using a self-wetting continuous friction measuring device, the performance of the device shall meet the standard set or agreed by the Brunei DCA.

10.2.6 Personnel measuring runway surface friction required in 10.2.5 shall be trained to fulfil their duties.

10.2.7 Corrective maintenance action shall be taken to prevent the runway surface friction characteristics for either the entire runway or a portion thereof from falling below a minimum friction level specified in Table 10-1.

Note.- A portion of runway in the order of 100 m long may be considered significant for maintenance or reporting action.

10.2.8 **Recommendation -** The runway surface should be visually assessed, as necessary, under natural or simulated rain conditions for ponding or poor drainage and where required, corrective maintenance action taken.

10.2.9 **Recommendation -** When a taxiway is used by turbine-engined aeroplanes, the surface of the taxiway shoulders should be maintained so as to be free of any loose stones or other objects that could be ingested by the aeroplane engines.

Note. Guidance on this is given in the Aerodrome Design Manual (Doc 9157), Part 2.

10.2.10 Notification shall be given to aerodrome users when the friction level of a paved runway or portion thereof is less than that specified by the State in accordance with 10.2.3. Notification shall be given to aerodrome users when the friction level of a paved runway or portion thereof is less than that specified by the Brunei DCA in accordance with 10.2.3.

Note.— Guidance on conducting a runway surface friction characteristics evaluation programme that includes determining and expressing the minimum friction level is provided in 15.1 Attachment A, Section 7.

Table 10-1. Guidelines for establishing the design objective, maintenance planning level and minimum friction levels of runways in use

Test equipment	Test tire		Test speed (km/h)	Test water depth (mm)	Design objective for new surface	Maintenance planning level	Minimum friction level
	Type	Pressure (kPa)					
(1)	(2)		(3)	(4)	(5)	(6)	(7)
Mu-meter Trailer	A	70	65	1.0	0.72	0.52	0.42
	A	70	95	1.0	0.66	0.38	0.26
Skiddometer Trailer	B	210	65	1.0	0.82	0.60	0.50
	B	210	95	1.0	0.74	0.47	0.34
Surface Friction Tester Vehicle	B	210	65	1.0	0.82	0.60	0.50
	B	210	95	1.0	0.74	0.47	0.34
Runway Friction Tester Vehicle	B	210	65	1.0	0.82	0.60	0.50
	B	210	95	1.0	0.74	0.54	0.41
TATRA Friction Tester Vehicle	B	210	65	1.0	0.76	0.57	0.48
	B	210	95	1.0	0.67	0.52	0.42
RUNAR Trailer	B	210	65	1.0	0.69	0.52	0.45
	B	210	95	1.0	0.63	0.42	0.32
GRIPTESTER Trailer	C	140	65	1.0	0.74	0.53	0.43
	C	140	95	1.0	0.64	0.36	0.24

10.3 Removal of contaminants

10.3.1 Standing water, mud, dust, sand, oil, rubber deposits and other contaminants shall be removed from the surface of runways in use as rapidly and completely as possible to minimize accumulation.

Note.- Information on removal of other contaminants is given in the PANS-Aerodromes (Doc 9981).

10.3.2 **Recommendation -** Taxiways should be kept clear of contaminants to the extent necessary to enable aircraft to be taxied to and from an operational runway.

10.3.3 **Recommendation -** Aprons should be kept clear of contaminants to the extent necessary to enable aircraft to manoeuvre safely or, where appropriate, to be towed or pushed.

10.3.4 **Recommendation -** Whenever the clearance of contaminants from the various parts of the movement area cannot be carried out simultaneously, the order of priority after the runway(s) in use should be set in consultation with the affected parties such as rescue and fire fighting service.

10.3.5 Reserved

10.3.6 Chemicals which may have harmful effects on aircraft or pavements, or chemicals which may have toxic effects on the aerodrome environment, shall not be used.

10.4 Runway pavement overlays

Note. The following specifications are intended for runway pavement overlay projects when the runway is to be returned temporarily to an operational status before resurfacing

is complete. This may necessitate a temporary ramp between the new and old runway surfaces. Guidance on overlaying pavements and assessing their operational status is given in the Aerodrome Design Manual (Doc 9157), Part 3.

10.4.1 The longitudinal slope of the temporary ramp, measured with reference to the existing runway surface or previous overlay course, shall be:

(a) 0.5 to 1.0 per cent for overlays up to and including 5 cm in thickness; and

(b) not more than 0.5 per cent for overlays more than 5 cm in thickness.

10.4.2 **Recommendation -** Overlaying should proceed from one end of the runway toward the other end so that based on runway utilization most aircraft operations will experience a down ramp.

10.4.3 **Recommendation -** The entire width of the runway should be overlaid during each work session.

10.4.4 **Recommendation -** Before a runway being overlaid is returned to a temporary operational status, a runway centre line marking conforming to the specifications in Section 5.2.3 should be provided. Additionally, the location of any temporary threshold should be identified by a 3.6 m wide transverse stripe.

10.4.5 **Recommendation -** The overlay should be constructed and maintained above the minimum friction level specified in 10.2.3.

10.5 Visual aids

10.5.1 A light shall be deemed to be unserviceable when the main beam average intensity is less than 50% of the value specified in the appropriate figure in ICAO Annex 14 Volume I Appendix 2. For light units where the main beam average intensity is required to be higher than the value specified in the appropriate figure in Appendix 2, a light shall be deemed to be unserviceable when the main beam average intensity value is less than 50 per cent of this higher value and not the value specified in Appendix 2.

Note.— Guidance on maintenance criteria for aeronautical ground lights, on the use of a site standard and on using a higher main beam average intensity is contained in the Aerodrome Design Manual (Doc 9157), Part 4.

10.5.2 A system of preventive maintenance of visual aids shall be employed to ensure lighting and marking systems reliability.

Note.—Guidance on preventive maintenance of visual aids is given in the ICAO Airport Services Manual (Doc 9137), Part 9.

10.5.3 **Recommendation -** The system of preventive maintenance employed for a precision approach runway category II or III should include at least the following checks:

a) visual inspection and in-field measurement of the intensity, beam spread and orientation of lights included in the approach and runway lighting systems;

b) control and measurement of the electrical characteristics of each circuitry included in the approach and runway lighting systems; and

c) control of the correct functioning of light intensity settings used by air traffic control.

10.5.4 **Recommendation -** In-field measurement of intensity, beam spread and orientation of lights included in approach and runway lighting systems for a precision approach runway category II or III should be undertaken by measuring all lights, as far as practicable, to ensure conformance with the applicable specification of ICAO Annex 14, Volume I, Appendix 2.

10.5.5 **Recommendation -** Measurement of intensity, beam spread and orientation of lights included in approach and runway lighting systems for a precision approach runway category II or III should be undertaken using a mobile measuring unit of sufficient accuracy to analyse the characteristics of the individual lights.

10.5.6 **Recommendation -** The frequency of measurement of lights for a precision approach runway category II or III should be based on traffic density, the local pollution level, the reliability of the installed lighting equipment and the continuous assessment of the results of the in-field measurements but, in any event, should not be less than twice a year for in-pavement lights and not less than once a year for other lights.

10.5.7 The system of preventive maintenance employed for a precision approach runway category II or III shall have as its objective that, during any period of category II or III operations, all approach and runway lights are serviceable and that, in any event, at least:

a) 95% of the lights are serviceable in each of the following particular significant elements:

1) precision approach category II and III lighting system, the inner 450 m;

2) runway centre line lights;

3) runway threshold lights; and

4) runway edge lights;

b) 90% of the lights are serviceable in the touchdown zone lights;

c) 85% of the lights are serviceable in the approach lighting system beyond 450 m; and

d) 75% of the lights are serviceable in the runway end lights.

In order to provide continuity of guidance, the allowable percentage of unserviceable lights shall not be permitted in such a way as to alter the basic pattern of the lighting system. Additionally, an unserviceable light shall not be permitted adjacent to another unserviceable light, except in a barrette or a crossbar where two adjacent unserviceable lights may be permitted.

10.5.8 The system of preventive maintenance employed for a stop bar provided at a runway-holding position used in conjunction with a runway intended for operations in runway visual range conditions less than a value of 300 m shall have the following objectives:

a) no more than two lights will remain unserviceable; and

b) two adjacent lights will not remain unserviceable unless the light spacing is significantly less than that specified.

10.5.9 The system of preventive maintenance employed for a taxiway intended for use in runway visual range conditions less than a value of 300 m shall have as its objective that no two adjacent taxiway centre line lights be unserviceable.

10.5.10 The system of preventive maintenance employed for a precision approach runway category I shall have as its objective that, during any period of category I operations, all approach and runway lights are serviceable and that, in any event, at least 85% of the lights are serviceable in each of the following:

a) Precision approach category I lighting system;

b) Runway threshold lights;

c) Runway edge lights; and

d) Runway end lights.

In order to provide continuity of guidance an unserviceable light shall not be permitted adjacent to another unserviceable light unless the light spacing is significantly less than that specified.

10.5.11 The system of preventive maintenance employed for a runway meant for take-off in runway visual range conditions less than a value of 550 m shall have as its objective thjat, during any period of operations, all runway lights are serviceable and that in any event:

a) At least 95% of the lights are serviceable in the runway centre lights (where provided) and in the runway edge lights; and

b) At least 75% of the lights are serviceable in the runway end lights.

In order to provide continuity of guidance an unserviceable light shall not be permitted adjacent to another unserviceable light.

10.5.12 The system of preventive maintenance employed for a runway meant for take-off in runway visual range conditions of a value of 550 m or greater shall have as its objective that, during any period of operations, all runway lights are serviceable and that, in any event, at least 85% of the lights are serviceable in the runway edge lights and runway end lights. In order to provide continuity of guidance, an unserviceable light shall not be permitted adjacent to another unserviceable light.

10.5.13 During low visibility procedures the appropriate authority shall restrict construction or maintenance activities in the proximity of aerodrome electrical systems.

Chapter 11. Aeronautical Study

11.1 Requirements

11.1.1 An Aeronautical Study shall be conducted by an aerodrome operator to assess the impact of deviations from the aerodrome requirements of BAR 14 Volume I – Aerodromes, to present alternative means of compliance that ensure the safety of aircraft operations, to estimate the effectiveness of each alternative and to recommend procedures to compensate for the deviation.

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

11.1.3 Aeronautical studies may not be conducted in cases of deviations from requirements if not specifically recommended in BAR 14 Volume I Aerodromes.

11.1.4 Technical analysis will provide justification for a deviation on the grounds that an equivalent level of safety can be attained by other means. It is generally applicable in situations where the cost of correcting a problem that violates a requirement is excessive but where the unsafe effects of the problem can be overcome by some procedural means which offers both practical and reasonable solutions.

11.1.5 In conducting a technical analysis and when considering alternative procedures in the deviation approval process, Brunei DCA [RASS] shall draw upon their practical experience and specialized knowledge. Brunei DCA [RASS] may also consult other specialists in relevant areas. It is essential to bear in mind the safety objective of the aerodrome certification requirements and the applicable standards so that the intent of the requirements is not circumvented.

11.1.6 *Acceptance of deviations*. In some instances, the only reasonable means of providing an equivalent level of safety is to adopt suitable procedures and to require as a condition of certification, that cautionary advice be published in the appropriate AIS publication.

11.1.7 The determination to require caution will be primarily dependent on two considerations:

i. A pilot's need to be made aware of potentially hazardous conditions, and

ii. The responsibility of the Brunei DCA [RASS] to publish deviations from these requirements that would otherwise be assumed under certificate status.

Note.1 - Examples of guidance on the methodology to be used for Aeronautical Study can be found in ICAO Circular 329, Assessment, Measurement and Reporting of Runway Surface Condition, Chapters 5 and 7.

Note.2 - Additional information for conducting an Aeronautical Study can be found Guidance ADR 023 – Conducting an aeronautical study or safety assessment

Chapter 12. Contracted Activities

12.1 Requirement

(a) Contracted activities include all activities within the aerodrome operator's scope in accordance with the terms of the certificate (e.g. Ground Handling, repair work, etc) that are performed by other organisations either itself certified to carry out such activity or if not certified, working under the aerodrome operator's approval. The aerodrome operator shall ensure that when contracting or purchasing any part of its activity, the contracted or purchased service or equipment or system conforms to the applicable requirements including applicable SMSs.

(b) When an aerodrome operator contracts any part of its activity to an organisation that is not itself certified in accordance with this Part to carry out such activity, the contracted organisation shall work under the approval and oversight of the aerodrome operator. The aerodrome operator shall ensure that the Brunei DCA is given access to the contracted organisation, to determine continued compliance with the applicable requirements.

Chapter 13. Obstacle Control

13.1 Requirement

(a) Obstacle control raises an issue in regard to the responsibilities of each potential party involved. The responsibilities of those parties shall be clearly defined and established by an aerodrome operator as follows:

i) who is responsible for obstacle surveys;

ii) who is responsible for the surveillance of the emergence of new obstacles; and

iii) when obstacles are identified, who is responsible for taking action (i.e. removal, marking, lighting, displacement, instrument procedures) and enforcing that action.

(b) Once the responsibilities have been defined, appropriate authority shall be given to the entity responsible for the enforcement action required.

(c) Arrangements shall be made by the aerodrome operator to enable the Brunei DCA to be consulted concerning b) or proposed construction beyond the limits of the obstacle limitation surfaces that extend above a height established by the Brunei DCA, in order to permit an aeronautical study or safety risk assessment of the effect of such construction on the operation of aircrafts.

Note 1.— Guidance on the control of obstacles including roles and responsibilities of stakeholders is given in ADR 033 Obstacle Control .

Note 2. – Additional guidance on the control of obstacles, roles and responsibilities of stakeholders and the practices of certain States can be found in Doc 9137 — Airport Services Manual, Part 6 — Control of Obstacles. And and ICAO Doc 8168, Procedures for Air Navigation Services – Aircraft Operations Volume I and II (PANS-OPS)

Chapter 14. Appendices

Appendix 1 Colours for Aeronautical Ground Lights, Markings, Signs and Panels

See Appendix 1 from ICAO Annex 14, Volume I - Aerodromes for the detailed specifications

Appendix 2 Aeronautical Ground Light Characteristics

See Appendix 2 from ICAO Annex 14, Volume I - Aerodromes for the detailed specifications

Appendix 3 Mandatory Instruction Markings and Information Markings

See Appendix 3 from ICAO Annex 14, Volume I - Aerodromes for the detailed specifications

Appendix 4 Requirements Concerning Design of Taxiing Guidance Signs

See Appendix 4 from ICAO Annex 14, Volume I - Aerodromes for the detailed specifications

Appendix 5 Location of Lights on Obstacles

See Appendix 5 from ICAO Annex 14, Volume I - Aerodromes for the detailed specifications

Chapter 15. Attachments

15.1 Attachment A - Guidance Material Supplementary to BAR 14 Volume 1

1. Number, siting and orientation of runways

Siting and orientation of runways

1.1 Many factors should be taken into account in the determination of the siting and orientation of runways. Without attempting to provide an exhaustive list of these factors nor an analysis of their effects, it appears useful to indicate those which most frequently require study. These factors may be classified under four headings:

1.1.1 *Type of operation.* Attention should be paid in particular to whether the aerodrome is to be used in all meteorological conditions or only in visual meteorological conditions, and whether it is intended for use by day and night, or only by day.

