Manual of Aerodrome Standards

Version 2.2: 26 February 2018

published by

The Director-General of Civil Aviation
Civil Aviation Authority of Singapore

under the

Singapore Air Navigation Order

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APPENDICES

AMENDMENT RECORDS

The amendments listed below have been incorporated into this copy of the Manual of Aerodrome Standards.

Amendment no.	Version no.	Subject	Source	Sections affected	Entered by (Date)	Approved by (Date)	Effective date
-	1.0	Original version	ASSU (ICAO Annex 14 Vol. I, up to and including changes arising from Amendment 5)	All	Koh M S (5 Sep 2003)	Ong C L (10 Sep 2003)	15 Sep 2003
1	1.1	Definition, Common Reference System, Airport Design, Aerodrome Dimension and Related Information, Conditions of Movement Areas and Related Facilities, Disable Aircraft Removal, Physical Requirements of Aerodrome Facilities, Runway Turn Pad, Runway Strips, Runway End Safety Area, Clearways, Stopways, Taxiways, Taxiway Strips, Holding Bays, Runway Holding Positions, Intermediate	ASSU (ICAO Annex 14 Vol. I, up to and including changes arising from Amendments 6 and 7)	1.2, 1.3, 1.4, 1.5, 6.2.5, 6.2.9, 6.2.10, 7.2.1, 7.2.3, 7.2.4, 7.2.5, 7.2.6, 7.2.7, 7.2.9, 7.2.11, 7.2.12, 8.2.2, 9.2.2, 9.2.3, 9.2.4, 9.2.5, 10.2.1, 11.2, 12.2.1, 13.2.3, 13.2.4, 13.2.7, 13.2.8, 13.2.9, 13.2.10, 14.2.1, 14.2.3, 14.2.4 and Appendix A.	Tan K W (1 Nov 2005)	Sng H S (10 Nov 2005)	1 Dec 2005

Amendment no.	Version no.	Subject	Source	Sections affected	Entered by (Date)	Approved by (Date)	Effective date
		Holding Positions and Road-Holding Position, Markings, Lights, Signs, Markers, Marking and Lighting of Obstacles, Marking and Lighting of Unserviceable Areas, Electrical System, Bird Hazard Reduction, Aerodrome Vehicle Operation, Surface Movement Guidance and Control Systems, Siting and Construction of Equipment and Installations on Operational Areas, Fencing, Maintenance, Pavement, Runway Pavement Overlays and Visual Aids.					
2	1.2	Definitions and airport design.	ASSU (ICAO Annex 14 Vol. I, up to and including changes arising from Amendment 8)	1.2, 1.5, 1.6, 5.2.1.3, 5.2.1.4, 5.2.1.5, 8.2 and Table 8-1	Tan K W (10 Jul 2006)	Sng H S (14 Jul 2006)	17 Jul 2006
3	1.3	Table of contents, Relevant legislation and document, Cross-references with ICAO and adopted Standards and Recommended Practices, Aerodrome certificate	ASSU	1.1.4, 1.1.5, 1.4, 1.5, 3.1.4, 6.2, 7.2, 8.2.2, 8.3, 9.2.2, 9.2.3, 9.2.4, 9.2.5, 11.2, 12.2, 13.2, Appendix A, Appendix B,	Lim B C (3 May 2007)	Loo C B (8 May 2007)	1 Jun 2007

Amendment no.	Version no.	Subject	Source	Sections affected	Entered by (Date)	Approved by (Date)	Effective date
		processing fee, Information to be reported to the AIS, Physical requirements of aerodrome facilities, Obstacle limitation requirements, Principles of shielding, Markings, Lights, Signs, Markers, Marking and lighting of unserviceable areas, Electrical systems, Provision of emergency services		Appendix G			
4	1.4	Table of contents, Aerodrome regulatory functions, Definitions, Introduction, Granting of an Aerodrome Certificate, Introduction, Strength of pavements, Declared distances, Condition of the movement area and related facilities, Obstacle limitation requirements, Objects outside the obstacle limitation surfaces, VOR aerodrome check-point sign, Markers, Lighting of Objects, Non-load-bearing surfaces, Bird hazard reduction, Siting of equipment and	ASSU (ICAO Annex 14 Vol. I, up to and including changes arising from Amendment 9[1])	1.1.2, 1.2, 3.1.1, 3.1.6, 5.2.1, 6.2.6, 6.2.8, 6.2.9, 8.2.2, 8.2.3, 9.2.4.4, 9.2.5, 10.2.3, 11.2.2, 13.2.4, 13.2.9, Appendix C, Appendix H	Justin Toh (16 Sept 2008)	Loo C B (22 Sept 2008)	1 Oct 2008

[1] Changes arising from Amendment 9 were not adopted into the MOAS.

Amendment no.	Version no.	Subject	Source	Sections affected	Entered by (Date)	Approved by (Date)	Effective date
		installations on operational areas					
5	1.5	Table of contents, Organisation of Aerodrome Regulatory and Operational Functions, Definition, Legislative background and applicability, Standards and recommended practices, Exemptions from aerodrome standards and recommended practices, Applying for an Aerodrome Certificate, Aerodrome Certificate processing fee, Transfer of Aerodrome Certificate, Safety management system – Introduction, Strength of pavements, Coordination between the aerodrome operator and the Aeronautical Information Services, Runways, Runway turn pads, Taxiways, Obstacle limitation surfaces, Obstacle limitation requirements, Objects outside the obstacle limitation surfaces, Other objects, Landing direction indicator, Signal panels and signal area, Runway turn	Aerodrome and ANS Regulation Division (Arising from ongoing review of MOAS)	Figure 1-1,1.2, 2.1.1, 2.1.2, 2.1.5, 3.1.3, 3.1.4, 3.6.4, 5.2.1, 6.2.6, 7.2.1, 7.2.3, 7.2.9, Table 7-2, 8.2.1, 8.2.2, Table 8-1, 8.2.3, 8.2.4, 9.2.1.2, 9.2.1.4, Table 9-1, 9.2.2.9, 9.2.2.17, 9.2.3.1, Table 9-3, 9.2.3.16, 9.2.3.19, 9.2.3.23, 10.2.1, 10.2.2, 10.2.3, 11.2.1, 11.2.2, 12.2.1, 13.2.1, Appendix J	Justin Toh (10 Jul 2009)	Loo C B (15 Jul 2009)	20 Jul 2009

Amendment no.	Version no.	Subject	Source	Sections affected	Entered by (Date)	Approved by (Date)	Effective date
		pad marking, Information marking, Lights – General, Taxiway centre line lights, Stop bars, Apron floodlighting, Objects to be marked and/or lighted, Marking of objects, Lighting of objects, Closed runways and taxiways, or parts thereof, Non-load-bearing surfaces, Electrical power supply systems for air navigation, Aerodrome emergency planning					
		Definitions – Instrument runway and obstacle, Rescue and fire fighting, Coordination between the aerodrome operator and the Aeronautical Information Services, Taxiway centre line marking, Mandatory instruction marking, Taxiway edge lights, Advanced visual docking guidance system, Mandatory instruction signs, Wind turbines, Aerodrome emergency planning, Rescue and fire fighting, Wildlife strike hazard	Aerodrome and ANS Regulation Division (Arising from Amendment 10 to ICAO Annex 14)	1.2, 6.2.11.3, 6.2.11.4, 6.2.13.1, 9.2.2.8.4, 9.2.2.8.5, 9.2.2.8.9, 9.2.2.8.11, 9.2.2.16.2, 9.2.2.16.3, 9.2.2.16.4, 9.2.2.16.9, 9.2.3.17.7, 9.2.3.17.8, 9.2.3.25, 9.2.4.2.13, 10.2.4, 13.2.1.2, 13.2.1.3, 13.2.2 – General, 13.2.2.6, 13.2.2.12, Table 13-2, 13.2.2.18-20,	Justin Toh (10 Jul 2009)	Loo C B (15 Jul 2009)	19 Nov 2009

Amendment no.	Version no.	Subject	Source	Sections affected	Entered by (Date)	Approved by (Date)	Effective date
		reduction, Pavements		13.2.2.25-28, 13.2.2.38, 13.2.4, 13.2.4.1-5, 14.2.2.1, Appendix H			
6	1.5	Aerodrome safety regulation, Definitions, Rescue and fire fighting, Taxiway centre line marking, Aerodrome emergency planning, Response time, Wildlife strike hazard reduction, Pavements	Aerodrome and ANS Regulation Division (Corrigendum to MOAS Version 1.5)	1.1.2.1, 1.2, 6.2.11.3, 9.2.2.8.5, 13.2.1.2, 13.2.2.26, 13.2.4.2-5, 14.2.2.1	Justin Toh (7 Sept 2009)	Loo C B (7 Sept 2009)	19 Nov 2009
7	1.6	Table of Contents, Responsibilities, Relevant legislation and document, Publication of differences in AIP, Definitions, Standards and recommended practices, Changes to aerodrome standards and recommended practices and their effects on existing aerodromes, Aeronautical studies, Processing an Aerodrome Certificate application, Granting of an Aerodrome Certificate, Purpose and scope of Aerodrome Manual, Distribution and amendment	Aerodrome and ANS Regulation Division (Arising from ongoing review of MOAS)	1.1.3, 1.1.4, 1.1.6, 1.2, 2.1.2, 2.1.3, 2.1.4, 3.1.5, 3.1.6, 3.2.2, 3.2.5, 3.3.2, 3.4.1, 3.6.2, 4.1.1, 4.1.2, 4.1.3, 4.2.1, 5.1.1, 5.1.2, 5.1.3, 5.1.5, 5.1.6, 5.1.7, 5.3.2, 5.3.3, 5.3.4, 6.2.6, 6.2.8, 8.1.1, 8.2.3, 9.2.2, 9.2.3, Table 5.X, 9.2.4, Table 9.4, 9.2.5, 10.2.3, 11.2.2, 13, 13.2.1, 13.2.2, 13.2.4, 13.2.5, 13.2.7, 13.2.8, Appendix A,	Justin Toh (9 July 2010)	Loo C B (12 July 2010)	12 July 2010

Amendment no.	Version no.	Subject	Source	Sections affected	Entered by (Date)	Approved by (Date)	Effective date
		of Aerodrome Manual, Routine notification and reporting, Application for changes to Aerodrome Certificate, Cancellation of Aerodrome Certificate, Aerodrome organization management and operational structure, Aerodrome operational staff and competency, Aerodrome operations library, Forms, documents and records, Aerodrome work safety – Introduction, Aerodrome work plans, Management and control of aerodrome works, Communications equipment, Works near aircraft movement areas, Completion, Reportable occurrences and reporting procedures, Aerodrome occurrence records, Aerodrome accident/incident investigations, Strength of pavements, Declared Distances, Obstacle Restriction and Removal – Introduction, Objects outside the obstacle limitation surfaces, Runway designation marking, Runway centre line marking,		Appendix, B, Appendix D, Appendix E, Appendix F, Appendix G, Appendix J			

Amendment no.	Version no.	Subject	Source	Sections affected	Entered by (Date)	Approved by (Date)	Effective date
		Threshold marking, Aiming point marking, Lighting of objects, Non-load-bearing surfaces, Aerodrome Operational Services, Equipment and Planning, Aerodrome emergency planning, Rescue and fire fighting, Wildlife strike hazard reduction, Apron management service, Aerodrome vehicle operations, Surface movement guidance and control systems					
		Definitions, Safety Management System – Introduction	Aerodrome and ANS Regulation Division (Arising from Amendment 10B to ICAO Annex 14)	1.2, 5.2.1.6, 5.2.1.7	Justin Toh (9 July 2010)	Loo C B (12 July 2010)	18 Nov 2010
8	1.7	Cover page; Table of Contents; Foreword; Aerodrome regulatory functions; Responsibilities; Relevant legislation and	Aerodrome and ANS Regulation Division (Arising from	1.1.2.3; 1.1.2.4; 1.1.3.1; 1.1.4.1; 1.1.4.4; 1.1.6.2; 1.1.7.1-2; 1.2; 2.1.1.1-2; 2.1.2.2;	Justin Toh (22 Dec 2010)	DGCA (28 Jan 2011)	31 Jan 2011

Amendment no.	Version no.	Subject	Source	Sections affected	Entered by (Date)	Approved by (Date)	Effective date
		document; Publication of difference in AIP; Document change management; Definitions; Legislative background and applicability; Standards and recommended practices; Aeronautical studies; Exemptions from aerodrome standards; Aerodrome Reference Code and aeroplane characteristics; Processing an Aerodrome Certificate application; Granting of an Aerodrome Certificate; Maintenance and control of Aerodrome Manual; Distribution and amendment of Aerodrome Manual; Routine notification and reporting; Provision of access for inspection and site safety audits; Refusal of Aerodrome Certificate; Suspension/Revocation of Aerodrome Certificate; Transfer of Aerodrome Certificate; Aerodrome operational staff and competency; Aeronautical data; Runway end safety areas; Taxiway centre line marking; Taxiway centre line lights; Advanced visual	ongoing review of MOAS)	2.1.4.1; 2.1.5.2; 2.1.5.4; 2.2.2.2; 3.1.5.8; 3.1.5.10; 3.1.6.1; 3.1.6.3; 3.2.4.1; 3.2.5.5; 3.3.2.1; 3.3.2.4; 3.5.1.1-3; 3.6.1.1; 3.6.3.3-4; 3.6.4.1; 4.1.2.2; 4.1.2.5; 6.2.1.1; 7.2.5; 9.2.2.8.7; 9.2.3.16.10; 9.2.3.25.13; 13.2.9; 13.2.11; Appendix D; AppendixD1			

Amendment no.	Version no.	Subject	Source	Sections affected	Entered by (Date)	Approved by (Date)	Effective date
		docking guidance system; Siting of equipment and installations on operational areas; Security lighting					
9	1.8	Table of Contents; Abbreviations and Symbols; Definitions; Applying for an Aerodrome Certificate; Granting of an Aerodrome Certificate; Maintenance and Control of Aerodrome Manual; Information to be included in the Aerodrome Manual; Suspension/Revocation of Aerodrome Certificate; Aerodrome operational staff and competency; Forms, documents and records; Aerodrome work safety - Introduction; Safety management system - General description, Key components; Aeronautical data; Visual approach slope indicator systems; Coordination between aerodrome operator and the Aeronautical Information Services; Runways; Runway strips; Obstacle Restriction	Aerodrome and ANS Regulation Division (Arising from ongoing review of MOAS)	1.2; 3.1.3.1;3.1.3.3; 3.1.6.6; 3.2.4.1; 3.2.6.3; 3.6.3.2; 4.1.2.5; 4.1.2.6; 4.1.2.7; 4.2.1.1; 5.1.1.3; 5.1.1.4; 5.2.2.2; 5.2.2.3; 5.2.2.4; 5.2.3.1; 6.2.1.2; 6.2.12.1; 6.2.13.4; 7.2.1.12; 7.2.4.14; 8.1.1.3; 8.1.1.3A; 8.1.1.4; 8.2; 8.2.1.8A; 8.2.1.10; 8.2.2.20; 8.2.2.21; 8.2.3.1; 9.2.3.1.2; 10.1.1.1; 10.1.1.1A; 10.1.1.2; 10.1.1.2A; 10.2.1.9; 10.2.3.6; 13.2.2.18; 13.2.2.38A; 13.2.6; 13.2.6.1; 13.2.6.2; Appendix C; Appendix E; Appendix G	Wong Qi Wen (11 Mar 2013)	DGCA (15 Mar 2013)	25 Mar 2013

Amendment no.	Version no.	Subject	Source	Sections affected	Entered by (Date)	Approved by (Date)	Effective date
		and Removal – Introduction; Obstacle limitation; Obstacle limitation surfaces; Obstacles limitation requirements; Objects outside the obstacle limitation surfaces; Visual aids for navigation – General, Introduction; Objects to be marked and/or lighted; Lighting of objects; Rescue and fire fighting; Provision of emergency services; Form for Application of an application certificate; Particulars to be included in an aerodrome manual; Documents and records that must be maintained by the aerodrome certificate holder					

Amendment no.	Version no.	Subject	Source	Sections affected	Entered by (Date)	Approved by (Date)	Effective date
10	1.9	Table of Contents; Aerodrome regulatory functions; Definitions; Aerodrome operator organization management; Safety management system - Key components; Aeronautical data; Strength of pavements; Condition of the movement area and related facilities; Physical requirements of aerodrome facilities; Runway Shoulders; Runway Strips; Runway end safety areas; Stopways; Radio altimeter operating area; Taxiways; Markings; Taxiways centre line marking; Lights; Approach lighting systems; Rapid exit taxiway indicator lights; Taxiway centre line lights; Stop bars; Runway guard lights; Apron floodlighting; Visual docking guidance system; Visual Aids for denoting obstacles; Aerodrome emergency planning; Rescue and fire fighting; Siting of equipment and installations on operational areas; Maintenance; Pavements;	Aerodrome and ANS Regulation Division (Arising from Amendment 11 to ICAO Annex 14)	1.1.2.1; 1.2; 4.1.1.4; 5.2.1.3; 5.2.3.1; 6.2.1; 6.2.6; 6.2.9; 7.2; 7.2.2; 7.2.4; 7.2.5; 7.2.7; 7.2.8; 7.2.9; 9.2.2.1; 9.2.2.8; 9.2.3.4;9.2.3.14; 9.2.3.15; 9.2.3.17; 9.2.3.20; 9.2.3.23; 9.2.3.24; 9.2.3.25; 9.2.3.28; 9.2.3.29; 10.2.1; 10.2.2; 10.2.3; 10.2.4; 13.2.1; 13.2.2; 13.2.9; 14.2.1; 14.2.2; 14.2.3; 14.2.4; 14.2.5; Appendix E; Appendix F	Wong Qi Wen (1 Sept 2014)	DGCA (4 Sept 2014)	16 Sept 2014

Amendment no.	Version no.	Subject	Source	Sections affected	Entered by (Date)	Approved by (Date)	Effective date
11	2.0	Runway friction measurement; Removal of contaminants; Runway pavement overlays; Visual Aids, Aerodrome dimensions and related information; Documents and publications that must be kept and made available for reference by aerodrome operator Table of Contents; Aerodrome operator organisation management and operational structure; Aerodrome work safety-Introduction; Submission of documents for development and modification works; Aerodrome manual and submission of risk assessment; Aerodrome work plans; Management and control of aerodrome works; Markers, markings and lights; Communications equipment; Works near aircraft movement areas; Completion; Safety management system- Key components; Aerodrome accident/incident reporting and investigation procedures-Reportable	Aerodrome and ANS Regulation Division	4.1.1.1; 4.1.1.2; 5.1.1.1; 5.1.2; 5.1.2.1; 5.1.2.2; 5.1.2.3; 5.1.3; 5.1.3.1; 5.1.3.2; 5.1.3.3; 5.1.3.4; 5.1.4; 5.1.4.1; 5.1.4.2; 5.1.4.3; 5.1.4.4; 5.1.4.5; 5.1.4.6; 5.1.4.7; 5.1.4.8; 5.1.4.9; 5.1.4.10; 5.1.4.11; 5.1.5; 5.1.5.1; 5.1.5.2; 5.1.5.3; 5.1.5.4; 5.1.5.5; 5.1.5.6; 5.1.5.6; 5.1.6; 5.1.6.1; 5.1.6.2; 5.1.6.3; 5.1.6.4; 5.1.7; 5.1.7.2; 5.1.7.3; 5.1.7.4; 5.1.8; 5.1.8.1; 5.1.8.2; 5.1.8.3; 5.1.9; 5.1.9.1; 5.1.9.2;	Nick Leow (11 Nov 2015)	DGCA (18 Nov 2015)	15 Jan 2016

Amendment no.	Version no.	Subject	Source	Sections affected	Entered by (Date)	Approved by (Date)	Effective date
		occurrences and reporting procedures; Aerodrome accident/incident investigations; Lights-Approach lighting systems; Runway centre line lights; Taxiway centre line markers; Provision of emergency services-Disabled aircraft removal; Particulars to be included in an aerodrome manual-Part 4		5.1.9.3; 5.1.9.4; 5.2.3.1; 5.3.2.2; 5.3.2.3; 5.3.2.4; 5.3.2.5; 5.3.2.6; 5.3.2.7; 5.3.4.1; 5.3.4.2; 5.3.4.3; 5.3.4.4; 5.3.4.5; 5.3.4.6; 9.2.3.4.15; 9.2.3.4.22; 9.2.3.4.24; 9.2.3.4.30; 9.2.3.4.32; 9.2.3.12.5; 9.2.5.6.3; 13.2.3.1; 13.2.3.2; 13.2.3.3; Appendix E			
12	2.1	Table of Contents; Abbreviations and symbols; Definitions; Provisions for future larger aeroplanes; Safety Management System; Reportable occurrences and reporting procedures; Aerodrome dimensions and related information; Coordination between the aerodrome operator and the Aeronautical Information Services; Runway strips; Taxiways; Taxiway strips; Aprons; Runway-holding position marking Approach lighting systems; Visual	Aerodrome and ANS Regulation Division (Arising from Amendment 12 and 13A to ICAO Annex 14)	1.2; 2.2.3.1; 2.2.3.3; 2.2.3.4; 5.2.1.3; 5.3.2.5; 6.2.5.1; 6.2.5.5; 6.2.13.4; 7.2.4.6; 7.2.4.11; 7.2.4.16; 7.2.9; 7.2.9.3; 7.2.9.4; 7.2.9.7; 7.2.9.11; 7.2.11.3; 7.2.11.6; 7.2.13.6; 9.2.2.10.5; 9.2.2.10.6; 9.2.2.10.7; 9.2.2.10.9; 9.2.3.4.17; 9.2.3.4.18; 9.2.3.4.34; 9.2.3.4.35; 9.2.3.5.45;	Wong Qi Wen (16 Nov 2016)	DGCA (18 Nov 2016)	21 Nov 2016