1.1.2 *Climatological conditions.* A study of the wind distribution should be made to determine the usability factor. In this regard, the following comments should be taken into account:

a) Wind statistics used for the calculation of the usability factor are normally available in ranges of speed and direction, and the accuracy of the results obtained depends, to a large extent, on the assumed distribution of observations within these ranges. In the absence of any sure information as to the true distribution, it is usual to assume a uniform distribution since, in relation to the most favourable runway orientations, this generally results in a slightly conservative usability factor.

b) The maximum mean crosswind components given in Chapter 3, 3.1.3, refer to normal circumstances. There are some factors which may require that a reduction of those maximum values be taken into account at a particular aerodrome. These include:

1) the wide variations which may exist, in handling characteristics and maximum permissible crosswind components, among diverse types of aeroplanes (including future types) within each of the three groups given in 3.1.3;

2) prevalence and nature of gusts;

3) prevalence and nature of turbulence;

4) the availability of a secondary runway;

5) the width of runways;

6) the runway surface conditions — water on the runway materially reduce the allowable crosswind component; and

7) the strength of the wind associated with the limiting crosswind component.

A study should also be made of the occurrence of poor visibility and/or low cloud base. Account should be taken of their frequency as well as the accompanying wind direction and speed.

1.1.3 *Topography of the aerodrome site, its approaches, and surroundings,* particularly:

a) compliance with the obstacle limitation surfaces;

b) current and future land use. The orientation and layout should be selected so as to protect as far as possible the particularly sensitive areas such as residential, school and hospital zones from the discomfort caused by aircraft noise. Detailed information on this topic is provided in the *Airport Planning Manual* (Doc 9184), Part 2, and in *Guidance on the Balanced Approach to Aircraft Noise Management* (Doc 9829);

c) current and future runway lengths to be provided;

d) construction costs; and

e) possibility of installing suitable non-visual and visual aids for approach-to-land.

1.1.4 *Air traffic in the vicinity of the aerodrome,* particularly:

a) proximity of other aerodromes or ATS routes;

b) traffic density; and

c) air traffic control and missed approach procedures.

Number of runways in each direction

1.2 The number of runways to be provided in each direction depends on the number of aircraft movements to be catered to.

2. Clearways and stopways

2.1 The decision to provide a stopway and/or a clearway as an alternative to an increased length of runway will depend on the physical characteristics of the area beyond the runway end, and on the operating performance requirements of the prospective aeroplanes. The runway, stopway and clearway lengths to be provided are determined by the aeroplane take-off performance, but a check should also be made of the landing distance required by the aeroplanes using the runway to ensure that adequate runway length is provided for landing. The length of a clearway, however, cannot exceed half the length of take-off run available.

2.2 The aeroplane performance operating limitations require a length which is enough to ensure that the aeroplane can, after starting a take-off, either be brought safely to a stop or complete the take-off safely. For the purpose of discussion it is supposed that the runway, stopway and clearway lengths provided at the aerodrome are only just adequate for the aeroplane requiring the longest take-off and accelerate-stop distances, taking into account its take-off mass, runway characteristics and ambient atmospheric conditions. Under these circumstances there is, for each take-off, a speed, called the decision speed; below this speed, the take-off must be abandoned if an engine fails, while above it the take-off must be completed. A very long take-off run and take-off distance would be required to complete a take-off when an engine fails before the decision speed is reached, because of the insufficient speed and the reduced power available. There would be no difficulty in stopping in the remaining accelerate-stop distance available provided action is taken immediately. In these circumstances the correct course of action would be to abandon the take-off.

2.3 On the other hand, if an engine fails after the decision speed is reached, the aeroplane will have sufficient speed and power available to complete the take-off

safely in the remaining take-off distance available. However, because of the high speed, there would be difficulty in stopping the aeroplane in the remaining accelerate-stop distance available.

2.4 The decision speed is not a fixed speed for any aeroplane, but can be selected by the pilot within limits to suit the accelerate-stop and take-off distance available, aeroplane take-off mass, runway characteristics and ambient atmospheric conditions at the aerodrome. Normally, a higher decision speed is selected as the accelerate-stop distance available increases.

2.5 A variety of combinations of accelerate-stop distances required and take-off distances required can be obtained to accommodate a particular aeroplane, taking into account the aeroplane take-off mass, runway characteristics, and ambient atmospheric conditions. Each combination requires its particular length of take-off run.

2.6 The most familiar case is where the decision speed is such that the take-off distance required is equal to the accelerate-stop distance required; this value is known as the balanced field length. Where stopway and clearway are not provided, these distances are both equal to the runway length. However, if landing distance is for the moment ignored, runway is not essential for the whole of the balanced field length, as the take-off run required is, of course, less than the balanced field length. The balanced field length can, therefore, be provided by a runway supplemented by an equal length of clearway and stopway, instead of wholly as a runway. If the runway is used for take-off in both directions, an equal length of clearway and stopway has to be provided at each runway end. The saving in runway length is, therefore, bought at the cost of a greater overall length.

2.7 In case economic considerations preclude the provision of stopway and, as a result, only runway and clearway are to be provided, the runway length (neglecting landing requirements) should be equal to the accelerate-stop distance required or the take-off run required, whichever is the greater. The take-off distance available will be the length of the runway plus the length of clearway.

2.8 The minimum runway length and the maximum stopway or clearway length to be provided may be determined as follows, from the data in the aeroplane flight manual for the aeroplane considered to be critical from the viewpoint of runway length requirements:

a) if a stopway is economically possible, the lengths to be provided are those for the balanced field length. The runway length is the take-off run required or the landing distance required, whichever is the greater. If the accelerate-stop distance required is greater than the runway length so determined, the excess may be provided as stopway, usually at each end of the runway. In addition, a clearway of the same length as the stopway must also be provided;

b) if a stopway is not to be provided, the runway length is the landing distance required, or if it is greater, the accelerate-stop distance required, which corresponds to the lowest practical value of the decision speed. The excess of the take-off distance required over the runway length may be provided as clearway, usually at each end of the runway.

2.9 In addition to the above consideration, the concept of clearways in certain circumstances can be applied to a situation where the take-off distance required for all engines operating exceeds that required for the engine failure case.

2.10 The economy of a stopway can be entirely lost if, after each usage, it must be regraded and compacted. Therefore, it should be designed to withstand at least a certain number of loadings of the aeroplane which the stopway is intended to serve without inducing structural damage to the aeroplane.

3. Calculation of declared distances

3.1 The declared distances to be calculated for each runway direction comprise: the take-off run available (TORA), take-off distance available (TODA), accelerate-stop distance available (ASDA), and landing distance available (LDA).

3.2 Where a runway is not provided with a stopway or clearway and the threshold is located at the extremity of the runway, the four declared distances should normally be equal to the length of the runway, as shown in Figure A-1 (A).

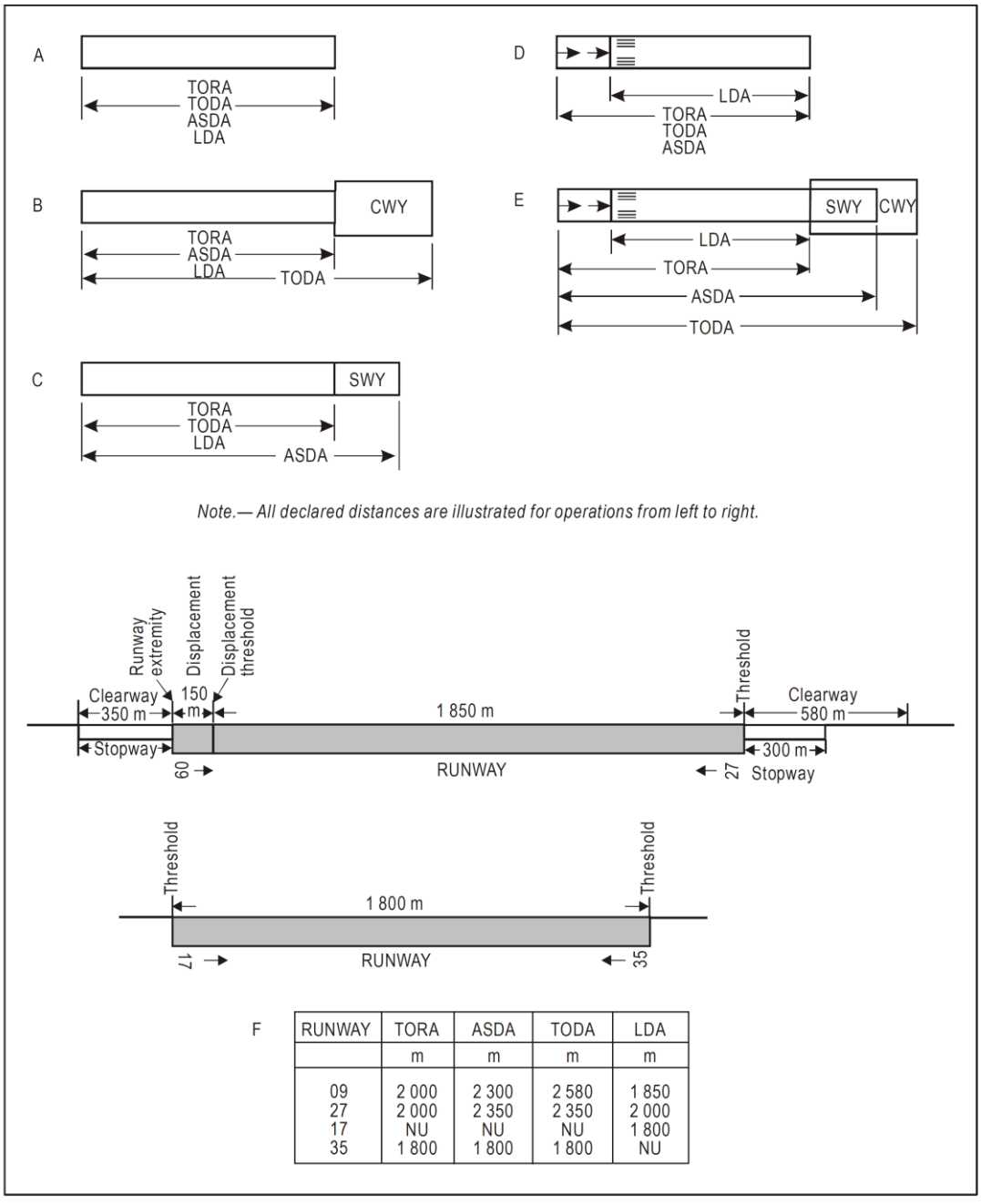
3.3 Where a runway is provided with a clearway (CWY), then the TODA will include the length of clearway, as shown in Figure A-1 (B).

3.4 Where a runway is provided with a stopway (SWY), then the ASDA will include the length of stopway, as shown in Figure A-1 (C).

3.5 Where a runway has a displaced threshold, then the LDA will be reduced by the distance the threshold is displaced, as shown in Figure A-1 (D). A displaced threshold affects only the LDA for approaches made to that threshold; all declared distances for operations in the reciprocal direction are unaffected.

3.6 Figures A-1 (B) through A-1 (D) illustrate a runway provided with a clearway or a stopway or having a displaced threshold. Where more than one of these features exist, then more than one of the declared distances will be modified — but the modification will follow the same principle illustrated. An example showing a situation where all these features exist is shown in Figure A-1 (E).

3.7 A suggested format for providing information on declared distances is given in Figure A-1 (F). If a runway direction cannot be used for take-off or landing, or both, because it is operationally forbidden, then this should be declared and the words “not usable” or the abbreviation “NU” entered.



RUNWAY	TORA	ASDA	TODA	LDA
	m	m	m	m
09	2 000	2 300	2 580	1 850
27	2 000	2 350	2 350	2 000
17	NU	NU	NU	1 800
35	1 800	1 800	1 800	NU

Figure A-1. Illustration of declared distances

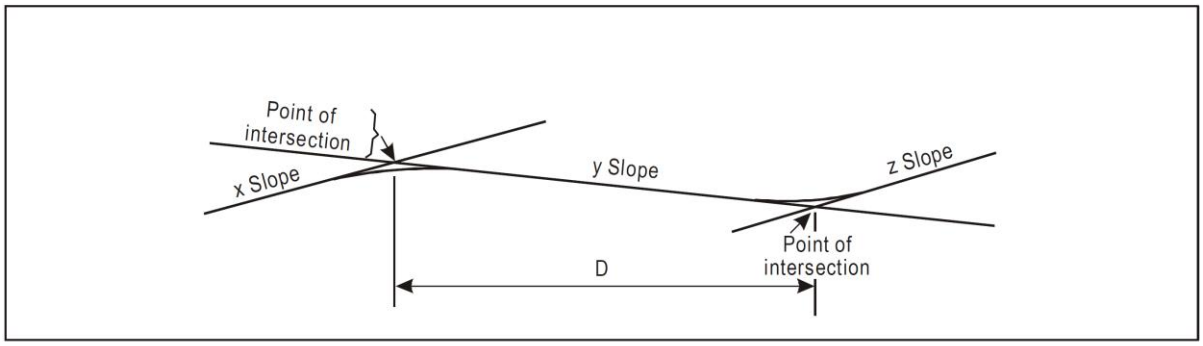


Figure A-2. Profile on centre line of runway

4. Slopes on a runway

4.1 Distance between slope changes

The following example illustrates how the distance between slope changes is to be determined (see Figure A-2): D for a runway where the code number is 3 should be at least:

15 000 (|x – y| + |y – z|) m

|x – y| being the absolute numerical value of x – y

|y – z| being the absolute numerical value of y – z

Assuming x = +0.01

Assuming y = –0.005

Assuming z = +0.005

then |x – y| = 0.015

then |y – z| = 0.01

To comply with the specifications, D should be not less than:

15 000 (0.015 + 0.01) m,

that is, 15 000 × 0.025 = 375 m

4.2 Consideration of longitudinal and transverse slopes

When a runway is planned that will combine the extreme values for the slopes and changes in slope permitted under Chapter 3, 3.1.13 to 3.1.19, a study should be made to ensure that the resulting surface profile will not hamper the operation of aeroplanes.