Amendment no.	Version no.	Subject	Source	Sections affected	Entered by (Date)	Approved by (Date)	Effective date
		approach slope indicator systems; Taxiway centre line lights; Runway status lights; Signs; Mandatory instruction signs; Information signs; VOR aerodrome check-point sign; Road-holding position sign; Boundary markers; Lighting of objects; Wind turbines; Electrical power supply systems for air navigation facilities; Monitoring; Rescue and fire fighting;; Aerodrome vehicle operations; Surface movement guidance and control systems; Autonomous runway incursion warning system; Pavements; List of related reference documents; Particulars to be included in an aerodrome manual Part 1, Part 4 and Part 5; Documents and publications that must be kept and made available for reference by aerodrome operator staff		9.2.3.17.8; 9.2.3.30; 9.2.4.1.4; 9.2.4.2; 9.2.4.2.15; 9.2.4.2.16; 9.2.4.2.18; 9.2.4.3.4; 9.2.4.3.15; 9.2.4.3.28; 9.2.4.3.29; 9.2.4.3.30; 9.2.4.3.31; 9.2.4.3.34; 9.2.4.4.4; 9.2.4.7.4; 9.2.5.8.2; 9.2.5.8.3; 10.2.3; 10.2.3.30; 10.2.3.33; 10.2.3.37; 10.2.3.40; 10.2.4.1; 12.2.1.10; 12.2.3.4; 13.2.2.6; 13.2.2.42A; 13.2.7; 13.2.8.6; 13.2.12; 14.2.2.1; Appendix B; Appendix D; Appendix E; Appendix F			
13	2.2	Table of Contents; Definitions; Aerodrome	Aerodrome and ANS Regulation	1.2, 3.1.6.1, 3.1.6.3, 5.1.4.4, 5.2.1.7,	Wong Qi Wen (22 Jan 2018)	DGCA (26 Jan 2018)	26 Feb 2018

Amendment no.	Version no.	Subject	Source	Sections affected	Entered by (Date)	Approved by (Date)	Effective date
		certification process and aerodrome manual requirements; Aerodrome work safety; safety management system; Aerodrome accident/incident reporting and investigation procedures; Aviation fuel quality at aerodromes; Particulars to be included in an aerodrome manual.	Division (Arising from ongoing review of MOAS)	5.3.2.5, 13.2.2.42A, 13.3, Appendix E			

FOREWORD

Under paragraph 67(1) of the Singapore Air Navigation Order, no person shall operate an aerodrome in Singapore for the take-off and landing of aircraft engaged in flights for the purpose of public transport or instruction in flying unless he is the holder of an aerodrome certificate granted under the Order.

The DGCA is responsible for the aerodrome certification process and for promulgating appropriate and clear Aerodrome Standards to be complied with by aerodrome operators. These Aerodrome Standards are based on the standards and recommended practices stipulated in Volume I of Annex 14 (entitled "Aerodromes – Aerodrome Design and Operations") to the Chicago Convention on International Civil Aviation (as in force and amended from time to time by the Council of the International Civil Aviation Organisation), and with such adaptations as may be determined by the DGCA to be applicable in Singapore. This Manual of Aerodrome Standards spells out the national Aerodrome Standards that aerodrome operators in Singapore are required to comply with in order to meet the requirements stipulated under paragraph 67 of the Air Navigation Order. It contains:

(a) the procedures for the certification of aerodromes; and

(b) aerodrome standards, recommended practices and guidance materials pertaining to the planning, operation and maintenance of aerodrome services, facilities and equipment.

Aerodrome operators or applicants for an aerodrome certificate should refer to the applicable sections of the Singapore Air Navigation Order, together with this Manual, to ascertain the requirements of, and the obligations imposed by or under, Singapore civil aviation legislation.

From time to time, the DGCA may wish to supplement the aerodrome standards and requirements stipulated in this Manual in the form of Aerodrome Safety Publications. Where appropriate, such directives will be incorporated into this Manual by amendment.

Amendments to this Manual of Aerodrome Standards are the responsibility of the DGCA. Readers should forward advice of errors, inconsistencies or suggestions for improvement to the Division Head of the Aerodrome and ANS Regulation Division at the address stipulated below:

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ABBREVIATIONS AND SYMBOLS

Abbreviations

AAIB	Air Accident Investigation Bureau of Singapore
ACN	Aircraft Classification Number
AGL	Aerodrome Ground Lighting
AIP	Aeronautical Information Publication
AIS	Aeronautical Information Services
ANA	Air Navigation Act
ANO	Air Navigation Order
aprx	Approximately
ARFF	Aerodrome rescue and fire fighting
ARIWS	Autonomous Runway Incursion Warning System
ASDA	Accelerate-stop distance available
ATC	Air Traffic Control
ATS	Air Traffic Services
cd	Candela
cm	Centimetre
C	Degree Celsius
CAAS	Civil Aviation Authority of Singapore
Cat.	Category
CBR	California Bearing Ratio
CIE	Commission Internationale de Éclairage

Abbreviations

DGCA	Director-General of Civil Aviation
DME	Distance Measuring Equipment
FATO	Final Approach and Takeoff area
ft	Foot
ICAO	International Civil Aviation Organisation
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
kg	Kilogram
km	Kilometre
km/h	Kilometre per Hour
kt	Knot
K	Degree Kelvin
L	Litre
LDA	Landing Distance Available
m	Metre
max	Maximum
mm	Millimetre
mnm	Minimum
MLS	Microwave Landing System
MN	Mega Newton
MOT	Ministry of Transport
MPa	Mega Pascal

Abbreviations

NM	Nautical Mile
OCA/H	Obstacle Clearance Altitude/Height
OFZ	Obstacle Free Zone
PAPI	Precision Approach Path Indicator
PCN	Pavement Classification Number
REL	Runway Entrance Light
RESA	Runway End Safety Area
RFF	Rescue and Fire ighting
RFFS	Rescue and Fire Fighting Services
RWSL	Runway Status Lights
SARPS	ICAO Standards and Recommended Practices
SMGCS	Surface Movement Guidance and Control System
SMR	Surface Movement Radar
SMS	Safety Management System
THL	Take-Off Hold Lights
TODA	Take-Off Distance Available
TORA	Take-Off Run Available
VMC	Visual Meteorological Conditions
Vol.	Volume
VOR	Very High Frequency Omni-directional Radio Range

Symbols

°	Degree
=	Equals
‘	Minute of Arc
µ	Friction Coefficient
>	Greater than
<	Less than
%	Percentage
±	Plus or Minus
“	Second of Arc

Chapter 1 – INTRODUCTION

Section 1.1 – General

1.1.1 Background and scope

1.1.1.1 Aerodrome safety is a vital link in aviation safety. Aerodrome safety is achieved by providing appropriate aerodrome services, facilities and equipment and maintaining them and the aerodrome environment to be safe for aircraft operations. By complying with the prescribed standards and procedures, and by taking a pro-active safety management approach in the operation of their aerodromes, aerodrome operators can demonstrate that they have discharged their safety obligations to the traveling public.

1.1.1.2 This Manual of Aerodrome Standards, as referred to under paragraph 2(1)(g) and 67B of the Singapore Air Navigation Order and as defined therein, contains:

(a) the procedures for the certification of aerodromes; and

(b) aerodrome standards, recommended practices and guidance materials pertaining to the planning, operation and maintenance of aerodrome services, facilities and equipment to be complied with by aerodrome operators.

1.1.1.3 The scope of this Manual is confined to the safety, regularity and efficiency aspects of aerodrome facilities, equipment and operational procedures. It does not cover such aspects as those related to aeronautical meteorology, the administration of aerodrome finances and the servicing of passengers and cargo. It also excludes air traffic services and aeronautical information services, although their coordination with the aerodrome operator, which forms an integral part of an aerodrome's operations, has been incorporated.

1.1.2 Aerodrome regulatory functions

Aerodrome safety regulation

1.1.2.1 Paragraph 1.4.1 of ICAO Annex 14 Vol. I states as a standard that States shall certify aerodromes used for international operations in accordance with the specifications contained in the Annex 14 as well as other relevant ICAO specifications through an appropriate regulatory framework. Paragraph 1.4.3 of Annex 14 stipulates, as a standard, that the regulatory framework shall include the establishment of criteria and procedures for the certification of aerodromes.

1.1.2.2 In line with these ICAO standards, Paragraph 67(1) of the Singapore Air Navigation Order stipulates that <u>no person shall operate an aerodrome in Singapore for the take-off and landing of aircraft engaged in flights for</u>

<u>the purpose of the public transport or instruction in flying unless he is the holder of an Aerodrome Certificate granted under this Order</u>.

1.1.2.3 Paragraph 67(4) of the same Order makes provision for the DGCA to grant an Aerodrome Certificate to an applicant if the DGCA is satisfied that

(a) the applicant is competent to operate and maintain his aerodrome properly, having regard to his previous conduct and experience, facility and equipment, organisation, staffing, maintenance and other arrangements;

(b) the Aerodrome Manual prepared for the applicant's aerodrome and submitted with his application for Aerodrome Certificate contains accurate information and complies with the requirements specified in the Eighteenth Schedule of the Air Navigation Order and this Manual of Aerodrome Standards;

(c) the applicant's aerodrome facilities, equipment and services comply with the standards specified in this Manual of Aerodrome Standards;

(d) the applicant's aerodrome operating procedures make satisfactory provision for the safety of aircraft; and

(e) an acceptable safety management system is in place at the applicant's aerodrome.

Paragraph 67(6) of the Order makes provision for the DGCA to grant an Aerodrome Certificate subject to such conditions as the DGCA may deem fit.

1.1.2.4 Not in use.

Aerodrome security regulation

1.1.2.5 The authority for setting policies and regulations on aerodrome, airport and aviation security rests with the Singapore Police Force. These policies and regulations are outside the scope of this Manual except those areas for preventing unlawful interference in civil aviation at the aerodrome and for preventing unauthorized entry of persons, vehicles, equipment, animals and other things into the movement area. Aerodrome operators shall establish arrangements with the Singapore Police Force and other agencies responsible for coordinating aerodrome security matters in order to implement aerodrome security measures (such as control of access to the aircraft movement areas, aerodrome fencing and security lighting) in accordance with the standards and recommended practices of ICAO Annex 17 under the direction of the Singapore Police Force.