4.3 Radio altimeter operating area

In order to accommodate aeroplanes making auto-coupled approaches and automatic landings (irrespective of weather conditions) it is desirable that slope changes be avoided or kept to a minimum, on a rectangular area at least 300 m long before the threshold of a precision approach runway. The area should be symmetrical about the extended centre line, 120 m wide. When special circumstances so warrant, the width may be reduced to no less than 60 m if an

aeronautical study indicates that such reduction would not affect the safety of operations of aircraft. This is desirable because these aeroplanes are equipped with a radio altimeter for final height and flare guidance, and when the aeroplane is above the terrain immediately prior to the threshold, the radio altimeter will begin to provide information to the automatic pilot for auto-flare.

Where slope changes cannot be avoided, the rate of change between two consecutive slopes should not exceed 2 per cent per 30 m.

5. Runway surface evenness

5.1 In adopting tolerances for runway surface irregularities, the following standard of construction is achievable for short distances of 3 m and conforms to good engineering practice:

Except across the crown of a camber or across drainage channels, the finished surface of the wearing course is to be of such regularity that, when tested with a 3 m straight-edge placed anywhere in any direction on the surface, there is no deviation greater than 3 mm between the bottom of the straight-edge and the surface of the pavement anywhere along the straight-edge.

5.2 Caution should also be exercised when inserting runway lights or drainage grilles in runway surfaces to ensure that adequate smoothness of the surface is maintained.

5.3 The operation of aircraft and differential settlement of surface foundations will eventually lead to increases in surface irregularities. Small deviations in the above tolerances will not seriously hamper aircraft operations. In general, isolated irregularities of the order of 2.5 cm to 3 cm over a 45 m distance are acceptable, as shown in Figure A-3. Although maximum acceptable deviations vary with the type and speed of an aircraft, the limits of acceptable surface irregularities can be estimated to a reasonable extent. The following table describes acceptable, tolerable and excessive limits:

a) if the surface irregularities exceed the heights defined by the acceptable limit curve but are less than the heights defined by the tolerable limit curve, at the specified minimum acceptable length, herein noted by the tolerable region, then maintenance action should be planned. The runway may remain in service. This region is the start of possible passenger and pilot discomfort;

b) if the surface irregularities exceed the heights defined by the tolerable limit curve, but are less than the heights defined by the excessive limit curve, at the specified minimum acceptable length, herein noted by the excessive region, then maintenance corrective action is mandatory to restore the condition to the acceptable region. The runway may remain in service but be repaired within a reasonable period. This region could lead to the risk of possible aircraft structural damage due to a single event or fatigue failure over time; and

c) if the surface irregularities exceed the heights defined by the excessive limit curve, at the specified minimum acceptable length, herein noted by the unacceptable region, then the area of the runway where the roughness has been identified warrants closure. Repairs must be made to restore the condition to within the acceptable limit region and the aircraft operators

may be advised accordingly. This region runs the extreme risk of a structural failure and must be addressed immediately.

Surface irregularity	Length of irregularity (m)								
	3	6	9	12	15	20	30	45	60
Acceptable surface irregularity height (cm)	2.9	3.8	4.5	5	5.4	5.9	6.5	8.5	10
Tolerable surface irregularity height (cm)	3.9	5.5	6.8	7.8	8.6	9.6	11	13.6	16
Excessive surface irregularity height (cm)	5.8	7.6	9.1	10	10.8	11.9	13.9	17	20

Note that “surface irregularity” is defined herein to mean isolated surface elevation deviations that do not lie along a uniform slope through any given section of a runway. For the purposes of this concern, a “section of a runway” is defined herein to mean a segment of a runway throughout which a continuing general uphill, downhill or flat slope is prevalent. The length of this section is generally between 30 and 60 metres, and can be greater, depending on the longitudinal profile and the condition of the pavement.

The maximum tolerable step type bump, such as that which could exist between adjacent slabs, is simply the bump height corresponding to zero bump length at the upper end of the tolerable region of the roughness criteria of Figure A-3. The bump height at this location is 1.75 cm.

5.4 Figure A-3 illustrates a comparison of the surface roughness criteria with those developed by the United States Federal Aviation Administration. Further guidance regarding temporary slopes for overlay works on operational runways can be found in the *Aerodrome Design Manual*, Part 3 — *Pavements* (Doc 9157).

5.5 Deformation of the runway with time may also increase the possibility of the formation of water pools. Pools as shallow as approximately 3 mm in depth, particularly if they are located where they are likely to be encountered at high speed by landing aeroplanes, can induce aquaplaning, which can then be sustained on a wet runway by a much shallower depth of water. Improved guidance regarding the significant length and depth of pools relative to aquaplaning is the subject of further research. It is, of course, especially necessary to prevent pools from forming whenever there is a possibility that they might become frozen.

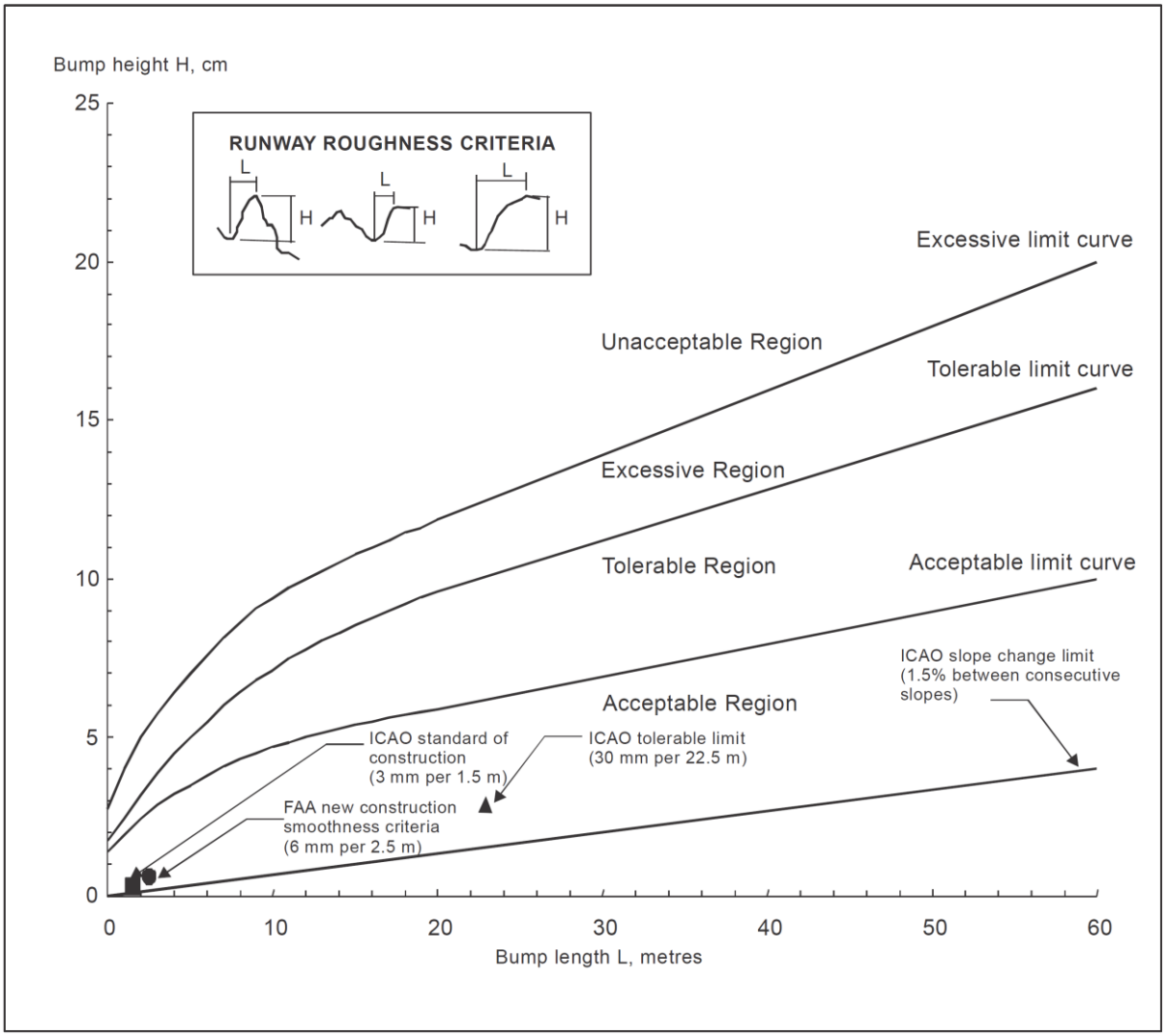


Figure A-3. Comparison of roughness criteria

Note.— These criteria address single event roughness, not long wavelength harmonic effects nor the effect of repetitive surface undulations.

6. Runway condition report for reporting runway surface condition

6.1 On a global level, movement areas are exposed to a multitude of climatic conditions and consequently a significant difference in the condition to be reported. The runway condition report (RCR) describes a basic methodology applicable for all these climatic variations and is structured in such a way that States can adjust them to the climatic conditions applicable for that State or region.

6.2 The concept of the RCR is premised on:

a) an agreed set of criteria used in a consistent manner for runway surface condition assessment, aeroplane (performance) certification and operational performance calculation;

b) a unique runway condition code (RWYCC) linking the agreed set of criteria with the aircraft landing and takeoff performance table, and related to the braking action experienced and eventually reported by flight crews;

c) reporting of contaminant type and depth that is relevant to take-off performance;

d) a standardized common terminology and phraseology for the description of runway surface conditions that can be used by aerodrome operator inspection personnel, air traffic controllers, aircraft operators and flight crew; and

e) globally-harmonized procedures for the establishment of the RWYCC with a built-in flexibility to allow for local variations to match the specific weather, infrastructure and other particular conditions.

6.3 These harmonized procedures are reflected in a runway condition assessment matrix (RCAM) which correlates the RWYCC, the agreed set of criteria and the aircraft braking action which the flight crew should expect for each value of the RWYCC.

6.4 Procedures which relate to the use of the RCAM are provided in the PANS-Aerodromes (Doc 9981).

6.5 It is recognized that information provided by the aerodrome's personnel assessing and reporting runway surface condition is crucial to the effectiveness of the runway condition report. A misreported runway condition alone should not lead to an accident or incident. Operational margins should cover for a reasonable error in the assessment, including unreported changes in the runway condition. But a misreported runway condition can mean that the margins are no longer available to cover for other operational variance (such as unexpected tailwind, high and fast approach above threshold or long flare).

6.6 This is further amplified by the need for providing the assessed information in the proper format for dissemination, which requires insight into the limitations set by the syntax for dissemination. This in turn restricts the wording of plain text remarks that can be provided.

6.7 It is important to follow standard procedures when providing assessed information on the runway surface conditions to ensure that safety is not compromised when aeroplanes use wet or contaminated runways. Personnel should be trained in the relevant fields of competence and their competence verified in a manner required by the State to ensure confidence in their assessments.

6.8 The training syllabus may include initial and periodic recurrent training in the following areas:

a) aerodrome familiarization, including aerodrome markings, signs and lighting;

b) aerodrome procedures as described in the aerodrome manual;

c) aerodrome emergency plan;

d) Notice to Airmen (NOTAM) initiation procedures;

e) completion of/initiation procedures for RCR;

f) aerodrome driving rules;

g) air traffic control procedures on the movement area;

h) radiotelephone operating procedures;

i) phraseology used in aerodrome control, including the ICAO spelling alphabet;

j) aerodrome inspection procedures and techniques;

k) type of runway contaminants and reporting;

l) assessment and reporting of runway surface friction characteristics;

m) use of runway friction measurement device;

n) calibration and maintenance of runway friction measurement device;

o) awareness of uncertainties related to l) and m); and

p) low visibility procedures.

7. Drainage characteristics of the movement area and adjacent areas

7.1 General

7.1.1 Rapid drainage of surface water is a primary safety consideration in the design, construction and maintenance of the movement area and adjacent areas. The objective is to minimize water depth on the surface by draining water off the runway in the shortest path possible and particularly out of the area of the wheel path. There are two distinct drainage processes taking place:

a) natural drainage of the surface water from the top of the pavement surface until it reaches the final recipient such as rivers or other water bodies; and

b) dynamic drainage of the surface water trapped under a moving tire until it reaches outside the tire-to-ground contact area.

7.1.2 Both processes can be controlled through:

a) design;

b) construction; and

c) maintenance.

of the pavements in order to prevent accumulation of water on the pavement surface.

7.2 Design of pavement

7.2.1 Surface drainage is a basic requirement and serves to minimize water depth on the surface. The objective is to drain water off the runway in the shortest path. Adequate surface drainage is provided primarily by an appropriately sloped surface (in both the longitudinal and transverse directions). The resulting combined longitudinal and transverse slope is the path for the drainage run-off. This path can be shortened by adding transverse grooves.

7.2.2 Dynamic drainage is achieved through built-in texture in the pavement surface. The rolling tire builds up water pressure and squeezes the water out the escape channels provided by the texture. The dynamic drainage of the tire-to-ground contact area may be improved by adding transverse grooves provided that they are subject to rigorous maintenance.

7.3 Construction of pavement

7.3.1 Through construction, the drainage characteristics of the surface are built into the pavement. These surface characteristics are:

a) slopes;

b) texture:

1) microtexture;

2) macrotexture;

7.3.2 Slopes for the various parts of the movement area and adjacent parts are described in Chapter 3 and figures are given as per cent. Further guidance is given in the *Aerodrome Design Manual* (Doc 9157), Part 1, Chapter 5.

7.3.3 Texture in the literature is described as microtexture or macrotexture. These terms are understood differently in various parts of the aviation industry.

7.3.4 Microtexture is the texture of the individual stones and is hardly detectable by the eye. Microtexture is considered a primary component in skid resistance at slow speeds. On a wet surface at higher speeds a water film may prevent direct contact between the surface asperities and the tire due to insufficient drainage from the tire-to-ground contact area.

7.3.5 Microtexture is a built-in quality of the pavement surface. By specifying crushed material that will withstand polishing microtexture, drainage of thin waterfilms are ensured for a longer period of time. Resistance against polishing is expressed in terms of the Polished Stone Values (PSV) which is in principle a value obtained from a friction measurement in accordance with international standards. These standards define the PSV minima that will enable a material with a good microtexture to be selected.

7.3.6 A major problem with microtexture is that it can change within short time periods without being easily detected. A typical example of this is the accumulation of rubber deposits in the touchdown area which will largely mask microtexture without necessarily reducing macrotexture.

7.3.7 Macrotexture is the texture among the individual stones. This scale of texture may be judged approximately by the eye. Macrotexture is primarily created by the size of aggregate used or by surface treatment of the pavement and is the major factor influencing drainage capacity at high speeds. Materials shall be selected so as to achieve good macrotexture.

7.3.8 The primary purpose of grooving a runway surface is to enhance surface drainage. Natural drainage can be slowed down by surface texture, but grooving can speed up the drainage by providing a shorter drainage path and increasing the drainage rate.

7.3.9 For measurement of macrotexture, simple methods such as the “sand and grease patch” methods described in the *Airport Services Manual* (Doc 9137), Part 2 were developed. These methods were used for the early research on which current airworthiness requirements are based, which refer to a classification categorizing macrotexture from A to E. This classification was developed, using sand or grease patch measuring techniques, and issued in 1971 by the Engineering Sciences Data Unit (ESDU).

Runway classification based on texture information from ESDU 71026:

Classification	*Texture depths (mm)*
A	0.10 – 0.14
B	0.15 – 0.24
C	0.25 – 0.50
D	0.51 – 1.00
E	1.01 – 2.54

7.3.10 Using this classification, the threshold value between microtexture and macrotexture is 0.1 mm mean texture depth (MTD). Related to this scale, the normal wet runway aircraft performance is based upon texture giving drainage and friction qualities midway between classification B and C (0.25 mm). Improved drainage through better texture might qualify for a better aircraft performance class. However such credit must be in accordance with aeroplane manufacturers' documentation and agreed by the State. Presently credit is given to grooved or porous friction course runways following design, construction and maintenance criteria acceptable to the State. The harmonized certification standards of some States refer to texture giving drainage and friction qualities midway between classification D and E (1.0 mm).

7.3.11 For construction, design and maintenance, States use various international standards. Currently *ISO 13473-1: Characterization of pavement texture by use of surface profiles — Part 1: Determination of Mean Profile Depth* links the volumetric measuring technique with non-contact profile measuring techniques giving comparable texture values. These standards describe the threshold value between microtexture and macrotexture as 0.5 mm. The volumetric method has a validity range from 0.25 to 5 mm MTD. The profilometry method has a validity range from 0 to 5 mm mean profile depth (MPD). The values of MPD and MTD differ due to the finite size of the glass spheres used in the volumetric technique and because the MPD is derived from a two-dimensional profile rather than a three-dimensional surface. Therefore a transformation equation must be established for the measuring equipment used to relate MPD to MTD.

7.3.12 The ESDU scale groups runway surfaces based on macrotexture from A through E, where E represents the surface with best dynamic drainage capacity. The ESDU scale thus reflects the dynamic drainage characteristics of the pavement. Grooving any of these surfaces enhances the dynamic drainage capacity. The resulting drainage capacity of the surface is thus a function of the texture (A through E) and grooving. The contribution from grooving is a function of the size of the grooves and the spacing between the grooves. Aerodromes exposed to heavy or torrential rainfall must ensure that the pavement and adjacent areas have drainage capability to withstand these rainfalls or put limitations on the use of the pavements under such extreme situations. These airports should seek to have the maximum allowable slopes and the use of aggregates providing good drainage characteristics. They should also consider grooved pavements in the E classification to ensure that safety is not impaired.

7.4 Maintenance of drainage characteristics of pavement

7.4.1 Macrotexture does not change within a short timespan but accumulation of rubber can fill up the texture and as such reduce the drainage capacity, which can result in impaired safety. Furthermore the runway structure may change over time and

give unevenness which results in ponding after rainfall. Guidance on rubber removal and unevenness can be found in the *Airport Services Manual* (Doc 9137), Part 2. Guidance on methods for improving surface texture can be found in the *Aerodrome Design Manual* (Doc 9157), Part 3.

7.4.2 When groovings are used, the condition of the grooves should be regularly inspected to ensure that no deterioration has occurred and that the grooves are in good condition. Guidance on maintenance of pavements is available in the *Airport Services Manual* (Doc 9137), Part 2 — *Pavement Surface Conditions* and Part 9 — *Airport Maintenance Practices* and the *Aerodrome Design Manual* (Doc 9157), Part 2.

7.4.3 The pavement may be shot blasted in order to enhance the pavement macrotexture.

8. Strips

8.1 Shoulders

8.1.1 The shoulder of a runway or stopway should be prepared or constructed so as to minimize any hazard to an aeroplane running off the runway or stopway. Some guidance is given in the following paragraphs on certain special problems which may arise, and on the further question of measures to avoid the ingestion of loose stones or other objects by turbine engines.

8.1.2 In some cases, the bearing strength of the natural ground in the strip may be sufficient, without special preparation, to meet the requirements for shoulders. Where special preparation is necessary, the method used will depend on local soil conditions and the mass of the aeroplanes the runway is intended to serve. Soil tests will help in determining the best method of improvement (e.g. drainage, stabilization, surfacing, light paving).

8.1.3 Attention should also be paid when designing shoulders to prevent the ingestion of stones or other objects by turbine engines. Similar considerations apply here to those which are discussed for the margins of taxiways in the *Aerodrome Design Manual* (Doc 9157), Part 2, both as to the special measures which may be necessary and as to the distance over which such special measures, if required, should be taken.

8.1.4 Where shoulders have been treated specially, either to provide the required bearing strength or to prevent the presence of stones or debris, difficulties may arise because of a lack of visual contrast between the runway surface and that of the adjacent strip. This difficulty can be overcome either by providing a good visual contrast in the surfacing of the runway or strip, or by providing a runway side stripe marking.

8.2 Objects on strips

Within the general area of the strip adjacent to the runway, measures should be taken to prevent an aeroplane's wheel, when sinking into the ground, from striking a hard vertical face. Special problems may arise for runway light fittings or other objects mounted in the strip or at the intersection with a taxiway or another runway. In the case of construction, such as runways or taxiways, where the surface must also be flush with the strip surface, a vertical face can be eliminated by chamfering from the top of the construction to not less than 30 cm below the strip surface level. Other objects, the functions of which do not require them to be at surface level, should be buried to a depth of not less than 30 cm.

8.3 Grading of a strip for precision approach runways

Chapter 3, 3.4.8, recommends that the portion of a strip of an instrument runway within at least 75 m from the centre line should be graded where the code number is 3 or 4. For a precision approach runway, it may be desirable to adopt a greater width where the code number is 3 or 4. Figure A-4 shows the shape and dimensions of a wider strip that may be considered for such a runway. This strip has been designed using information on aircraft running off runways. The portion to be graded extends to a distance of 105 m from the centre line, except that the distance is gradually reduced to 75 m from the centre line at both ends of the strip, for a length of 150 m from the runway end.

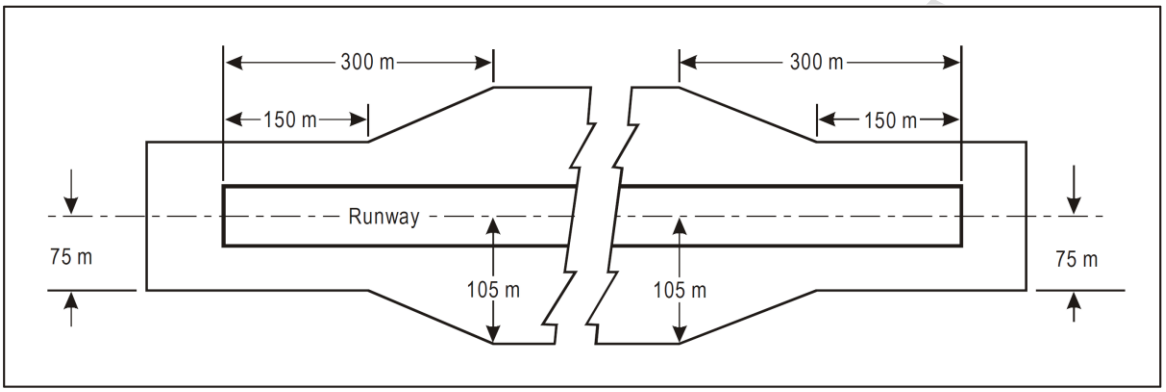


Figure A-4. Graded portion of a strip including a precision approach runway where the code number is 3 or 4

9. Runway end safety areas

9.1 Where a runway end safety area is provided in accordance with Chapter 3, consideration should be given to providing an area long enough to contain overruns and undershoots resulting from a reasonably probable combination of adverse operational factors. On a precision approach runway, the ILS localizer is normally the first upstanding obstacle, and the runway end safety area should extend up to this facility. In other circumstances, the first upstanding obstacle may be a road, a railroad or other constructed or natural feature. The provision of a runway end safety area should take such obstacles into consideration.

9.2 Where provision of a runway end safety area would be particularly prohibitive to implement, consideration would have to be given to reducing some of the declared distances of the runway for the provision of a runway end safety area and installation of an arresting system.

9.3 Research programmes, as well as evaluation of actual aircraft overruns into arresting systems, have demonstrated that the performance of some arresting systems can be predictable and effective in arresting aircraft overruns.

9.4 Demonstrated performance of an arresting system can be achieved by a validated design method, which can predict the performance of the system. The design and performance should be based on the type of aircraft anticipated to use the associated runway that imposes the greatest demand upon the arresting system.

9.5 The design of an arresting system must consider multiple aircraft parameters, including but not limited to, allowable aircraft gear loads, gear configuration, tire contact pressure, aircraft centre of gravity and aircraft speed. Accommodating undershoots must also be addressed. Additionally, the design must allow the safe

operation of fully loaded rescue and firefighting vehicles, including their ingress and egress.

9.6 The information relating to the provision of a runway end safety area and the presence of an arresting system should be published in the AIP.

9.7 Additional information is contained in the *Aerodrome Design Manual* (Doc 9157), Part 1.

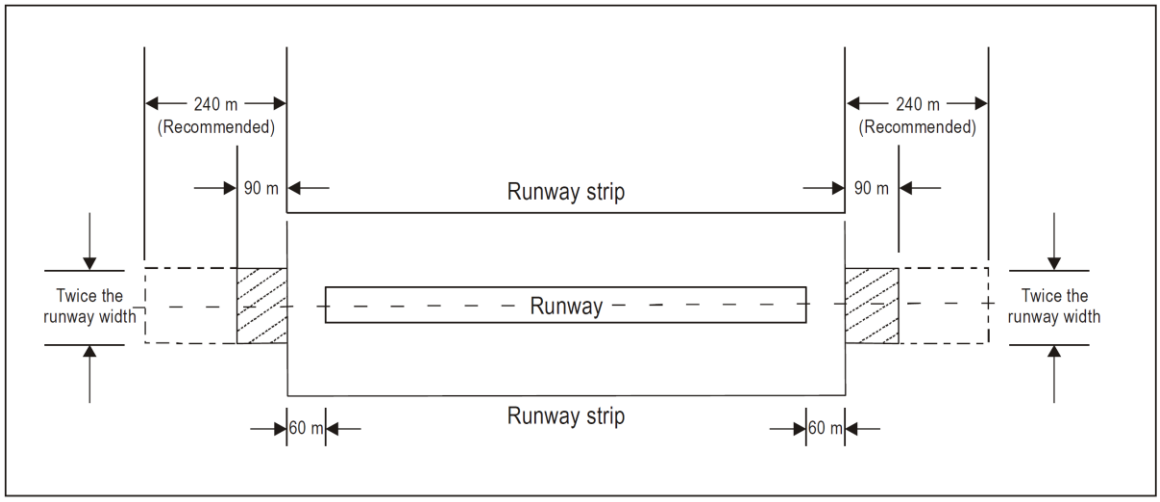


Figure A-5. Runway end safety area for a runway where the code number is 3 or 4

10. Location of threshold

10.1 General

10.1.1 The threshold is normally located at the extremity of a runway, if there are no obstacles penetrating above the approach surface. In some cases, however, due to local conditions it may be desirable to displace the threshold permanently (see below). When studying the location of a threshold, consideration should also be given to the height of the ILS reference datum and/or MLS approach reference datum and the determination of the obstacle clearance limits. (Specifications concerning the height of the ILS reference datum and MLS approach reference datum are given in Annex 10, Volume I.)

10.1.2 In determining that no obstacles penetrate above the approach surface, account should be taken of mobile objects (vehicles on roads, trains, etc.) at least within that portion of the approach area within 1 200 m longitudinally from the threshold and of an overall width of not less than 150 m.

10.2 Displaced threshold

10.2.1 If an object extends above the approach surface and the object cannot be removed, consideration should be given to displacing the threshold permanently.

10.2.2 To meet the obstacle limitation objectives of Chapter 4, the threshold should ideally be displaced down the runway for the distance necessary to provide that the approach surface is cleared of obstacles.

10.2.3 However, displacement of the threshold from the runway extremity will inevitably cause reduction of the landing distance available, and this may be of greater operational significance than penetration of the approach surface by marked and lighted obstacles. A decision to displace the threshold, and the extent of such displacement, should therefore have regard to an optimum balance between the

considerations of clear approach surfaces and adequate landing distance. In deciding this question, account will need to be taken of the types of aeroplanes which the runway is intended to serve, the limiting visibility and cloud base conditions under which the runway will be used, the position of the obstacles in relation to the threshold and extended centre line and, in the case of a precision approach runway, the significance of the obstacles to the determination of the obstacle clearance limit.

10.2.4 Notwithstanding the consideration of landing distance available, the selected position for the threshold should not be such that the obstacle free surface to the threshold is steeper than 3.3 per cent where the code number is 4 or steeper than 5 per cent where the code number is 3.

10.2.5 In the event of a threshold being located according to the criteria for obstacle free surfaces in the preceding paragraph, the obstacle marking requirements of Chapter 6 should continue to be met in relation to the displaced threshold.

10.2.6 Depending on the length of the displacement, the RVR at the threshold could differ from that at the beginning of the runway for take-offs. The use of red runway edge lights with photometric intensities lower than the nominal value of 10 000 cd for white lights increases that phenomenon. The impact of a displaced threshold on take-off minima should be assessed by the appropriate authority.

10.2.7 Provisions in BAR 14, Volume I, regarding marking and lighting of displaced thresholds and some operational recommendations can be found in 5.2.4.9, 5.2.4.10, 5.3.5.5, 5.3.8.1, 5.3.9.7, 5.3.10.3, 5.3.10.7 and 5.3.12.6.

11. Approach lighting systems

11.1 Types and characteristics

11.1.1 The specifications in this volume provide for the basic characteristics for simple and precision approach lighting systems. For certain aspects of these systems, some latitude is permitted, for example, in the spacing between centre line lights and crossbars. The approach lighting patterns that have been generally adopted are shown in Figures A-7 and A-8. A diagram of the inner 300 m of the precision approach category II and III lighting system is shown in Figure 5-14.

11.1.2 The approach lighting configuration is to be provided irrespective of the location of the threshold, i.e. whether the threshold is at the extremity of the runway or displaced from the runway extremity. In both cases, the approach lighting system should extend up to the threshold. However, in the case of a displaced threshold, inset lights are used from the runway extremity up to the threshold to obtain the specified configuration. These inset lights are designed to satisfy the structural requirements specified in Chapter 5, 5.3.1.9, and the photometric requirements specified in Appendix 2, Figure A2-1 or A2-2 of ICAO Annex 14 Vol.I.