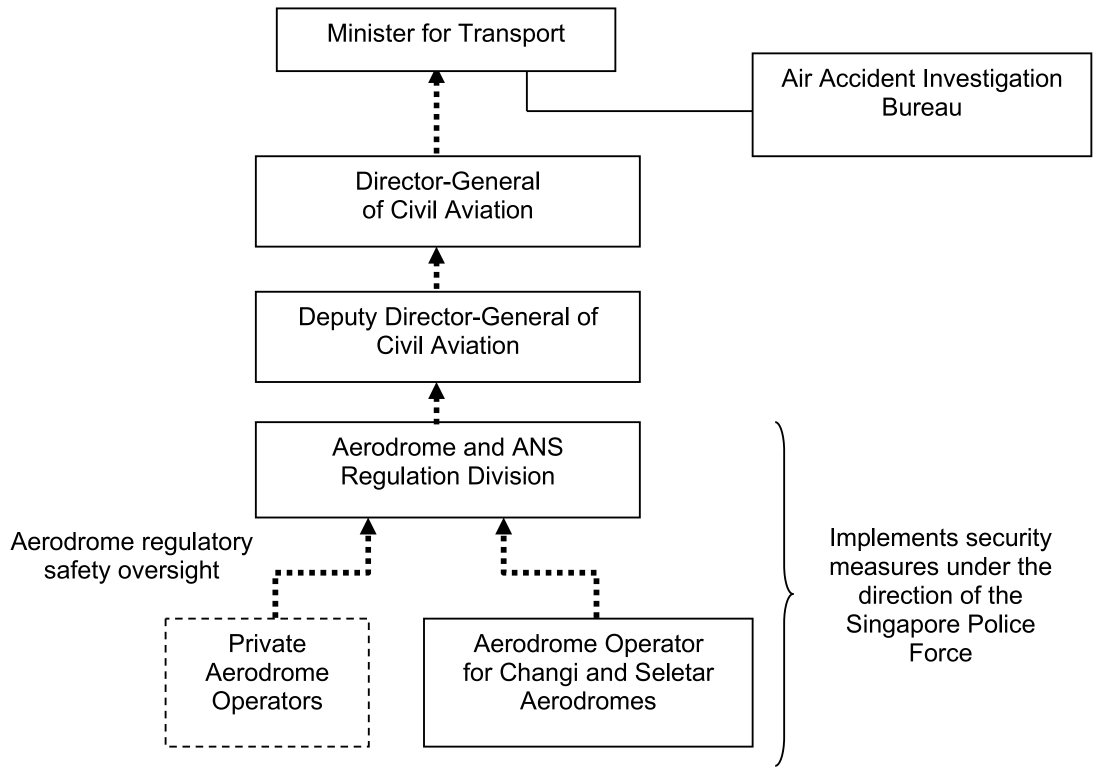
Air accident investigation

1.1.2.6 The responsibility for investigation of air accidents and incidents in Singapore lies with the Air Accident Investigation Bureau (AAIB) of the Ministry of Transport. In parallel, the Aerodrome and ANS Regulation

Division may also conduct investigations to determine if any aerodrome safety regulations and requirements have been breached.

1.1.2.7 A chart showing the elements of the above-mentioned regulatory setup is shown below.

Figure 1-1 – Organisation of Aerodrome Regulatory and Operational Functions



1.1.3 Responsibilities

1.1.3.1 The roles and responsibilities of the Aerodrome and ANS Regulation Division include:

(a) ensuring that aerodromes in Singapore offer a safe operational environment in accordance with the Convention on International Civil Aviation;

(b) reviewing ICAO State letters on the subject of aerodromes, preparing response thereto and taking action thereon;

(c) notifying ICAO of differences between Singapore's national aerodrome safety regulations and practices vis-à-vis the SARPs contained in ICAO Annex 14 Vol. I;

(d) carrying out aerodrome certification in accordance with the Singapore Air Navigation Order;

(e) developing and continue to review national safety standards and recommended practices relating to aerodromes;

(f) monitoring and ensuring adherence to these standards and recommended practices through regular safety audits, providing measures for enforcing compliance and taking enforcement actions, when required;

(g) conducting regular reviews of aerodrome regulations and practices, and developing and issuing Aerodrome Safety Directives and/or Aerodrome Safety Publications containing guidance material relating to aerodrome standards and recommended practices to promote the improvement of aerodrome safety;

(h) reviewing aerodrome-related accident and incident investigation reports produced by the AAIB and performing investigations, where necessary, to determine if there is any violation of safety regulations and requirements by aerodrome operators and take enforcement actions, when required;

(i) notifying the Aeronautical Information Services regarding the certified status and particulars of aerodromes for promulgation in the Aeronautical Information Publications;

(j) maintaining a technical library containing files for each certified aerodrome, national aerodrome standards, recommended practices, guidance materials for aerodrome inspectors and where necessary, other relevant reference materials; and

(k) providing the DGCA with such information and advice as the DGCA may from time to time require.

1.1.3.2 Notwithstanding that the Aerodrome and ANS Regulation Division sets and maintains aerodrome standards and recommended practices, certifies aerodrome operators and conducts aerodrome safety oversight audits, the responsibility for the safety of aerodrome operations rests with the certified aerodrome operators. A certified aerodrome operator with a Safety Management System in place is required to maintain its own safety audit and inspection program with the Aerodrome and ANS Regulation Division taking an interest in what the internal safety audit program is achieving and how the aerodrome operator organisation is performing from a safety perspective.

1.1.3.3 The Aerodrome and ANS Regulation Division monitors the safety performance through conducting regular safety audits, reviewing the findings, identifying preventive and corrective actions needed, examining safety occurrences at the aerodromes and evaluating concerns expressed by the public or other industry participants.

1.1.4 Relevant legislation and document

1.1.4.1 The relevant legislation and document hierarchy relating to the certification of aerodromes in Singapore consists of:

(a) the relevant provisions of the Air Navigation Act (ANA) and Air Navigation Order (ANO), particularly paragraph 67 of the Order, and the Civil Aviation Authority of Singapore Act (CAAS Act);

(b) this Manual of Aerodrome Standards (with references to relevant sections of ICAO Annex 14 Vol. I and related guidance material);

(c) Aerodrome Safety Directives, as and when published, by the DGCA; and

(d) Aerodrome Safety Publications, as and when published, by the Aerodrome and ANS Regulation Division.

1.1.4.2 These regulatory documents establish, for aerodrome operators and aerodrome operators-to-be, a comprehensive description of safety conformance requirements and guidelines.

1.1.4.3 The ANA, ANO and CAAS Act establish the legislative framework (i.e. Regulations) and regulatory regime within which all aerodrome operators must operate.

1.1.4.4 The Manual of Aerodrome Standards contains the standards and recommended practices published by the DGCA. These requirements are based on the SARPs contained in ICAO Annex 14 Vol. I and other related ICAO guidance material. The DGCA may also adopt suitable standards and/or recommended practices from other States into this Manual. Aerodrome operators shall document their internal actions in their Aerodrome Manuals to demonstrate their continued compliance with requirements in this Manual.

1.1.4.5 Aerodrome Safety Directives and/or Aerodrome Safety Publications, where published, are intended to supplement the standards and recommended practices contained in the Manual of Aerodrome Standards, or to provide recommended practices and additional materials for education. These documents illustrate a means, but not necessarily the only means, of complying with the Regulations. These Directives or Publications may explain certain regulatory requirements by providing interpretive and explanatory materials. It is expected that aerodrome operators will provide adequate practices and/or document internal actions in their own Aerodrome Manuals to address the subject matter contained in these Directives or Publications.

1.1.4.6 In addition to the document mentioned above, to provide systematic and clear working procedures and guidelines for the function of the Aerodrome and ANS Regulation Division, an Aerodrome Inspector Handbook is also produced by the Division Head of Aerodrome and ANS Regulation Division for the Division’s officers to refer to and comply with in carrying out their tasks.

1.1.5 Cross-references with ICAO and adopted Standards and Recommended Practices

1.1.5.1 To facilitate cross-referencing of the standards and recommended practices prescribed in this Manual with those contained in ICAO Annex 14 Vol. I, other relevant ICAO documents, and standards and/or recommended practices adopted from other States a list of corresponding clauses between these documents showing the sources of reference documents from which the standards and recommended practices of this Manual are derived is shown in Appendix A attached.

1.1.5.2 Notwithstanding the above, where there is a difference between a Standard and/or Recommended Practice stated in ICAO Annex 14 Vol. I or the standard and/or recommended practice of the originating State and one prescribed in this Manual, the standard or recommended practice stipulated in this Manual shall prevail.

1.1.6 Publication of differences in AIP

1.1.6.1 Differences between the Standards prescribed in this Manual and those contained in ICAO Annex 14 Vol. I, if any, are promulgated by the Aerodrome and ANS Regulation Division through section Gen 1.7 of the Singapore Aeronautical Information Publication (AIP) and also notified to ICAO.

1.1.6.2 Exemptions granted by the DGCA are promulgated through the AIP.

1.1.7 Document change management

1.1.7.1 The power to issue and amend this Manual rests with the DGCA.

1.1.7.2 Not in use.

1.1.7.3 Requests for any change in content of this Manual may be directed to:

Division Head
Aerodrome and ANS Regulation Division
Civil Aviation Authority of Singapore
PO Box 1 Singapore Changi Airport
Singapore 918141

1.1.7.4 The need to amend this Manual may be generated by a number of causes, including but not be limited to the following:

(a) promotion of safety;

(b) response to changed CAAS or legislative requirements;

(c) response to ICAO prescription; or

(d) accommodation of new initiatives or technologies.

1.1.8 Related reference documents

1.1.8.1 This Manual should be read in conjunction with the list of reference documents shown in Appendix B.

Section 1.2 – Definitions

Definition	Meaning
Accident	An occurrence associated with the operation of an aircraft which, in the case of a manned aircraft, takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, or in the case of an unmanned aircraft, takes place between the time the aircraft is ready to move with the purpose of flight until such time as it comes to rest at the end of the flight and the primary propulsion system is shut down, in which: a) a person is fatally or seriously injured as a result of – being in the aircraft, or – direct contact with any part of the aircraft, including parts which have become detached from the aircraft, or – direct exposure to jet blast, except when the injuries are from natural causes, self-inflicted, or inflicted by other persons, or when the injuries are to stowaways hiding outside the areas normally available to the passengers and

crew or;

b) the aircraft sustains damage or structural failure which
- – adversely affects the structural strength, performance or flight characteristics of the aircraft, and
- – would normally require major repair or replacement of the affected component except for engine failure or damage, when the damage is limited to a single engine (including its cowlings or accessories), to propellers, wing tips, antennas, probes, vanes, tires, brakes, wheels, fairings, panels, landing gear doors, windscreens, the aircraft skin (such as small dents or puncture holes), or for minor damages to main rotor blades, tail rotor blades, landing gear, and those resulting from hail or bird strike (including holes in the radome); or

c) the aircraft is missing or is completely inaccessible.

Note 1.— For statistical uniformity only, an injury resulting in death within thirty days of the date of the accident is classified, by ICAO, as a fatal injury.

Note 2.— An aircraft is considered to be missing when the official search has been terminated and the wreckage has not been located.

Note 3.— The type of unmanned aircraft system to be investigated is addressed in ICAO Annex 13, Section 5.1.

Note 4.— Guidance for the determination of aircraft damage can be found in ICAO Annex 13, Attachment F

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.

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

Definition	Meaning
Aerodrome beacon	Aeronautical beacon used to indicate the location of an aerodrome from the air.
Aerodrome Certificate	Means a certificate granted by the DGCA pursuant to paragraph 67 of the Air Navigation Order to an aerodrome operator to operate an aerodrome, subsequent to the acceptance of the aerodrome operator's Aerodrome Manual.
Aerodrome elevation	The elevation of the highest point of the landing area.
Aerodrome facilities and equipment	Means any facility or equipment, inside or outside the boundaries of an aerodrome, that is constructed, or installed, and maintained for the arrival, departure and surface movement of aircraft.
Aerodrome identification sign	A sign placed on an aerodrome to aid in identifying the aerodrome from the air.
Aerodrome Manual	Means the manual forming part of the application for an Aerodrome Certificate under the Air Navigation Order and includes any amendments thereto made in accordance with the Order.
Aerodrome operator	In relation to a certified aerodrome, means the holder of an Aerodrome Certificate.
Aerodrome reference point	The designated geographical location of an aerodrome.
Aerodrome and ANS Regulation Division	Refers to the DGCA, the Deputy Director-General (DDG) having oversight of the Safety Regulation Group, the Division Head of the Aerodrome and ANS Regulation Division, or appointed officers of the Aerodrome and ANS Regulation Division under the Civil Aviation Authority of Singapore, or any person authorised to act on their behalf.

Definition	Meaning
Aerodrome Safety Directives	Documents published by the DGCA for purposes of immediate promulgation of local Standards and Recommended Practices in response to, but not limited to, amendments to ICAO Annexes. The Aerodrome Safety Directives will be incorporated into subsequent amendments of the Manual of Aerodrome Standards. Aerodrome operators shall conform to the Standards promulgated in the Directives in accordance with the provisions of the ANO, failing which filing exemption and providing justification (through appropriate risk assessment and / or aeronautical studies) to the Division Head of Aerodrome and ANS Regulation Division is compulsory. Aerodrome operators should endeavour to conform with the Recommended Practices promulgated in the Directives, failing which notification to the Division Head of Aerodrome and ANS Regulation Division is compulsory.
Aerodrome Safety Publications	Published by the Aerodrome and ANS Regulation Division for purposes of promulgating supplementary guidance materials to the Standards and Recommended Practices in the Manual of Aerodrome Standards. The publications are intended to provide recommendations and guidance to illustrate a means, but not necessarily the only means, of complying with Regulations. Aerodrome Safety Publications may explain certain regulatory requirements by providing interpretive and explanatory materials.
Aerodrome traffic density	a) *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. b) *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. c) *Heavy*. Where the number of movements in the mean busy hour is of the order of 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 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 Information Circular	Means a notice containing information which relates to flight safety, air navigation, technical, administrative or legislative matters.
Aeronautical Information Publication	Means a publication issued by and with the authority of the Aeronautical Information Services and containing aeronautical information of a lasting character essential to air navigation.
Aeronautical Information Services	Means the services established within the defined area of coverage responsible for the provision of aeronautical information and data necessary for the safety, regularity and efficiency of air navigation and, where appropriate, includes the personnel and facilities employed to provide information pertaining to the availability of air navigation services and their associated procedures necessary for the safety, regularity and efficiency of air navigation.

Definition	Meaning
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 – Attachment A, Section 2 of the ICAO Annex 14 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.*
AIP amendment	Means permanent changes to the information contained in the Aeronautical Information Publication.
AIP supplement	Means temporary changes, published by means of special pages, to the information contained in the Aeronautical Information Publication.
Aircraft Classification Number	A number expressing the relative effect of an aircraft on a pavement for a specified standard subgrade category. *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 (ramp) mass is used to calculate the ACN. 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.
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.

Definition	Meaning
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.
Aviation fuel	Fuel intended for use in aircraft
Aviation fuel installation	Any apparatus or container, including a vehicle, designed, manufactured or adapted for the storage of aviation fuel or for the delivery of such fuel to an aircraft
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.
Bird incident	Means an incident where a) there Is a collision between an aircraft and one or more birds; b) where one or more birds pass sufficiently close to an aircraft in flight to cause alarm to the pilot.
Calendar	Discrete temporal reference system that provides the basis for defining temporal position to a resolution of one day (ISO 19108*).
Certified aerodrome	Means an aerodrome whose operator has been granted an Aerodrome Certificate.
Clearway	A defined rectangular area on the ground or water under the control of the aerodrome operator, selected or prepared as a suitable area over which an aeroplane may make a portion of its initial climb to a specified height.

Definition	Meaning
Controlled aerodrome	An aerodrome provided with air traffic control services
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 quality	A degree or level of confidence that the data provided meet the requirements of the data user in terms of accuracy, resolution and integrity.
Datum	Any quantity or set of quantities that may serve as a reference or basis for the calculation of other quantities (ISO 19104*).
Declared distances	a) *Take-off run available (TORA).* The length of runway declared available and suitable for the ground run of an aeroplane taking off. b) *Take-off distance (TODA).* The length of the take-off run available plus the length of the clearway, if provided. c) *Accelerate-stop distance available (ASDA).* The length of the take-off run available plus the length of the stopway, if provided. d) *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.
Director-General of Civil Aviation	Means the Director-General of the Civil Aviation Authority of Singapore, who is also referred to as the Chief Executive of the Civil Aviation Authority of Singapore under the Singapore Air Navigation Order and includes any person acting on that capacity.
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.

Definition	Meaning
Ellipsoid height (Geodetic height)	The height related to the reference ellipsoid, measured along the ellipsoid outer normal through the point in question.
Fatal injury	Means any injury which results in death within 30 days of the accident.
Facility malfunction incident	Means an incident that involves an unserviceability of a visual/non-visual aid, electrical system, aeronautical telecommunications facility and/or other equipment needed for aircraft operation.
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 Aerodrome Design Manual, 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.*

Definition	Meaning
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*). *Note – In the Gregorian calendar, common years have 365 days and leap years 366 days divided into 12 sequential months.*
Hazard beacon	An aeronautical beacon used to designate a danger to air navigation.
Holding bay	A defined area where aircraft can be held, or bypassed, to facilitate efficient surface movement of aircraft.
Human Factors Principle	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.
Incident	An occurrence, other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation.
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.

Definition	Meaning
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 1000m. 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 60m (200 ft) and either a visibility not less than 800m or a runway visual range not less than 550m. 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 60m (200 ft) but not lower than 30m (100 ft) and a runway visual range not less than 300m. 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 to and along the surface of the runway and: A - intended for operations with a decision height (DH) lower than 30m (100ft), or no decision height and a runway visual range not less than 175m. B - intended for operations with a decision height (DH) lower than 15m (50 ft), or no decision height and a runway visual range less than 175m but not less than 50m. C - intended for operations with no decision height (DH) and 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 – Refer to ICAO Annex 6 for instrument approach operation types.

Integrity (aeronautical data)	A degree of assurance that an aeronautical data and its value has not been lost nor altered since the data origination or authorized amendment.
Integrity classification (aeronautical data)	Classification based upon the potential risk resulting from the use of corrupted data. Aeronautical data is classified as: a) 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; b) 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 c) 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.
Investigation	A process conducted for the purpose of accident prevention which includes the gathering and analysis of information, the drawing of conclusions, including the determination of causes and, when appropriate, the making of safety recommendations.
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 take-off.

Definition	Meaning
Laser-beam critical flight zone (LCFZ)	Airspace in the immediate proximity to the aerodrome but beyond the LFFZ where the irradiance is restricted to a level unlikely to cause glare effects.
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.
Major aerodrome activity	Means any significant aerodrome activity: (i) which would affect the aerodrome reference code; or (ii) which introduces a new critical airside infrastructure (such as the construction of a new runway) or airfield system or which changes an existing critical airside infrastructure or airfield system.
Manoeuvring area	That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, excluding aprons.
Manual of Aerodrome Standards	The document published by the DGCA, under paragraph 67B of the Air Navigation Order and containing the standards, recommended practices and guidance material on aerodromes as may be determined by the DGCA to be applicable in Singapore.
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.
Minister	Refers to the Minister for Transport.
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 aprons.

Definition	Meaning
Non-instrument runway	A runway intended for the operation of aircraft using visual approach procedures or an instrument approach procedure to a point beyond which the approach may continue in visual meteorological conditions. *Note –Visual meteorological conditions (VMC) are described in Chapter 3 of ICAO Annex 2.*
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.
NOTAM or Notice to Airmen	Means a notice distributed by means of telecommunication containing information concerning the establishment, condition or change in any aeronautical facility, service or procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations.
NOTAO or Notice to Aerodrome Operators	Notices published by the Aerodrome and ANS Regulation Division for purposes of bringing to the attention of aerodrome operators educational materials related to aviation safety. The Notice could be initiated as a result of ICAO State letters which do not require immediate changes to local regulations, new safety initiatives or international best practices as identified by the Aerodrome and ANS Regulation Division. Aerodrome operators are encouraged to review and adopt the materials if practicable. Where appropriate, the materials presented in the Notice may be incorporated into subsequent amendments of the Manual of Aerodrome Standards as Standards or Recommended Practices.
Obstacle	Any fixed (whether temporary or permanent) or mobile object or parts thereof, that: a) are located on an area intended for the surface movement of aircraft; or b) extend above a defined surface intended to protect aircraft in flight; or c) stand outside those defined surfaces and that have been assessed as being a hazard to air navigation.

Definition	Meaning
Obstacle limitation surfaces	Means 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 aircraft operations to be conducted safely and to prevent the aerodrome from becoming unusable by the growth of obstacles around the aerodrome.
Occurrence	Means an accident or incident.
Orthometric height	Height of a point related to the geoid, generally presented as an MSL elevation.
Pavement classification number (PCN)	A number expressing the bearing strength of a pavement for unrestricted operations.
Precision approach runway	See ‘Instrument runway’.
Pre-flight information bulletin	Means a presentation of current NOTAM information of operational significance, prepared prior to flight.
Primary runway(s)	Runway(s) used in preference to others whenever conditions permit.
Promulgated information incident	Means an incident that involves significantly incorrect, inadequate, or misleading information promulgated in any aeronautical information publication, map or chart.
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 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 tthat they are about to enter an active runway

Definition	Meaning
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, that is intended: a) to reduce the risk of damage to aircraft running off a runway; and b) to protect aircraft flying over the area during take-off or landing operations.
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 centerline 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 organisational structure, accountabilities, policies and procedures.
Security incident	Means an incident that involves unlawful interference.
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.

Definition	Meaning
Serious incident	Means an incident involving circumstances indicating that there was a high probability of an accident and associated with the operation of an aircraft which, in the case of a manned aircraft, takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, or in the case of an unmanned aircraft, takes place between the time the aircraft is ready to move with the purpose of flight until such time as it comes to rest at the end of the flight and the primary propulsion system is shut down. *Note 1.— The difference between an accident and a serious incident lies only in the result.* *Note 2.— Examples of serious incidents can be found in ICAO Annex 13 Attachment C.*
Serious injury	Means an injury that is sustained by a person in an accident and which: a) requires hospitalization for more than 48 hours, commencing within seven days from the date the injury was received; or b) results in a fracture of any bone(except simple fractures of fingers, toes or nose); or c) involves lacerations which cause severe haemorrhage, nerve, muscle, or tendon damage; or d) involves injury to any internal organ; or e) involves second or third degree burns, or any burns affecting more than 5% of the body surface; or f) involves verified exposure to infectious substances or injurious radiation.
Shoulder	An area adjacent to the edge of a pavement so prepared as to provide a transition between the pavement and the adjacent surface.