11.1.3 Flight path envelopes to be used in designing the lighting are shown in Figure A-6.

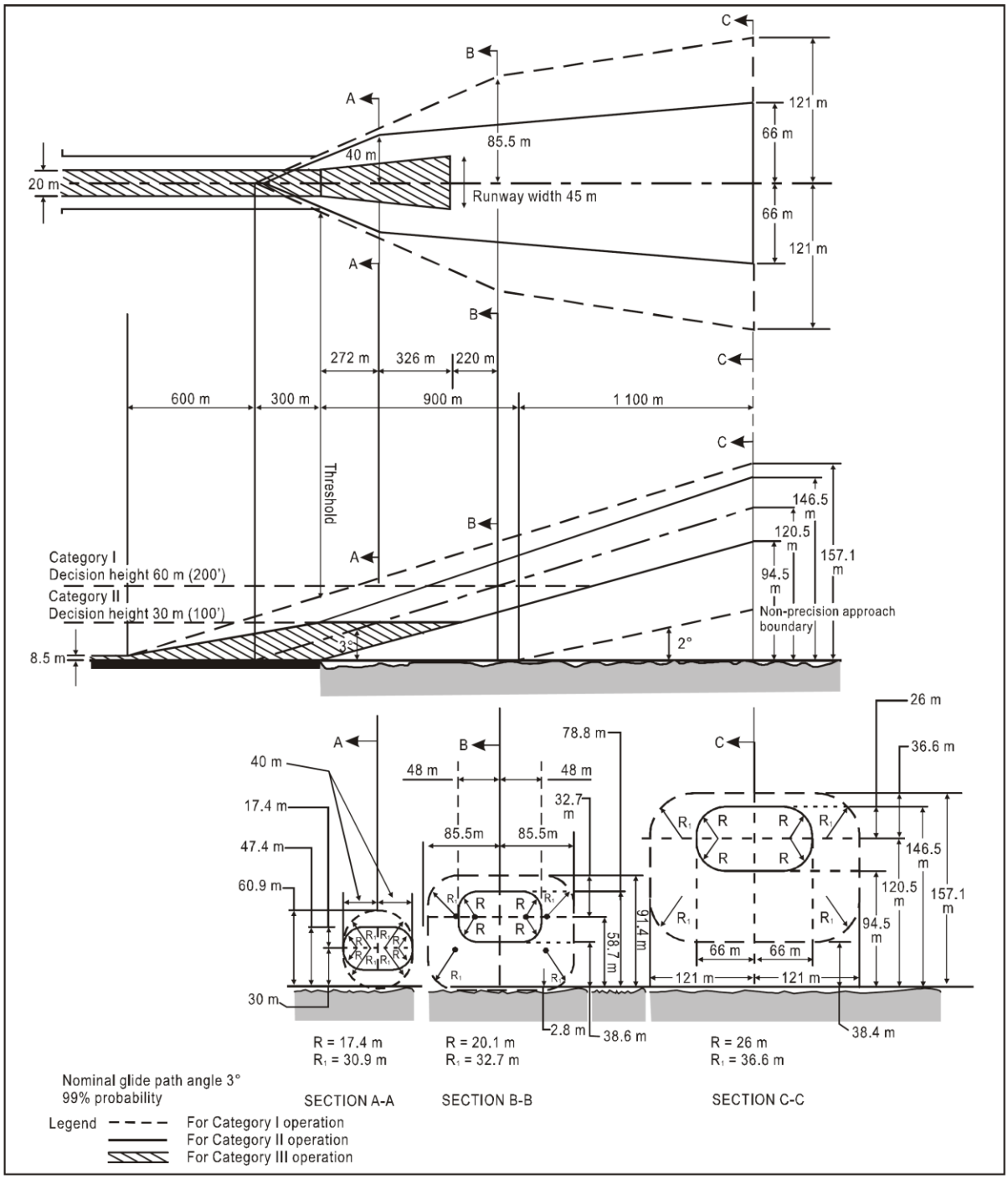


Figure A-6. Flight path envelopes to be used for lighting design for category I, II and III operations

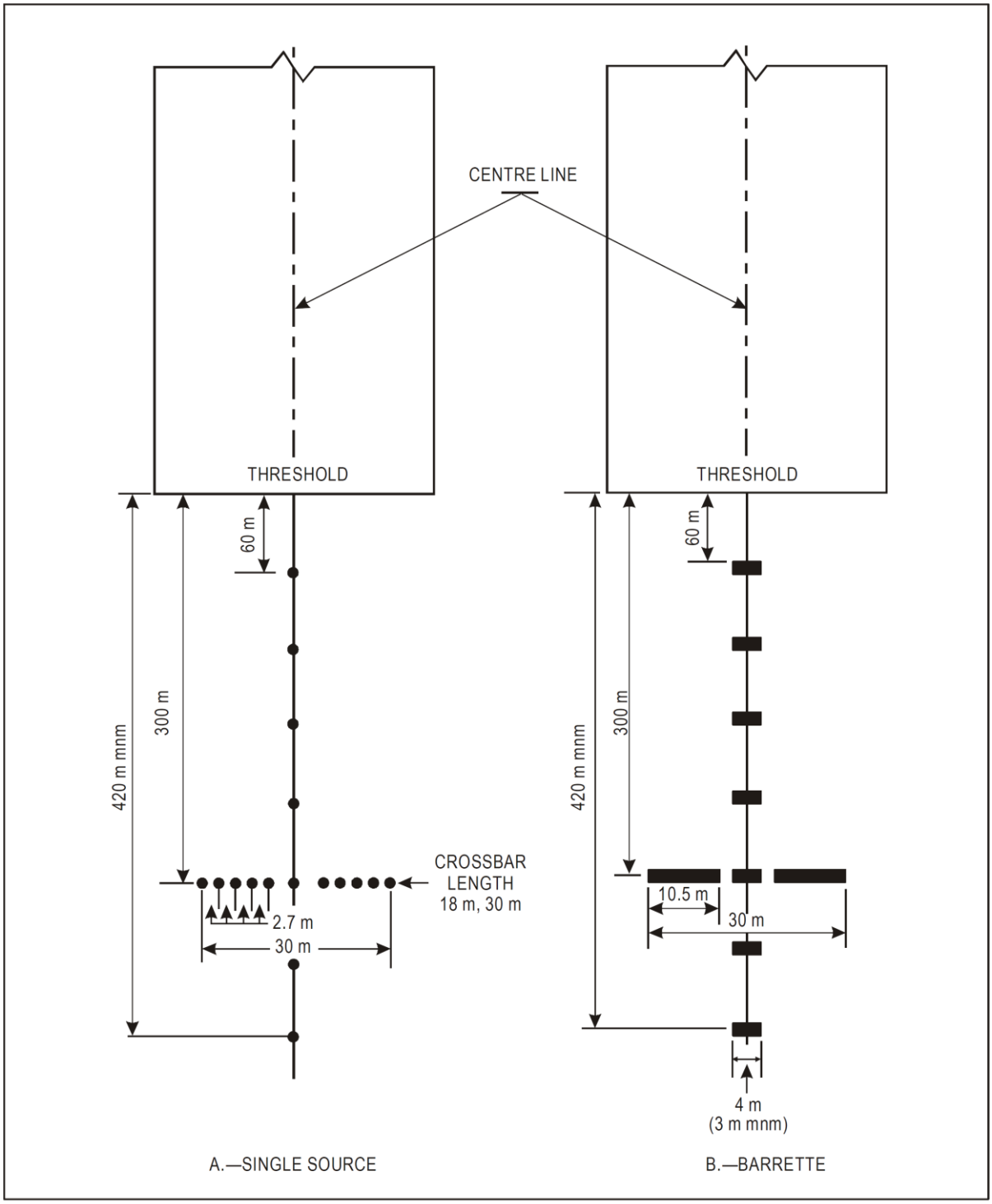


Figure A-7. Simple approach lighting systems

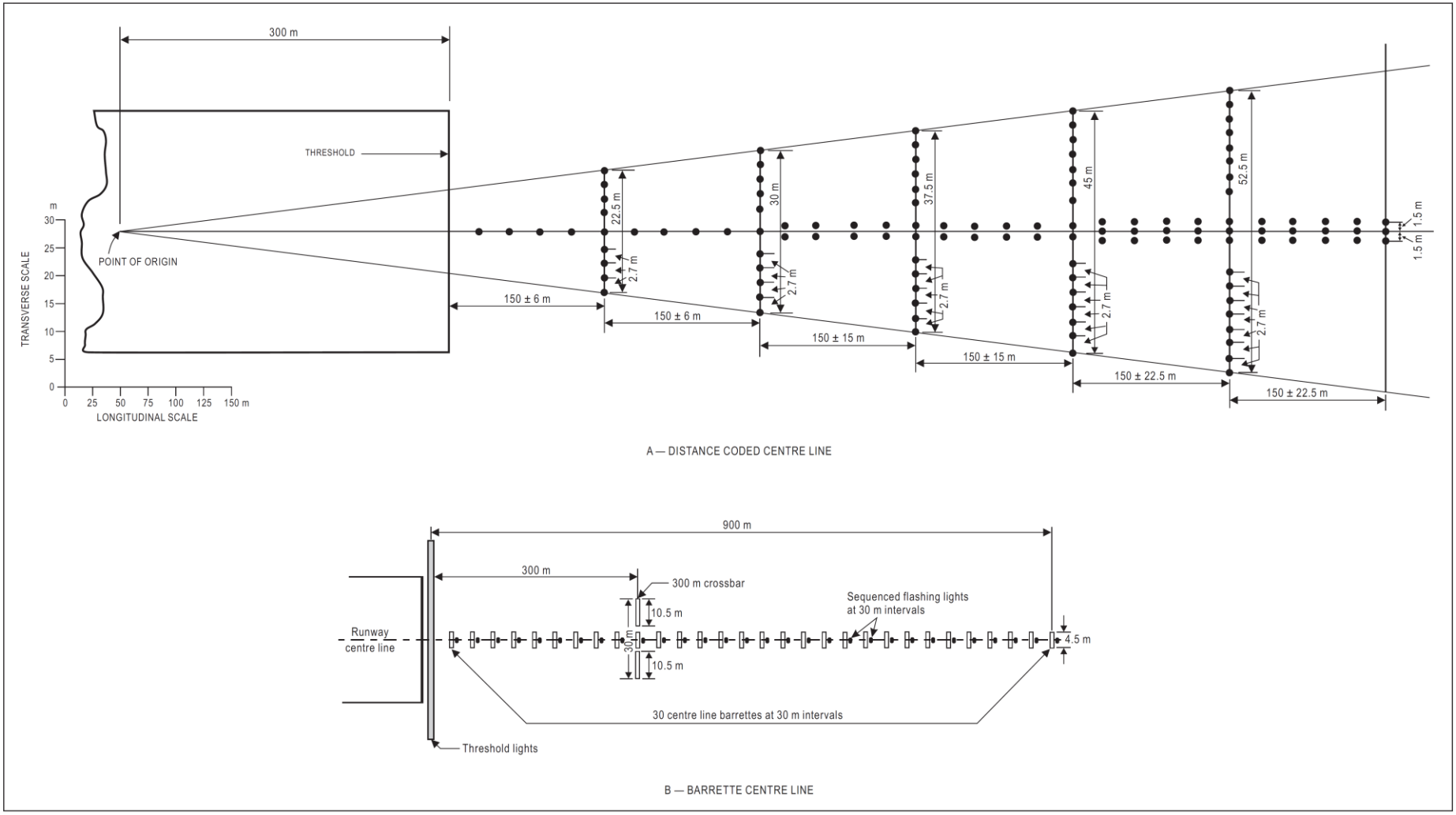


Figure A-8. Precision approach category I lighting systems **ATT A-21** **3/11/22**

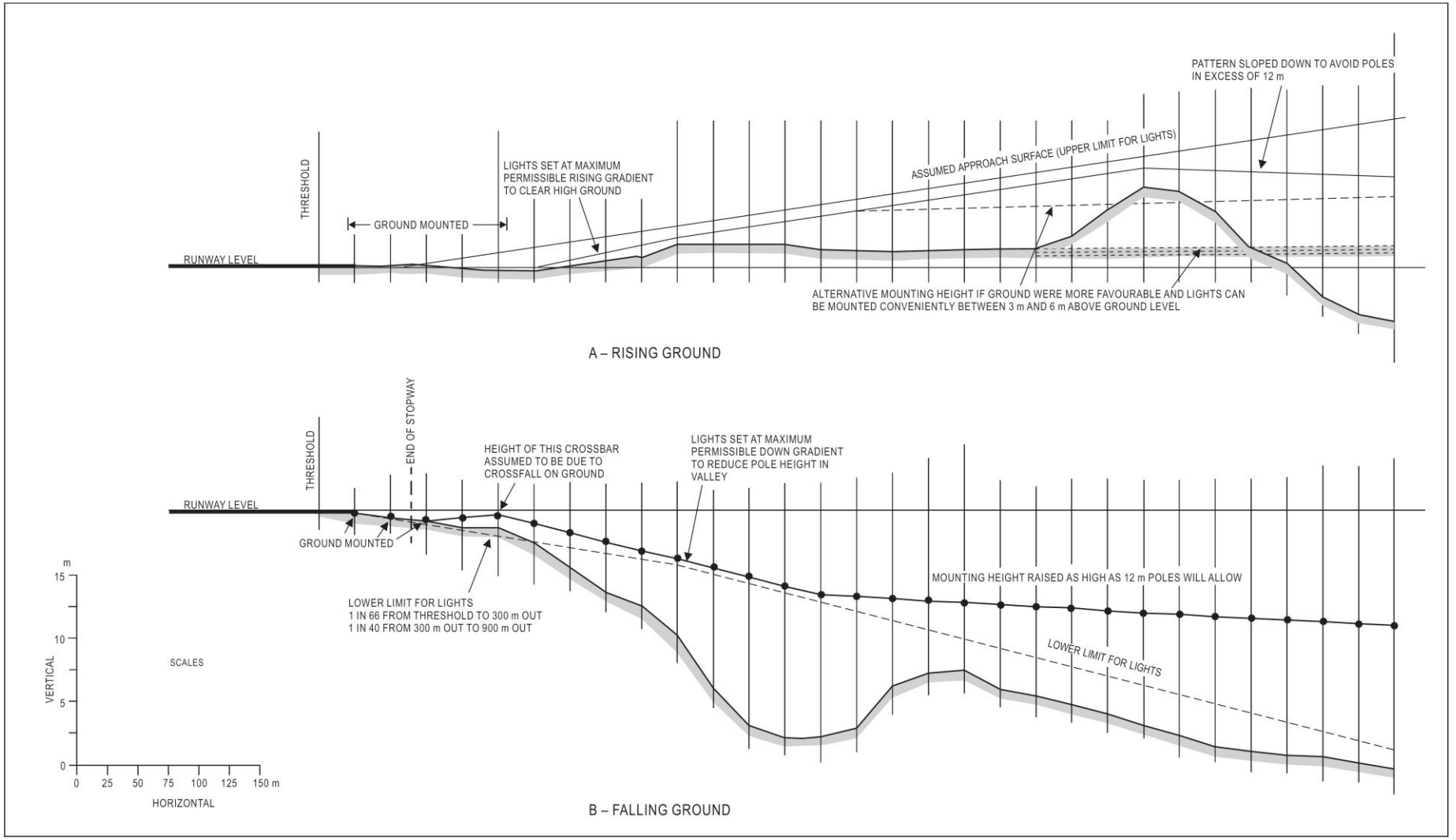


Figure A-9. Vertical installation tolerance

11.2 Installation tolerances

Horizontal

11.2.1 The dimensional tolerances are shown in Figure A-8.

11.2.2 The centre line of an approach lighting system should be as coincident as possible with the extended centre line of the runway with a maximum tolerance of ±15□.