Definition	Meaning
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.
Significant aerodrome activity	Means any activity or development which, if carried out, would require amendments to the aerodrome manual, such as a change in the frequency of runway inspections.
Station declination	An alignment variation between the zero degree radial of a VOR and true north, determined at the time the VOR 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.
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 change-over, 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 aeroplanes first contact the runway.
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 -* *Cross wind component means the surface wind component at right angles to the runway centre line.*
Unserviceable area	A part of the movement area that is unfit and unavailable for use by aircraft.
Work area	A part of an aerodrome in which maintenance or construction works are in progress.

Note

Terms and definitions that are shown in singular above shall also take on the same meaning when they are expressed in plural form in this Manual and vice versa.

* ISO Standard 19104, *Geographic Information – Terminology*
* ISO Standard 19108, *Geographic Information – Temporal schema*

Section 1.3 – Common reference systems

1.3.1 Horizontal reference system

1.3.1.1 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).

1.3.2 Vertical reference system

1.3.2.1 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 gravity field 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.

1.3.3 Temporal reference system

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

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

Section 1.4 – Not in use

Section 1.5 – Not in use

Section 1.6 – Airport design

1.6.1 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.

Note – Guidance on all aspects of the planning of aerodromes including security considerations is contained in the Airport Planning Manual, Part 1.

1.6.2 **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 are described in the Airport Planning Manual (Doc 9184), Part 2.

Chapter 2 – APPLICATION OF STANDARDS AND RECOMMENDED PRACTICES TO AERODROMES

Section 2.1 – General

2.1.1 Legislative background and applicability

2.1.1.1 Paragraph 67(4)(c) of the Air Navigation Order stipulates that the DGCA may grant an Aerodrome Certificate to an applicant if he is satisfied that the applicant's aerodrome facilities, equipment and services comply with the standards specified in the Manual of Aerodrome Standards. Para 67C of the same Order stipulates that an aerodrome operator shall comply with the applicable standards set out in the Manual of Aerodrome Standards and shall not at any time contravene, or cause or permit the contravention of, any condition of the aerodrome certificate.

2.1.1.2 Not in use.

2.1.2 Standards and recommended practices

2.1.2.1 Standards and Recommended Practices in the context of this Manual of Aerodrome Standards 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 ANO, this Manual and Aerodrome Safety Directives. 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 Division Head of Aerodrome and ANS Regulation Division of CAAS 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 ANO, this Manual and Aerodrome Safety Directives and/or Aerodrome Safety Publications. In the event of non-compliance with any recommended practice, notification to the Division Head of Aerodrome and ANS Regulation Division of CAAS is compulsory.

2.1.2.2 In this Manual of Aerodrome Standards and in the Aerodrome Safety Directives and/or Aerodrome Safety Publications, standards are identified by the words ‘must’ or ‘shall’. Unless otherwise exempted pursuant to paragraph 67M of the ANO by the DGCA, they shall be complied with at all times. Figures, appendices and tables associated with these standards form part of the main document and have the same status as the primary text. This Manual of Aerodrome Standards may also require standards from other documents to be followed. In such cases, the referred standards become part of this Manual.

2.1.2.3 Recommended practices are identified by the words ‘should’ or ‘may’. Aerodrome operators should endeavour to comply with recommended practices. Figures, appendices and tables associated with these recommended practices form part of the main document and have the same status as the primary text.

2.1.3 Changes to aerodrome standards and recommended practices and their effects on existing aerodromes

2.1.3.1 Standards and recommended practices are subject to change from time to time. In general, existing aerodrome facilities may not need to be immediately modified in accordance with new standards and/or recommended practices that arise, unless advance notice has been given for the aerodrome operator to comply. The Aerodrome and ANS Regulation Division will determine and promulgate an appropriate time frame, depending on the critical nature of the requirement and other aerodrome operational considerations, for such revisions in standards and recommended practices to be applicable, so that they can be complied with by the aerodrome operators concerned.

2.1.3.2 Pursuant to paragraph 2.1.3.1 above, in the interim and unless otherwise directed by the Aerodrome and ANS Regulation Division, an aerodrome operator’s existing facility that does not meet the new standards specified in this Manual must continue to comply with the standards that were applicable to it under the conditions of the issuance of its Aerodrome Certificate.

2.1.3.3 At a certified aerodrome, an existing aerodrome facility that does not comply with this Manual of Aerodrome Standards must be identified and recorded in the Aerodrome Manual described in Chapter 3. It must include the date or period when that facility was first introduced or last upgraded and an indication from the aerodrome operator of a plan or timescale to bring the facility in compliance with this Manual. As part of the site safety audits conducted by the Aerodrome and ANS Regulation Division, evidence to demonstrate efforts to implement the above-mentioned plan or timescale may be required.

2.1.3.4 Other than existing aerodrome facilities and equipment that are allowed to continue to be in use, or exemptions granted to the aerodrome operator for specific cases of consideration, an aerodrome operator is expected to comply with the standards and recommended practices contained in this Manual of Aerodrome Standards when introducing a new aerodrome facility or equipment, or when carrying out replacement or improvement works on an existing facility or equipment, unless the replacement or improvement works is limited to those of very minor nature.

2.1.4 Aeronautical studies

2.1.4.1 Where an aerodrome operator is not able to comply with any standard stipulated in this Manual, appropriate risk assessment and/ or aeronautical studies shall be conducted to assess the impact of deviations from the standards. The purpose of such studies is to present alternative means of ensuring the safety of aircraft operations, to estimate the effectiveness of each alternative and to recommend procedures to compensate for the deviation.

2.1.4.2 An aeronautical study is mostly frequently undertaken during the planning of a new airport or new airport facility, or during the certification of an existing aerodrome. It may also be carried out when aerodrome standards cannot be met as a result of development.

2.1.4.3 An aeronautical study is a study of an aeronautical problem carried out by an aerodrome operator to identify possible solutions and select a solution that is acceptable without degrading safety. The Aerodrome and ANS Regulation Division will review these studies on a case by case basis and determine their acceptability.

2.1.4.4 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 on situations where the cost of correcting a problem that violates a standard is excessive but where the unsafe effects of the problem can be overcome by some procedural or other means which offer both practical and reasonable solutions.

2.1.4.5 In conducting a technical analysis, an aerodrome operator should draw upon their practical experience and specialized knowledge. The aerodrome operator may also consult other specialists in relevant areas. When considering alternative procedures in the deviation approval process, it is essential to bear in mind the safety objective of the aerodrome certification regulations and the applicable standards so that the intent of the regulations is not circumvented.

2.1.4.6 In some instances, the only reasonable means of providing an equivalent level of safety is to adopt suitable procedures and to require, as a condition of certification, that cautionary advice be published in the appropriate AIS publications.

2.1.4.7 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 Aerodrome and ANS Regulation Division to publish deviations from standards that would otherwise be assumed under the certificate status.

2.1.5 Exemptions from aerodrome standards

2.1.5.1 When an aerodrome is not able to comply with any standard specified in the Manual of Aerodrome Standards, the aerodrome operator shall apply for an exemption from the relevant standard. The form for *Request for Grant of Exemption* can be found in <u>Appendix J</u> of this Manual. Applications must be supported, in writing, by cogent reasons including any aeronautical study conducted and their associated results, and where appropriate, an indication of when compliance with the current standards can be expected.

2.1.5.2 Under paragraph 67M(1) of the Air Navigation Order, the Minister may, after taking into account all safety-related aspects and operating circumstances, exempt, by notice in writing, any aerodrome operator from any provision of paragraphs 67, 67A and 67C to 67L of the Order.

2.1.5.3 As stated in paragraph 67M(2) of the ANO, any exemption granted by the Minister shall be subject to any condition or procedure specified by the Minister in the relevant Aerodrome Certificate as being necessary in the interest of safety.

2.1.5.4 Under paragraph 67L(1) of the ANO, when an aerodrome does not comply with any standard specified in the Manual of Aerodrome Standards, the DGCA may determine, after taking into consideration such aeronautical or other studies as he deems fit, any condition or procedure necessary to ensure that the aerodrome attains a level of safety equivalent to that established by the standard. Paragraph 67L(2) of the ANO stipulates that in such cases, the aerodrome operator shall ensure that his aerodrome complies with any condition or procedure determined by the DGCA.

2.1.5.5 Paragraph 67L(3) of the ANO stipulates that any deviation of an aerodrome from any standard shall be set out in an endorsement to the relevant Aerodrome Certificate.

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

2.1.5.7 An exemption granted in respect of an existing facility shall continue to apply until its expiry date.

2.1.6 Conflict with other standards and recommended practices

2.1.6.1 Compliance with the standards and recommended practices specified in this Manual of Aerodrome Standards does not absolve an aerodrome operator from obligations in respect of requirements prescribed by other government or statutory authorities. Where another statutory requirement conflicts with the provisions of this Manual, the matter must be referred to the Aerodrome and ANS Regulation Division for resolution.

2.1.7 Other terms used with standards and recommended practices

2.1.7.1 The status of other terms used jointly with standards and recommended practices in this Manual is explained as follows:

a) Appendices

Appendices contain materials grouped separately for convenience but forming part of the standards and recommended practices.

b) Definitions

Definitions do not have independent status but is an essential part of each standard and recommended practice in which the term is used, since a change in the meaning of the term would affect the specifications.

c) Tables and Figures

Tables and Figures add to or illustrate a standard or recommended practice and which are referred to herein, form part of the associated standard or recommended practice and have the same status.

d) Forewords

Forewords contain historical and explanatory material based on the action of the Aerodrome and ANS Regulation Division or ICAO.

e) Introductions

Introductions comprise explanatory material introduced at the beginning of parts, chapters, or sections of this Manual to assist in the understanding of the application of the text.

f) Notes

Notes are included in the text, where appropriate, to give factual information or references bearing on the standards and recommended practices in question, but do not constitute part of the standards or recommended practices.

g) Attachments

Attachments comprise material supplementary to the standards and recommended practices, or are included as a guide to their application.

Section 2.2 – Use of ICAO Aerodrome Reference Code

2.2.1 Use of ICAO Aerodrome Reference Code to specify aerodrome standards and recommended practices

2.2.1.1 ICAO has devised a reference code to provide a simple method for inter-relating the numerous specifications concerning the characteristics of aerodromes so as to provide a series of aerodrome facilities that are suitable for 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 wing span and outer main gear wheel span. A particular specification is related to the more appropriate of the two elements of the code or to an appropriate combination of the two code elements. 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.

2.2.1.2 This Manual of Aerodrome Standards adopts ICAO's method of applying the aerodrome reference code to determine the characteristics required of aerodromes and aerodrome facilities.

2.2.2 Aerodrome Reference Code and aeroplane characteristics

2.2.2.1 When applying the standards and recommended practices prescribed in this Manual, the aeroplanes which the aerodrome is intended to serve are first identified and the two elements of the code.

2.2.2.2 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.

2.2.2.3 The aeroplane reference code numbers and letters shall have the meanings assigned to them in Table 2-1 of this Manual.

2.2.2.4 The code number for element 1 shall be determined from Table 2-1 of this Manual, column 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 – 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.

Table 2-1 – Aerodrome Reference Code

Code element 1		Code element 2		
Code number	Aeroplane reference field length	Code letter	Wing span	Outer main gear wheel span[a]
(1)	(2)	(3)	(4)	(5)
1	Less than 800 m	A	Up to but not including 15 m	Up to but not including 4.5 m
2	800 m up to but not including 1 200 m	B	15 m up to but not including 24 m	4.5 m up to but not including 6 m
3	1 200 m up to but not including 1 800 m	C	24 m up to but not including 36 m	6 m up to but not including 9 m
4	1 800 m and over	D	36 m up to but not including 52 m	9 m up to but not including 14 m
		E	52 m up to but not including 65 m	9 m up to but not including 14 m
		F	65 m up to but not including 80 m	14 m up to but not including 16 m
a. Distance between the outer edges of the main gear wheels.				
Note – Guidance on planning for aeroplanes with wing spans greater than 80 m is given in the ICAO Aerodrome Design Manual Parts 1 and 2.				

2.2.2.5 The code letter for element 2 shall be determined from this Manual, column 3, by selecting the code number which corresponds to the greatest wing span, or the greatest outer main gear wheel span, whichever gives the more demanding code number of the aeroplanes for which the facility is intended.

Note – Guidance to assist the aerodrome operator in determining the aerodrome reference code is given in the ICAO Aerodrome Design Manual, Parts 1 and 2.

2.2.3 Provisions for future larger aeroplanes

2.2.3.1 Nothing in this Manual of Aerodrome Standards is intended to inhibit the planning or provision of aerodrome facilities for larger aeroplanes that may be accommodated by the aerodrome at a later date. Appropriate additional safeguards may be taken into account to cater for more demanding aircraft that may be introduced at a later date. These relate mainly to minimum clearance requirements and guidance is given in ICAO Aerodrome Design Manual Parts 1 and 2. However, where movement area facilities are built for future larger aeroplanes, the aerodrome operator must liaise with the Aerodrome and ANS Regulation Division to determine the interim notification of aeroplane reference code and maintenance arrangements.

Provisions for the accommodation of more demanding aircraft at existing aerodromes can be found in the PANS-Aerodromes (Doc 9981). Guidance on some possible effects of future aircraft on these specifications is given in the Aerodrome Design Manual (Doc 9157), Part 2.

2.2.3.2 It is the prerogative of aerodrome operators to select the appropriate aeroplane and aeroplane characteristics for master planning of their aeroplanes. This Manual of Aerodrome Standards has included ICAO Code F specifications for aerodrome facilities intended for aeroplanes larger than B747 wide body jets.

2.2.3.3 When the aerodrome accommodates an aeroplane that exceeds the certified characteristics of the aerodrome, the compatibility between the operation of the aeroplane and aerodrome infrastructure and operations shall be assessed and appropriate measures be 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).

2.2.3.4 Information concerning alternative measures, operational procedures and operating restrictions implemented at an aerodrome arising from 2.2.3.3 shall be promulgated.

Note 1 – See Annex 15, Appendix 1, AD 2.20 on the provision of detailed description of local traffic regulations.

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

Chapter 3 – AERODROME CERTIFICATION PROCESS AND AERODROME MANUAL REQUIREMENTS

Section 3.1 – General

3.1.1 Introduction

3.1.1.1 This chapter describes the requirement for aerodromes to operate with an Aerodrome Certificate and the process of certification by the Aerodrome and ANS Regulation Division of the Civil Aviation Authority of Singapore.

3.1.1.2 The aerodrome certification process only addresses the aviation safety aspect of the aerodrome. It is the responsibility of the applicant to ensure that the use of the site as an aerodrome is in compliance with other State and local statutory requirements such as land-use or environment regulations. The Aerodrome Certificate does not absolve the applicant from observing such requirements.

3.1.2 Requirement to hold an Aerodrome Certificate

3.1.2.1 Paragraph 67(1) of the Air Navigation Order states that no person shall operate an aerodrome in Singapore for the take-off and landing of aircraft engaged in flights for the purpose of public transport or instruction in flying unless he is the holder of an Aerodrome Certificate granted under this Order.

3.1.3 Applying for an Aerodrome Certificate

3.1.3.1 Paragraph 67(2) of the ANO stipulates that an applicant for the grant or renewal of an Aerodrome Certificate shall submit:

(a) an application in the form set out in this Manual of Aerodrome Standards; and

(b) an Aerodrome Manual for the aerodrome for which the application is made.

3.1.3.2 The applicant must be the owner of the aerodrome site, or have obtained permission from the owner to use the site as an aerodrome.

3.1.3.2A Approvals from other State authorities as required by other local statutory requirements shall be obtained by the applicant and submitted together with the application.

3.1.3.3 The *Form For Application/Renewal Of An Aerodrome Certificate* can be found in Appendix C of this Manual, or can be obtained from the Aerodrome and ANS Regulation Division of the Civil Aviation Authority of Singapore at the following address:

Division Head
Aerodrome and ANS Regulation Division
Civil Aviation Authority of Singapore
PO Box 1 Singapore Changi Airport
Singapore 918141

3.1.3.4 Under paragraph 67(3) of the Air Navigation Order, the Aerodrome Manual to be submitted with the application must contain the information and instructions relating to the matters specified in the Eighteenth Schedule of the Order, and contain such other information and instructions as may be necessary to enable the aerodrome operating staff to perform their duties. The detailed requirements of the Aerodrome Manual are explained in section 3.2 of this chapter.

3.1.4 Aerodrome Certificate processing fee

3.1.4.1 An aerodrome certificate shall remain in force for a period of 5 years from the date of certification indicated on the aerodrome certificate, subject to the payment of an annual fee as specified in paragraph 21 of the Twelfth Schedule, or until the date of its suspension or cancellation under paragraph 67(10) of the Air Navigation Order.

3.1.5 Processing an Aerodrome Certificate application

3.1.5.1 Applications shall be submitted in sufficient time to allow for detailed consideration and inspection of the aerodrome before the intended or desired date of grant of the Aerodrome Certificate.

3.1.5.2 Engineering and survey reports of the physical characteristics of the movement area, pavement strength and surface, obstacle limitation surfaces, etc., as required by the Aerodrome and ANS Regulation Division, shall be provided as part of the submission.

3.1.5.3 As part of the certification process, the Aerodrome and ANS Regulation Division may carry out inspection or testing of any aspect of the aerodrome or require substantiation of any information provided by the applicant. However, it should be clearly understood that the Aerodrome and ANS Regulation Division's sample checking process does not absolve the applicant from the responsibility to provide accurate information.

3.1.5.4 Special assessment may be necessary if there are aerodrome facilities that are not in full compliance with the applicable standards contained in this Manual. This may involve more time and resources and may result in restrictions being imposed on aircraft operations.

3.1.5.5 On receipt of the application, the Aerodrome and ANS Regulation Division will carry out a detailed examination of the Aerodrome Manual submitted to check for completeness of coverage and compliance with the requirements stipulated under the Eighteenth Schedule of the Air Navigation Order and with the Manual of Aerodrome Standards, including the data to be published by the Aeronautical Information Services. Request for amendments and/or supplementary information to the Aerodrome Manual shall be prepared by the applicant and submitted to the Aerodrome and ANS Regulation Division. All aspects of the aerodrome operation, including the management structure, adequacy and competency of operation and maintenance staff, arrangements and provisions for their training, aerodrome site, facility, equipment, related services and operating procedures, etc. will be assessed in relation to the scale, scope and circumstances of the applicant's proposed operations. Relevant documents submitted by the aerodrome operator will be retained by the Aerodrome and ANS Regulation Division during the currency of the Aerodrome Certificate.

3.1.5.6 A flight operations assessment may be required by the Aerodrome and ANS Regulation Division to ensure that the operation of the aerodrome at the location specified in the application will not endanger the safety of aircraft operations.

3.1.5.7 The Aerodrome and ANS Regulation Division will also conduct a visit to the applicant's aerodrome for on-site verification of aerodrome data; inspection of aerodrome services, facilities and equipment; interview of aerodrome operating staff; examination of operating procedures and training methods; checking the availability and adequacy of related services needed to support aerodrome operations; assessment of the aerodrome's safety management system; review of aerodrome operator's safety documents and records; as well as survey for any presence of obstacles in obstacle limitation surfaces at and in the vicinity of the aerodrome.

3.1.5.8 For the purpose of paragraph 3.1.5.7 above, the applicant shall allow the DGCA or any other authorised person access to any part of the aerodrome or any aerodrome facility, equipment, records and operator personnel. The applicant shall also co-operate in facilitating the activities relating to the site audit.

3.1.5.9 Subject to any considerations that the Aerodrome and ANS Regulation Division may decide, any deficiencies found by the Aerodrome and ANS Regulation Division during the on-site audit mentioned above shall be addressed and rectified by the applicant within the time frame given by the Aerodrome and ANS Regulation Division. Where necessary, changes to the Aerodrome Manual shall be made accordingly and the revised Aerodrome Manual shall be submitted to the Division for acceptance before the issuance of an Aerodrome Certificate can be considered.

3.1.5.10 Once the Aerodrome Manual is accepted by the Aerodrome and ANS Regulation Division, the applicant shall make copies of the Aerodrome Manual and distribute it to its stakeholders and other relevant parties.

3.1.6 Granting of an Aerodrome Certificate

3.1.6.1 Under paragraph 67(4) of the Air Navigation Order, the DGCA may grant an Aerodrome Certificate to an applicant if he is satisfied that

(a) the applicant is competent to operate and maintain his aerodrome properly, having regard to his previous conduct and experience, equipment, organisation, staffing, maintenance and other arrangements;

(b) the Aerodrome Manual prepared for the applicant's aerodrome and submitted with his application contains accurate information and complies with the requirements specified in the Eighteenth Schedule of the Order;

(c) the applicant's aerodrome facilities, equipment and services comply with the standards specified in the Manual of Aerodrome Standards;

(d) the applicant's aerodrome operating procedures make satisfactory provision for the safety of aircraft; and

(e) an acceptable safety management system is in place at the applicant's aerodrome.

3.1.6.2 The holder of an Aerodrome Certificate or an applicant for an Aerodrome Certificate shall be required to establish and implement an operating safety management system that complies with the standards specified in this Manual of Aerodrome Standards for each aerodrome.

3.1.6.3 Paragraph 67(6) of the same Order also makes provisions for the DGCA to grant an Aerodrome Certificate subject to such conditions as he thinks fit. In such cases, these conditions shall be set out in the General Conditions and/ or Special Conditions or otherwise notified to the applicant in writing, and the reasons for the conditions shall be provided to the applicant in writing.