11.2.3 The longitudinal spacing of the centre line lights should be such that one light (or group of lights) is located in the centre of each crossbar, and the intervening centre line lights are spaced as evenly as practicable between two crossbars or a crossbar and a threshold.

11.2.4 The crossbars and barrettes should be at right angles to the centre line of the approach lighting system with a tolerance of ±30□, if the pattern in Figure A-8 (A) is adopted or ± 2°, if Figure A-8 (B) is adopted.

11.2.5 When a crossbar has to be displaced from its standard position, any adjacent crossbar should, where possible, be displaced by appropriate amounts in order to reduce the differences in the crossbar spacing.

11.2.6 When a crossbar in the system shown in Figure A-8 (A) is displaced from its standard position, its overall length should be adjusted so that it remains one-twentieth of the actual distance of the crossbar from the point of origin. It is not necessary, however, to adjust the standard 2.7 m spacing between the crossbar lights, but the crossbars should be kept symmetrical about the centre line of the approach lighting.

Vertical

11.2.7 The ideal arrangement is to mount all the approach lights in the horizontal plane passing through the threshold (see Figure A-9), and this should be the general aim as far as local conditions permit. However, buildings, trees, etc., should not obscure the lights from the view of a pilot who is assumed to be 1° below the electronic glide path in the vicinity of the outer marker.

11.2.8 Within a stopway or clearway, and within 150 m of the end of a runway, the lights should be mounted as near to the ground as local conditions permit in order to minimize risk of damage to aeroplanes in the event of an overrun or undershoot. Beyond the stopway and clearway, it is not so necessary for the lights to be mounted close to the ground, and therefore undulations in the ground contours can be compensated for by mounting the lights on poles of appropriate height.

11.2.9 It is desirable that the lights be mounted so that, as far as possible, no object within a distance of 60 m on each side of the centre line protrudes through the plane of the approach lighting system. Where a tall object exists within 60 m of the centre line and within 1 350 m from the threshold for a precision approach lighting system, or 900 m for a simple approach lighting system, it may be advisable to install the lights so that the plane of the outer half of the pattern clears the top of the object.

11.2.10 In order to avoid giving a misleading impression of the plane of the ground, the lights should not be mounted below a gradient of 1 in 66 downwards from the threshold to a point 300 m out, and below a gradient of 1 in 40 beyond the 300 m point. For a precision approach category II and III lighting system, more stringent criteria may be necessary, e.g. negative slopes not permitted within 450 m of the threshold.

11.2.11 *Centre line.* The gradients of the centre line in any section (including a stopway or clearway) should be as small as practicable, and the changes in gradients should be as few and small as can be arranged and should not exceed 1 in 60. Experience has shown that as one proceeds outwards from the runway, rising gradients in any section of up to 1 in 66, and falling gradients of down to 1 in 40, are acceptable.

11.2.12 *Crossbars.* The crossbar lights should be so arranged as to lie on a straight line passing through the associated centre line lights, and wherever possible this line should be horizontal. It is permissible, however, to mount the lights on a transverse gradient not more than 1 in 80, if this enables crossbar lights within a stopway or clearway to be mounted nearer to the ground on sites where there is a cross-fall.

11.3 Clearance of obstacles

11.3.1 An area, hereinafter referred to as the light plane, has been established for obstacle clearance purposes, and all lights of the system are in this plane. This plane is rectangular in shape and symmetrically located about the approach lighting system's centre line. It starts at the threshold and extends 60 m beyond the approach end of the system, and is 120 m wide.

11.3.2 No objects are permitted to exist within the boundaries of the light plane which are higher than the light plane except as designated herein. All roads and highways are considered as obstacles extending 4.8 m above the crown of the road, except aerodrome service roads where all vehicular traffic is under control of the aerodrome authorities and coordinated with the aerodrome traffic control tower. Railroads, regardless of the amount of traffic, are considered as obstacles extending 5.4 m above the top of the rails.

11.3.3 It is recognized that some components of electronic landing aids systems, such as reflectors, antennas, monitors, etc., must be installed above the light plane. Every effort should be made to relocate such components outside the boundaries of the light plane. In the case of reflectors and monitors, this can be done in many instances.

11.3.4 Where an ILS localizer is installed within the light plane boundaries, it is recognized that the localizer, or screen if used, must extend above the light plane. In such cases the height of these structures should be held to a minimum and they should be located as far from the threshold as possible. In general the rule regarding permissible heights is 15 cm for each 30 m the structure is located from the threshold. As an example, if the localizer is located 300 m from the threshold, the screen will be permitted to extend above the plane of the approach lighting system by 10 × 15 = 150 cm maximum, but preferably should be kept as low as possible consistent with proper operation of the ILS.

11.3.5 In locating an MLS azimuth antenna the guidance contained in Annex 10, Volume I, Attachment G, should be followed. This material, which also provides guidance on collocating an MLS azimuth antenna with an ILS localizer antenna, suggests that the MLS azimuth antenna may be sited within the light plane boundaries where it is not possible or practical to locate it beyond the outer end of the approach lighting for the opposite direction of approach. If the MLS azimuth antenna is located on the extended centre line of the runway, it should be as far as possible from the closest light position to the MLS azimuth antenna in the direction of the runway end. Furthermore, the MLS azimuth antenna phase centre should be at least 0.3 m above the light centre of the light position closest to the MLS azimuth antenna in the direction of the runway end. (This could be relaxed to

0.15 m if the site is otherwise free of significant multipath problems.) Compliance with this requirement, which is intended to ensure that the MLS signal quality is not affected by the approach lighting system, could result in the partial obstruction of the lighting system by the MLS azimuth antenna. To ensure that the resulting obstruction does not degrade visual guidance beyond an acceptable level, the MLS azimuth antenna should not be located closer to the runway end than 300 m and the preferred location is 25 m beyond the 300 m crossbar (this would place the antenna 5 m behind the light position 330 m from the runway end). Where an MLS azimuth antenna is so located, a central part of the 300 m crossbar of the approach lighting system would alone be partially obstructed. Nevertheless, it is important to ensure that the unobstructed lights of the crossbar remain serviceable all the time.

11.3.6 Objects existing within the boundaries of the light plane, requiring the light plane to be raised in order to meet the criteria contained herein, should be removed, lowered or relocated where this can be accomplished more economically than raising the light plane.

11.3.7 In some instances objects may exist which cannot be removed, lowered or relocated economically. These objects may be located so close to the threshold that they cannot be cleared by the 2 per cent slope. Where such conditions exist and no alternative is possible, the 2 per cent slope may be exceeded or a “stair step” resorted to in order to keep the approach lights above the objects. Such “step” or increased gradients should be resorted to only when it is impracticable to follow standard slope criteria, and they should be held to the absolute minimum. Under this criterion no negative slope is permitted in the outermost portion of the system.

11.4 Consideration of the effects of reduced lengths

11.4.1 The need for an adequate approach lighting system to support precision approaches where the pilot is required to acquire visual references prior to landing cannot be stressed too strongly. The safety and regularity of such operations is dependent on this visual acquisition. The height above runway threshold at which the pilot decides there are sufficient visual cues to continue the precision approach and land will vary, depending on the type of approach being conducted and other factors such as meteorological conditions, ground and airborne equipment, etc. The required length of approach lighting system which will support all the variations of such approaches is 900 m, and this shall always be provided whenever possible.

11.4.2 However, there are some runway locations where it is impossible to provide the 900 m length of approach lighting system to support precision approaches.

11.4.3 In such cases, every effort should be made to provide as much approach lighting system as possible. The appropriate authority may impose restrictions on operations to runways equipped with reduced lengths of lighting. There are many factors which determine at what height the pilot must have decided to continue the approach to land or execute a missed approach. It must be understood that the pilot does not make an instantaneous judgement upon reaching a specified height. The actual decision to continue the approach and landing sequence is an accumulative process which is only concluded at the specified height. Unless lights are available prior to reaching the decision point, the visual assessment process is impaired and the likelihood of missed approaches will increase substantially. There are many operational considerations which must be taken

into account by the appropriate authorities in deciding if any restrictions are necessary to any precision approach and these are detailed in BAR 6.

12. Priority of installation of visual approach slope indicator systems

12.1 It has been found impracticable to develop guidance material that will permit a completely objective analysis to be made of which runway on an aerodrome should receive first priority for the installation of a visual approach slope indicator system. However, factors that must be considered when making such a decision are:

a) frequency of use;

b) seriousness of the hazard;

c) presence of other visual and non-visual aids;

d) type of aeroplanes using the runway; and

e) frequency and type of adverse weather conditions under which the runway will be used.

12.2 With respect to the seriousness of the hazard, the order given in the application specifications for a visual approach slope indicator system, 5.3.5.1 b) to e) of Chapter 5, may be used as a general guide. These may be summarized as:

a) inadequate visual guidance because of:

1) approaches over water or featureless terrain, or absence of sufficient extraneous light in the approach area by night;

2) deceptive surrounding terrain;

b) serious hazard in approach;

c) serious hazard if aeroplanes undershoot or overrun; and

d) unusual turbulence.

12.3 The presence of other visual or non-visual aids is a very important factor. Runways equipped with ILS or MLS would generally receive the lowest priority for a visual approach slope indicator system installation. It must be remembered, though, that visual approach slope indicator systems are visual approach aids in their own right and can supplement electronic aids. When serious hazards exist and/or a substantial number of aeroplanes not equipped for ILS or MLS use a runway, priority might be given to installing a visual approach slope indicator on this runway.

12.4 Priority should be given to runways used by turbojet aeroplanes.

13. Lighting of unserviceable areas

Where a temporarily unserviceable area exists, it may be marked with fixed-red lights. These lights should mark the most potentially dangerous extremities of the area. A minimum of four such lights should be used, except where the area is triangular in shape where a minimum of three lights may be employed. The number of lights should be increased when the area is large or of unusual configuration. At least one light should be installed for each 7.5 m of peripheral

distance of the area. If the lights are directional, they should be orientated so that as far as possible their beams are aligned in the direction from which aircraft or vehicles will approach. Where aircraft or vehicles will normally approach from several directions, consideration should be given to adding extra lights or using omnidirectional lights to show the area from these directions. Unserviceable area lights should be frangible. Their height should be sufficiently low to preserve clearance for propellers and for engine pods of jet aircraft.

14. Rapid exit taxiway indicator lights

14.1 Rapid exit taxiway indicator lights (RETILs) comprise a set of yellow unidirectional lights installed in the runway adjacent to the centre line. The lights are positioned in a 3-2-1 sequence at 100 m intervals prior to the point of tangency of the rapid exit taxiway centre line. They are intended to give an indication to pilots of the location of the next available rapid exit taxiway.

14.2 In low visibility conditions, RETILs provide useful situational awareness cues while allowing the pilot to concentrate on keeping the aircraft on the runway centre line.

14.3 Following a landing, runway occupancy time has a significant effect on achievable runway capacity. RETILs allow pilots to maintain a good roll-out speed until it is necessary to decelerate to an appropriate speed for the turn into a rapid exit turn-off. A roll-out speed of 60 knots until the first RETIL (three-light barrette) is reached is seen as the optimum.

15. Intensity control of approach and runway lights

15.1 The conspicuity of a light depends on the impression received of contrast between the light and its background. If a light is to be useful to a pilot by day when on approach, it must have an intensity of at least 2 000 or 3 000 cd, and in the case of approach lights an intensity of the order of 20 000 cd is desirable. In conditions of very bright daylight fog it may not be possible to provide lights of sufficient intensity to be effective. On the other hand, in clear weather on a dark night, an intensity of the order of 100 cd for approach lights and 50 cd for the runway edge lights may be found suitable. Even then, owing to the closer range at which they are viewed, pilots have sometimes complained that the runway edge lights seemed unduly bright.

15.2 In fog the amount of light scattered is high. At night this scattered light increases the brightness of the fog over the approach area and runway to the extent that little increase in the visual range of the lights can be obtained by increasing their intensity beyond 2 000 or 3 000 cd. In an endeavour to increase the range at which lights would first be sighted at night, their intensity must not be raised to an extent that a pilot might find excessively dazzling at diminished range.

15.3 From the foregoing will be evident the importance of adjusting the intensity of the lights of an aerodrome lighting system according to the prevailing conditions, so as to obtain the best results without excessive dazzle that would disconcert the pilot. The appropriate intensity setting on any particular occasion will depend both on the conditions of background brightness and the visibility. Detailed guidance material on selecting intensity setting for different conditions is given in the *Aerodrome Design Manual* (Doc 9157), Part 4.

16. Signal area

A signal area need be provided only when it is intended to use visual ground signals to communicate with aircraft in flight. Such signals may be needed when the aerodrome does not have an aerodrome control tower or an aerodrome flight information service unit, or when the aerodrome is used by aeroplanes not equipped with radio. Visual ground signals may also be useful in the case of failure of two-way radio communication with aircraft. It should be recognized, however, that the type of information which may be conveyed by visual ground signals should normally be available in AIPs or NOTAM. The potential need for visual ground signals should therefore be evaluated before deciding to provide a signal area.

17. Rescue and firefighting services

17.1 Administration

17.1.1 The rescue and firefighting service at an aerodrome shall be under the administrative control of the aerodrome management, which should also be responsible for ensuring that the service provided is organized, equipped, staffed, trained and operated in such a manner as to fulfil its proper functions.

17.1.2 In drawing up the detailed plan for the conduct of search and rescue operations in accordance with 4.2.1 of BAR 12 — *Search and Rescue*, the aerodrome management shall coordinate its plans with the relevant rescue coordination centres to ensure that the respective limits of their responsibilities for an aircraft accident within the vicinity of an aerodrome are clearly delineated.

17.1.3 Coordination between the rescue and firefighting service at an aerodrome and public protective agencies, such as local fire brigade, police force, coast guard and hospitals, shall be achieved by prior agreement for assistance in dealing with an aircraft accident.

17.1.4 A grid map of the aerodrome and its immediate vicinity shall be provided for the use of the aerodrome services concerned. Information concerning topography, access roads and location of water supplies should be indicated. This map shall be conspicuously posted in the control tower and fire station, and available on the rescue and firefighting vehicles and such other supporting vehicles required to respond to an aircraft accident or incident. Copies should also be distributed to public protective agencies as desirable.

17.1.5 Coordinated instructions shall be drawn up detailing the responsibilities of all concerned and the action to be taken in dealing with emergencies. The appropriate authority should ensure that such instructions are promulgated and observed.

17.2 Training

The training curriculum should include initial and recurrent instruction in at least the following areas:

a) airport familiarization;

b) aircraft familiarization;

c) rescue and firefighting personnel safety;

d) emergency communications systems on the aerodrome, including aircraft fire-related alarms;

e) use of the fire hoses, nozzles, turrets and other appliances required for compliance with Chapter 9, 9.2;

f) application of the types of extinguishing agents required for compliance with Chapter 9, 9.2;

g) emergency aircraft evacuation assistance;

h) firefighting operations;

i) adaptation and use of structural rescue and firefighting equipment for aircraft rescue and firefighting;

j) dangerous goods;

k) familiarization with firefighters' duties under the aerodrome emergency plan; and

l) protective clothing and respiratory protection.

17.3 Level of protection to be provided

17.3.1 In accordance with Chapter 9, 9.2, aerodromes should be categorized for rescue and firefighting purposes and the level of protection provided should be appropriate to the aerodrome category.

17.3.2 However, Chapter 9, 9.2.3, permits a lower level of protection to be provided for a limited period where the number of movements of the aeroplanes in the highest category normally using the aerodrome is less than 700 in the busiest consecutive three months. It is important to note that the concession included in 9.2.3 is applicable only where there is a wide range of difference between the dimensions of the aeroplanes included in reaching 700 movements.

17.4 Rescue equipment for difficult environments

17.4.1 Suitable rescue equipment and services should be available at an aerodrome where the area to be covered by the service includes water, swampy areas or other difficult environment that cannot be fully served by conventional wheeled vehicles. This is particularly important where a significant portion of approach/departure operations takes place over these areas.

17.4.2 The rescue equipment should be carried on boats or other vehicles such as helicopters and amphibious or air cushion vehicles, capable of operating in the area concerned. The vehicles should be so located that they can be brought into action quickly to respond to the areas covered by the service.

17.4.3 At an aerodrome bordering the water, the boats or other vehicles should preferably be located on the aerodrome, and convenient launching or docking sites provided. If these vehicles are located off the aerodrome, they should preferably be under the control of the aerodrome rescue and firefighting service or, if this is not practicable, under the control of another competent public or private organization working in close coordination with the aerodrome rescue and firefighting service (such as police, military services, harbour patrol or coast guard).

17.4.4 Boats or other vehicles should have as high a speed as practicable so as to reach an accident site in minimum time. To reduce the possibility of injury during rescue operations, water jet-driven boats are preferred to water propeller-driven boats

unless the propellers of the latter boats are ducted. Should the water areas to be covered by the service be frozen for a significant period of the year, the equipment should be selected accordingly. Vehicles used in this service should be equipped with life rafts and life preservers related to the requirements of the larger aircraft normally using the aerodrome, with two-way radio communication, and with floodlights for night operations. If aircraft operations during periods of low visibility are expected, it may be necessary to provide guidance for the responding emergency vehicles.

17.4.5 The personnel designated to operate the equipment should be adequately trained and drilled for rescue services in the appropriate environment.

17.5 Facilities

17.5.1 The provision of special telephone, two-way radio communication and general alarm systems for the rescue and firefighting service is desirable to ensure the dependable transmission of essential emergency and routine information. Consistent with the individual requirements of each aerodrome, these facilities serve the following purposes:

a) direct communication between the activating authority and the aerodrome fire station in order to ensure the prompt alerting and dispatch of rescue and firefighting vehicles and personnel in the event of an aircraft accident or incident;

b) direct communication between the rescue and firefighting service and the flight crew of an aircraft in emergency;

c) emergency signals to ensure the immediate summoning of designated personnel not on standby duty;

d) as necessary, summoning essential related services on or off the aerodrome; and

e) maintaining communication by means of two-way radio with the rescue and firefighting vehicles in attendance at an aircraft accident or incident.

17.5.2 The availability of ambulance and medical facilities for the removal and after-care of casualties arising from an aircraft accident should receive the careful consideration of the appropriate authority and should form part of the overall emergency plan established to deal with such emergencies.

18. Operators of vehicles

18.1 The authorities responsible for the operation of vehicles on the movement area should ensure that the operators are properly qualified. This may include, as appropriate to the driver's function, knowledge of:

a) the geography of the aerodrome;

b) aerodrome signs, markings and lights;

c) radiotelephone operating procedures;

d) terms and phrases used in aerodrome control including the ICAO spelling alphabet;

e) rules of air traffic services as they relate to ground operations;

f) airport rules and procedures; and

g) specialist functions as required, for example, in rescue and firefighting.

18.2 The operator should be able to demonstrate competency, as appropriate, in:

a) the operation or use of vehicle transmit/receive equipment;

b) understanding and complying with air traffic control and local procedures;

c) vehicle navigation on the aerodrome; and

d) special skills required for the particular function.

In addition, as required for any specialist function, the operator should be the holder of a State driver's licence, a State radio operator's licence or other licences.

18.3 The above should be applied as is appropriate to the function to be performed by the operator, and it is not necessary that all operators be trained to the same level, for example, operators whose functions are restricted to the apron.

18.4 If special procedures apply for operations in low visibility conditions, it is desirable to verify an operator's knowledge of the procedures through periodic checks.

19. The aircraft classification rating-pavement classification rating (ACR-PCR) method of reporting pavement strength

Applicable as of 28 November 2024

19.1 Overload operations

19.1.1 Overloading of pavements can result either from loads too large, or from a substantially increased application rate, or both. Loads larger than the defined (design or evaluation) load shorten the design life, whilst smaller loads extend it. With the exception of massive overloading, pavements in their structural behaviour are not subject to a particular limiting load above which they suddenly or catastrophically fail. Behaviour is such that a pavement can sustain a definable load for an expected number of repetitions during its design life. As a result, occasional minor overloading is acceptable, when expedient, with only limited loss in pavement life expectancy and relatively small acceleration of pavement deterioration. For those operations in which magnitude of overload and/or the frequency of use do not justify a detailed analysis, the following criteria are suggested:

a) for flexible and rigid pavements, occasional movements by aircraft with ACR not exceeding 10 per cent above the reported PCR should not adversely affect the pavement; and

b) the annual number of overload movements should not exceed approximately 5 per cent of the total annual movements excluding light aircraft.

19.1.2 Such overload movements should not normally be permitted on pavements exhibiting signs of distress or failure. Furthermore, overloading should be avoided during any periods of thaw following frost penetration, or when the strength of the pavement or its subgrade could be weakened by water. Where overload

operations are conducted, the appropriate authority should review the relevant pavement condition regularly, and should also review the criteria for overload operations periodically since excessive repetition of overloads can cause severe shortening of pavement life or require major rehabilitation of pavement.

19.2 ACRs for several aircraft types

For convenience, a dedicated software is available on the ICAO website, for computing any aircraft ACRs at any mass on rigid and flexible pavements for the four standard subgrade strength categories detailed in Chapter 2, 2.6.6 b).

20. Autonomous runway incursion warning system (ARIWS)

Note 1.— These autonomous systems are generally quite complex in design and operation and, as such, deserve careful consideration by all levels of the industry, from the regulating authority to the end user. This guidance is offered to provide a more clear description of the system(s) and offer some suggested actions required in order to properly implement these system(s) at an aerodrome in any State.

Note 2.— The Manual on the Prevention of Runway Incursion *(Doc 9870) presents different approaches for the prevention of runway incursion.*

20.1 General description

20.1.1 The operation of an ARIWS is based upon a surveillance system which monitors the actual situation on a runway and automatically returns this information to warning lights at the runway (take-off) thresholds and entrances. When an aircraft is departing from a runway (rolling) or arriving at a runway (short final), red warning lights at the entrances will illuminate, indicating that it is unsafe to enter or cross the runway. When an aircraft is aligned on the runway for take-off and another aircraft or vehicle enters or crosses the runway, red warning lights will illuminate at the threshold area, indicating that it is unsafe to start the take-off roll.

20.1.2 In general, an ARIWS consists of an independent surveillance system (primary radar, multilateration, specialized cameras, dedicated radar, etc.) and a warning system in the form of extra airfield lighting systems connected through a processor which generates alerts independent from ATC directly to the flight crews and vehicle operators.

20.1.3 An ARIWS does not require circuit interleaving, secondary power supply or operational connection to other visual aid systems.

20.1.4 In practice, not every entrance or threshold needs to be equipped with warning lights. Each aerodrome will have to assess its needs individually depending on the characteristics of the aerodrome. There are several systems developed offering the same or similar functionality.

20.2 Flight crew actions

20.2.1 It is of critical importance that flight crews understand the warning being transmitted by the ARIWS system. Warnings are provided in near real-time,

directly to the flight crew because there is no time for “relay” types of communications. In other words, a conflict warning generated to ATS which must then interpret the warning, evaluate the situation and communicate to the aircraft in question, would result in several seconds being taken up where each second is critical in the ability to stop the aircraft safely and prevent a potential collision. Pilots are presented with a globally consistent signal which means “STOP IMMEDIATELY” and must be taught to react accordingly. Likewise, pilots receiving an ATS clearance to take-off or cross a runway, and seeing the red light array, must STOP and advise ATS that they aborted/stopped because of the red lights. Again, the criticality of the timeline involved is so tight that there is no room for misinterpretation of the signal. It is of utmost importance that the visual signal be consistent around the world.

20.2.2 It must also be stressed that the extinguishing of the red lights does not, in itself, indicate a clearance to proceed. That clearance is still required from air traffic control. The absence of red warning lights only means that potential conflicts have not been detected.

20.2.3 In the event that a system becomes unserviceable, one of two things will occur. If the system fails in the extinguished condition, then no procedural changes need to be accomplished. The only thing that will happen is the loss of the automatic, independent warning system. Both ATS operations and flight crew procedures (in response to ATS clearances) will remain unchanged.

20.2.4 Procedures should be developed to address the circumstance where the system fails in the illuminated condition. It will be up to the ATS and/or aerodrome operator to establish those procedures depending on their own circumstances. It must be remembered that flight crews are instructed to “STOP” at all red lights. If the affected portion of the system, or the entire system, is shut off the situation is reverted to the extinguished scenario described in 20.2.3.

20.3 Aerodromes

20.3.1 An ARIWS does not have to be provided at all aerodromes. An aerodrome considering the installation of such a system may wish to assess its needs individually, depending on traffic levels, aerodrome geometry, ground taxi patterns, etc. Local user groups such as the Local Runway Safety Team (LRST) can be of assistance in this process. Also, not every runway or taxiway needs to be equipped with the lighting array(s), and not every installation requires a comprehensive ground surveillance system to feed information to the conflict detection computer.

20.3.2 Although there may be local specific requirements, some basic system requirements are applicable to all ARIWS:

a) the control system and energy power supply of the system must be independent from any other system in use at the aerodrome, especially the other parts of the lighting system;

b) the system must operate independently from ATS communications;

c) the system must provide a globally accepted visual signal that is consistent and instantly understood by crews; and

d) local procedures should be developed in the case of malfunction or failure of a portion of, or the entire system.

20.4 Air traffic services

20.4.1 The ARIWS is designed to be complementary to normal ATS functions, providing warnings to flight crews and vehicle operators when some conflict has been unintentionally created or missed during normal aerodrome operations. The ARIWS will provide a direct warning when, for example, ground control or tower (local) control has provided a clearance to hold short of a runway but the flight crew or vehicle operator has “missed” the hold short portion of their clearance and tower has issued a take-off or landing clearance to that same runway, and the non-read back by the flight crew or vehicle operator was missed by air traffic control.

20.4.2 In the case where a clearance has been issued and a crew reports a non-compliance due to “red lights”, or aborting because of “red lights”, then it is imperative that the controller assess the situation and provide additional instructions as necessary. It may well be that the system has generated a false warning or that the potential incursion no longer exists; however, it may also be a valid warning. In any case, additional instructions and/or a new clearance need to be provided. In a case where the system has failed, then procedures will need to be put into place as described in 20.2.3 and 20.2.4. In no case should the illumination of the ARIWS be dismissed without confirmation that, in fact, there is no conflict. It is worth noting that there have been numerous incidents avoided at aerodromes with such systems installed. It is also worth noting that there have been false warnings as well, usually as a result of the calibration of the warning software, but in any case, the potential conflict existence or non-existence must be confirmed.

20.4.3 While many installations may have a visual or audio warning available to ATS personnel, it is in no way intended that ATS personnel be required to actively monitor the system. Such warnings may assist ATS personnel in quickly assessing the conflict in the event of a warning and help them to provide appropriate further instructions, but the ARIWS should not play an active part in the normal functioning of any ATS facility.

20.4.4 Each aerodrome where the system is installed will develop procedures depending upon its unique situation. Again, it must be stressed that under no circumstances should pilots or operators be instructed to “cross the red lights”. As indicated previously, the use of local runway safety teams can greatly assist in this development process.

20.5 Promulgation of information

20.5.1 Information on the characteristics and status of an ARIWS at an aerodrome are promulgated in the AIP section AD 2.9 in PANS-AIM (Doc 10066), and its status updated as necessary through NOTAM or ATIS in compliance with 2.9.1 of this BAR.

20.5.2 Aircraft operators are to ensure that flight crews’ documentation include procedures regarding ARIWS and appropriate guidance information, in compliance with BAR 6, Part I.

20.5.3 Aerodromes may provide additional sources of guidance on operations and procedures for their personnel, aircraft operators, ATS and third-party personnel who may have to deal with an ARIWS.

21. Taxiway design guidance for minimizing the potential for runway incursions

21.1 Good aerodrome design practices can reduce the potential for runway incursions while maintaining operating efficiency and capacity. The following taxiway design guidance may be considered to be part of a runway incursion prevention programme as a means to ensure that runway incursion aspects are addressed during the design phase for new runways and taxiways. Within this focused guidance, the prime considerations are to limit the number of aircraft or vehicles entering or crossing a runway, provide pilots with enhanced unobstructed views of the entire runway, and correct taxiways identified as hot spots as much as possible.

21.2 The centre line of an entrance taxiway should be perpendicular to the runway centre line, where possible. This design principle provides pilots with an unobstructed view of the entire runway, in both directions, to confirm that the runway and approach are clear of conflicting traffic before proceeding towards the runway. Where the taxiway angle is such that a clear unobstructed view, in both directions, is not possible, consideration should be given to providing a perpendicular portion of the taxiway immediately adjacent to the runway to allow for a full visual scan by the pilots prior to entering or crossing a runway.

21.3 For taxiways intersecting with runways, avoid designing taxiways wider than recommended in this BAR. This design principle offers improved recognition of the location of the runway holding position and the accompanying sign, marking and lighting visual cues.

21.4 Existing taxiways wider than recommended in this Annex, can be rectified by painting taxi side stripe markings to the recommended width. As far as practicable, it is preferable to redesign such locations properly rather than to repaint such locations.

21.5 Multi-taxiway entrances to a runway should be parallel to each other and should be distinctly separated by an unpaved area. This design principle allows each runway holding location an earthen area for the proper placement of accompanying sign, marking and lighting visual cues at each runway holding position. Moreover, the design principle eliminates the needless costs of building unusable pavement and as well as the costs for painting taxiway edge markings to indicate such unusable pavement. In general, excess paved areas at runway holding positions reduce the effectiveness of sign, marking and lighting visual cues.

21.6 Build taxiways that cross a runway as a single straight taxiway. Avoid dividing the taxiway into two after crossing the runway. This design principle avoids constructing “Y-shaped” taxiways known to present risk of runway incursions.

21.7 If possible, avoid building taxiways that enter at the mid-runway location. This design principle helps to reduce the collision risks at the most hazardous locations (high energy location) because normally departing aircraft have too much energy to stop, but not enough speed to take-off, before colliding with another errant aircraft or vehicle.

21.8 Provide clear separation of pavement between a rapid exit taxiway and other non-rapid taxiways entering or crossing a runway. This design principle avoids two

taxiways from overlapping each other to create an excessive paved area that would confuse pilots entering a runway.

21.9 Avoid the placement of different pavement materials (asphalt and cement concrete) at or near the vicinity of the runway holding position, as far as practicable. This design principle avoids creating visual confusion as to the actual location of the runway holding position.

21.10 Many aerodromes have more than one runway, notably paired parallel runways (two runways on one side of the terminal), which creates a difficult problem in that either on arrival or departure an aircraft is required to cross a runway. Under such a configuration, the safety objective here is to avoid or at least keep to a minimum the number of runway crossings. This safety objective may be achieved by constructing a “perimeter taxiway”. A perimeter taxiway is a taxi route that goes around the end of a runway, enabling arrival aircraft (when landings are on outer runway of a pair) to get to the terminal, or departure aircraft (when departures are on outer runway of a pair) to get to the runway, without either crossing a runway or conflicting with a departing or approaching aircraft.

21.11 A perimeter taxiway would be designed according to the following criteria:

a) Sufficient space is required between the landing threshold and the taxiway centre line where it crosses under the approach path to enable the critical taxiing aircraft to pass under the approach without penetrating any approach surface.

b) The jet blast impact of aircraft taking off should be considered in consultation with aircraft manufacturers; the extent of take-off thrust should be evaluated when determining the location of a perimeter taxiway.

c) The requirement for a runway end safety area, as well as possible interference with landing systems and other navigation aids should also be taken into account. For example, in the case of an ILS, the perimeter taxiway should be located behind the localiser antenna, not between the localiser antenna and the runway, due to the potential for severe ILS disturbance, noting that this is harder to achieve as the distance between the localizer and the runway increases.

d) Human factors issues should also be taken into account. Appropriate measures should be put in place to assist pilots to distinguish between aircraft that are crossing the runway and those that are safely on a perimeter taxiway.

22. Aerodrome mapping data

22.1 Introduction

Chapter 2, 2.1.2 and 2.1.3, relate to the provision of aerodrome mapping data. The aerodrome mapping data features are collected and made available to the aeronautical information services for aerodromes designated by States with consideration of the intended applications. These applications are closely tied to an identified need and operational use where the application of the data would provide a safety benefit or could be used as mitigation of a safety concern.

22.2 Applications

22.2.1 Aerodrome mapping data include aerodrome geographic information that supports applications which improve the user's situational awareness or supplement surface navigation, thereby increasing safety margins and operational efficiency. With appropriate data element accuracy, these data sets support collaborative decision-making, common situational awareness and aerodrome guidance applications. The data sets are intended to be used in the following air navigation applications:

a) on-board positioning and route awareness including moving maps with own aircraft position, surface guidance and navigation;

b) traffic awareness including surveillance and runway incursion detection and alerting (such as, respectively, in A-SMGCS levels 1 and 2);

c) ground positioning and route awareness including situational displays with aircraft and vehicles position and taxi route, surface guidance and navigation (such as A-SMGCS levels 3 and 4);

d) facilitation of aerodrome-related aeronautical information, including NOTAMs;

e) resource and aerodrome facility management; and

f) aeronautical chart production.

22.2.2 The data may also be used in other applications such as training/flight simulators and on-board or ground enhanced vision systems (EVS), synthetic vision systems (SVS) and combined vision systems (CVS).

22.3 Determination of aerodromes to be considered for collection of aerodrome mapping data features

In order to determine which aerodromes may make use of applications requiring the collection of aerodrome mapping data features, the following aerodrome characteristics may be considered:

– safety risks at the aerodrome;

– visibility conditions;

– aerodrome layout; and

– traffic density.

Note.— Further guidance on aerodrome mapping data can be found in the Airport Services Manual, *Part 8* — Airport Operational Service *(Doc 9137).*

23. Runway distance remaining signs (RDRSs)

23.1 Runway distance remaining signs (RDRSs) do not have to be provided at all aerodromes. An aerodrome considering the installation of such signs may wish to assess their need individually, depending on factors such as runway length, aerodrome elevation, aerodrome geometry, traffic levels, lack of runway end safety area, lack of runway friction and climate.

23.2 RDRSs are placed along the full length of the runway at longitudinal spacing of 300 m (±30 m), parallel and equidistant from the runway centre line as in Configurations A, B or C, illustrated in Figure A-10. RDRSs are arranged by any of three different configurations as shown in Figure A-10.

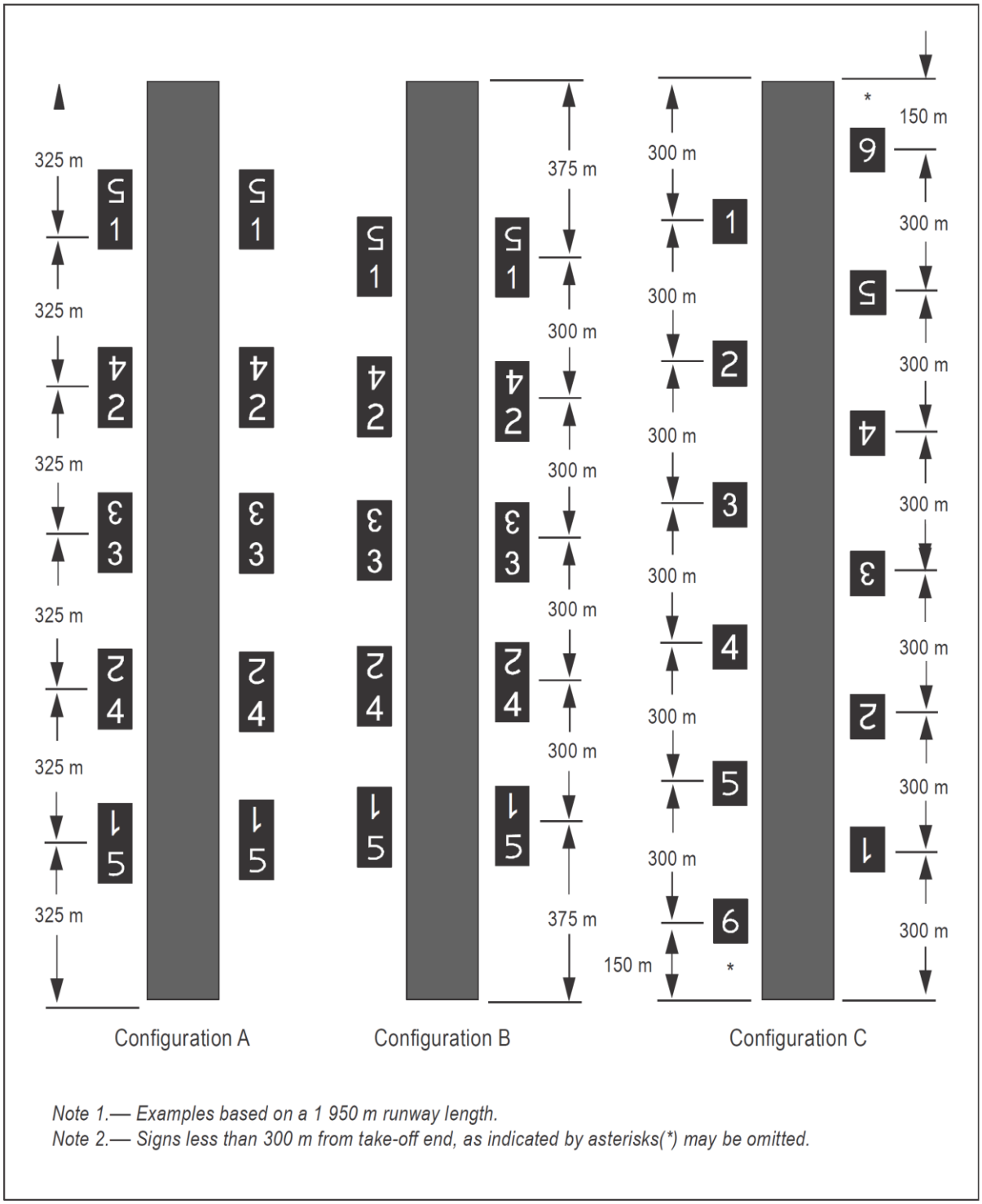
23.3 In Configuration A, the RDRSs consist of double-faced signs and are located on both sides of the runway. Where the runway length is not an exact multiple of 300 m, the signs are placed at locations where the runway total length is divided equally.

23.4 In Configuration B, the RDRSs consist of double-faced signs and are located on both sides of the runway. Where the runway length is not an exact multiple of 300 m, one-half of the excess distance is added to the distance of each sign from each runway extremity. To illustrate the case where the distance between the end of the runway and the sign is the maximum, for a runway length of 1 950 m, the excess distance is 150 m and the location of the last sign on each runway end is 300 m plus one-half of 150 m, or 375 m. This configuration allows a maximum of 375 m at the end of the runway, but the other signs are exactly 300 m apart. The signs may be omitted on one side of the runway because of clearance conflict or by design.

Note.— For Configurations A and B, the signs may be omitted on one side of the runway because of clearance conflict or by design.

23.5 In Configuration C, the RDRSs consist of single-faced signs and are located on one side of each runway, viewed in the direction of take-off or landing. The advantage of Configuration C is that the runway distance remaining is more accurately reflected for a runway length that is not an exact multiple of 300 m.

23.6 An RDRS may be omitted if the sign cannot be placed within the tolerance of ±30 m.



Note 1.— Examples based on a 1 950 m runway length.
Note 2.— Signs less than 300 m from take-off end, as indicated by asterisks(*) may be omitted.

Figure A-10. Runway distance remaining sign configurations

15.2 Attachment B. Obstacle limitation surfaces (Figure B-1)

ATTACHMENT B. OBSTACLE LIMITATION SURFACES

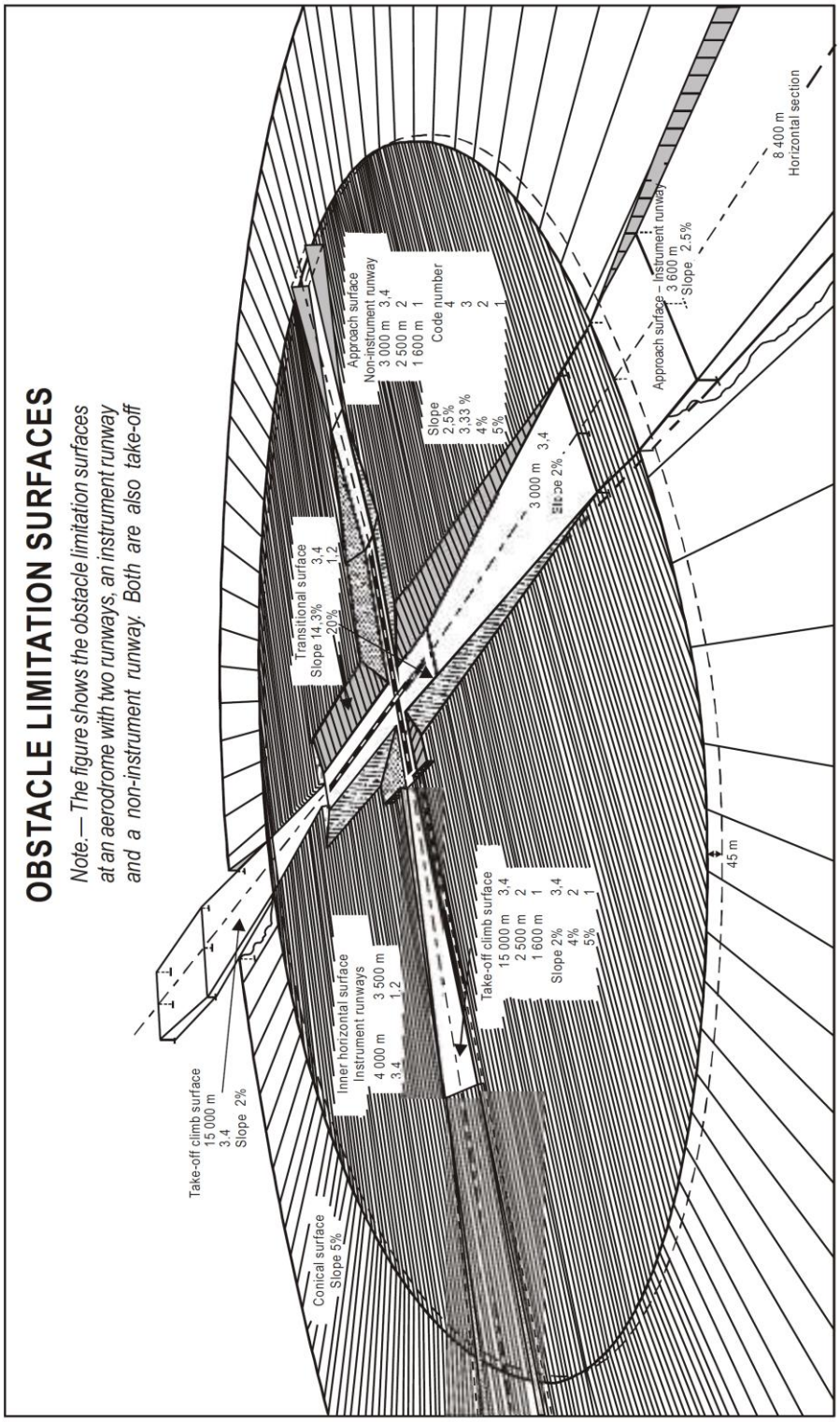


Figure B-1

-END-