3.1.6.4 The General Conditions shall be applicable to all aerodrome operators. Special Conditions shall only be applicable to particular aerodrome operators. As one of the conditions of granting the Aerodrome Certificate, aerodrome operators shall ensure that the General and Special Conditions, if any, are brought to the attention of their managerial and operating staff, and strictly complied with. A copy of the Aerodrome Certificate, General Conditions and Special Conditions, if any, shall be included in the aerodrome operator's Aerodrome Manual that is distributed its stakeholders and other relevant parties.

3.1.6.5 Aerodrome Certificates are granted on the condition that the aerodrome operator will, at all times, be in compliance with the applicable regulations and mandatory requirements.

3.1.6.6 An Aerodrome Certificate shall remain in force for a period of 5 years after the date of the grant or renewal of the certificate, unless it is earlier suspended or cancelled.

Section 3.2 – Aerodrome Manual

3.2.1 Requirement to submit an Aerodrome Manual

3.2.1.1 Paragraph 67(3) of the Air Navigation Order requires an applicant for an Aerodrome Certificate to submit an Aerodrome Manual containing

(*a*) information and instructions relating to the matters specified in the Eighteenth Schedule of the Order; and

(*b*) all such other information and instructions as may be necessary to enable the aerodrome operating staff to perform their duties.

3.2.2 Purpose and scope of Aerodrome Manual

3.2.2.1 The Aerodrome Manual is a fundamental requirement of the aerodrome certification process. It contains all the pertinent information concerning the aerodrome site, facilities, equipment, services, operating procedures, emergency planning, organization and management, including the safety management system.

3.2.2.2 The information presented in the Aerodrome Manual shall demonstrate that the aerodrome conforms to the aerodrome standards stipulated in this Manual of Aerodrome Standards and that there are no apparent shortcomings which would adversely affect the safety of aircraft movements. Non-conformance with any standard stipulated in this Manual of Aerodrome Standards shall be highlighted in the Aerodrome Manual.

3.2.2.3 The Aerodrome Manual serves as a reference document agreed between the aerodrome operator and the Aerodrome and ANS Regulation Division with respect to the standards, conditions and the level of service to be maintained at the aerodrome.

3.2.2.4 The Aerodrome Manual provides a checklist of aerodrome standards, recommended practices and operating procedures to be maintained and the level of services to be provided at the aerodrome. Information provided in the Aerodrome Manual will enable the Aerodrome and ANS Regulation Division of the Civil Aviation Authority of Singapore to assess the suitability of the aerodrome for the aircraft operations proposed and to judge an applicant's fitness to hold an Aerodrome Certificate. It is also the basic reference guide for conducting site inspections for granting an Aerodrome Certificate, and for subsequent safety surveillance inspections to be carried out by the Aerodrome and ANS Regulation Division at regular intervals.

3.2.2.5 The purpose of the Aerodrome Manual is also to provide all such information and instructions as may be necessary to enable the aerodrome operating staff to effectively perform their duties in ensuring that the aerodrome is safe for use by aircraft. To achieve this aim, the Aerodrome Manual shall contain instructions for operating procedures from the aerodrome operator to his operational staff, including contractors and agents working for the aerodrome operator, as well as details of organisation structure such as key operational personnel and their areas of responsibility.

3.2.3 Format of an Aerodrome Manual

3.2.3.1 An Aerodrome Manual may contain a main Aerodrome Manual covering all areas that need to be addressed, as well as relevant supporting documents and manuals for aerodrome operations that are referred to in the main Aerodrome Manual. The main Aerodrome Manual may be supplemented by other documents and manuals, airport circulars, notices and instructions issued by the aerodrome operator to his staff and contractors or agents on airport operational matters from time to time. The contents of these supplementary materials should be incorporated into the main Aerodrome Manual once they become permanent in nature.

3.2.3.2 The Aerodrome Manual is a living manual subject to frequent amendment and as such it should be contained in a loose leaf binder to facilitate easy amendment. The page and paragraph numbering system should also be designed to allow for easy addition and deletion. An amendment record page should be included in each copy of the Aerodrome Manual.

3.2.3.3 As a working and reference document for aerodrome operational staff, the Aerodrome Manual must be user-friendly. The information and instructions contained therein must be clear, concise and unambiguous.

3.2.4 Maintenance and control of Aerodrome Manual

3.2.4.1 Paragraph 67A(1) of the Air Navigation Order requires an aerodrome operator to

(a) produce an Aerodrome Manual for his aerodrome and provide the DGCA with a copy thereof which is kept complete and current;

(b) keep at least one complete and current copy of the Aerodrome Manual at the aerodrome and, if the aerodrome is not his principal place of business, keep another such copy of the Aerodrome Manual at his principal place of business;

(c) make the copy of the Aerodrome Manual referred to in sub-paragraph (b) available for inspection by the DGCA or any authorised person;

(d) maintain the Aerodrome Manual and make such amendments as may be necessary to maintain the accuracy of the information in the Aerodrome Manual and to keep its contents up to date;

(e) notify the DGCA, as soon as practicable, of any amendment made to the Aerodrome Manual.

(f) make such amendment or addition to the Aerodrome Manual as the DGCA may require for

(i) maintaining the accuracy of the Aerodrome Manual;

(ii) ensuring the safe and efficient operation of aircraft at the aerodrome; or

(iii) ensuring the safety of air navigation.

3.2.5 Distribution and amendment of Aerodrome Manual

3.2.5.1 The Aerodrome Manual is an important document and must be issued under the authority of the aerodrome operator and signed by a senior executive of the organization. Any amendments to the Aerodrome Manual shall be approved by person(s) authorised by the aerodrome operator to do so.

3.2.5.2 Copies of relevant sections of the Aerodrome Manual shall be made available to each supervisory member of the aerodrome operating staff including those employed by the operator's contractors or agents, where relevant, so that the aerodrome operating staff

(a) is aware of the contents of every part of the aerodrome manual relevant to his duties; and

(b) undertakes his duties in conformity with the relevant provisions of the Aerodrome Manual.

3.2.5.3 For this purpose, aerodrome operating staff shall mean all persons, whether employed by the aerodrome operator, who in the course of their duties are

(a) concerned with ensuring that the aerodrome is safe for use by aircraft; or

(b) required to have access to the aerodrome manoeuvring area or apron.

3.2.5.4 In addition sufficient copies of the Aerodrome Manual shall be placed at the aerodrome operator's library and at the workplace of other relevant operating staff concerned.

3.2.5.5 Apart from submission of the Aerodrome Manual to the DGCA and internal distribution of copies to relevant operating staff, copies of the Aerodrome Manual shall also be made available to other external parties with a part to play in the aerodrome's safety process. In particular, the airport emergency section of the Aerodrome Manual shall also be extended to all external parties (e.g. Civil Defence, State Police, Fire Department or health agencies) involved in the aerodrome's emergency alert and response.

3.2.5.6 The Aerodrome Manual shall be a controlled document. An aerodrome operator shall appoint a document controller to be responsible for updating and distributing its Aerodrome Manual. Each copy of the Aerodrome Manual shall be numbered and a list of their holders maintained by the document controller. Amendments shall be recorded on the amendment page in front of each copy.

3.2.5.7 Each holder of the Aerodrome Manual shall be responsible for ensuring that his copy is kept up to date. For copies intended for common use, a person shall be designated to look after their amendment.

3.2.5.8 Manuscript amendments to the Aerodrome Manual are not acceptable. Changes or additions shall be subject of an additional or replacement page suitably dated. If the amendment affects the action of external parties, an acknowledgement slip shall be requested from each external party concerned when amendments are circulated so as to document that each party concerned has received and taken notice of the amendment.

3.2.5.9 The aerodrome operator shall make prompt amendments to the Aerodrome Manual when there are updates to any part of the contents of the Aerodrome Manual or, when required by the Aerodrome and ANS Regulation Division of the Civil Aviation Authority of Singapore upon review of the Aerodrome Manual or any proposed updates or amendments. Such amendments required by the Aerodrome and ANS Regulation Division shall be binding on the aerodrome operator.

3.2.5.10 The aerodrome operator shall send the amended pages, together with an amendment list to Aerodrome and ANS Regulation Division for acceptance.

3.2.6 Information to be included in the Aerodrome Manual

3.2.6.1 The Eighteenth Schedule of the Air Navigation Order outlines the format, organization and particulars to be included in an Aerodrome Manual.

3.2.6.2 The details of the particulars to be covered in the Aerodrome Manual are explained in Appendix E found in this Manual of Aerodrome Standards.

3.2.6.3 Applicants for Aerodrome Certificate and aerodrome operators shall ensure that the Aerodrome Manuals prepared for their aerodromes address the required contents comprehensively and clearly. The Aerodrome and ANS Regulation Division reserves the right to reject the Aerodrome Manual and/or to request for supplementary information to be provided with the Aerodrome Manual if the manual, or any part of it, is found to be unacceptable, incomplete or inadequate.

Section 3.3 – AIP and NOTAM action

3.3.1 Initiating AIP and NOTAM to promulgate a certified aerodrome

3.3.1.1 Paragraph 67E(3)(b) of the ANO requires an aerodrome operator to ensure that, in respect of his aerodrome and amongst other services related to safety to be provided, Aeronautical Information Services are available. Upon granting of an Aerodrome Certificate, the aerodrome operator shall prepare and submit, through the Aerodrome and ANS Regulation Division, to the Aeronautical Information Services a Notice to Airmen (NOTAM) and/or Aeronautical Information Publication (AIP) Amendment setting out all the aerodrome information which will be permanently included in AIP Singapore, including the effective dates for which the aerodrome is certified and for which it will commence operations.

3.3.2 Routine notification and reporting

3.3.2.1 Under paragraph 67H(1) of the Air Navigation Order, an aerodrome operator shall review every AIP, AIP Supplement, AIP Amendment, NOTAM, Pre-flight Information Bulletin and Aeronautical Information Circular issued by the Aeronautical Information Services provider on receipt thereof and shall, immediately after such review, notify the Aeronautical Information Services provider of any inaccurate information contained therein that pertains to his aerodrome.

3.3.2.2 Under paragraph 67H(2) of the same Order, an aerodrome operator shall, in writing, notify the Aeronautical Information Services of any change to any aerodrome facility or equipment or the level of service at the aerodrome

(a) which has been planned in advance; and

(b) which is likely to affect the accuracy of the information contained in any publication by the Aeronautical Information Services

before effecting the change.

3.3.2.3 For the purpose of paragraph 3.3.2.2 above, the aerodrome operator shall consult and coordinate work closely with the Aeronautical Information Services to determine the required lead time with which to notify the Aeronautical Information Services of different types of planned changes.

3.3.2.4 Paragraph 67H(3) of the same Order requires an aerodrome operator, subject to paragraph 67H(4) of the Order (which is reproduced in paragraph 3.3.2.5 below), to give the Aeronautical Information Services provider and the air traffic control unit immediate notice detailing any of the following circumstances of which the aerodrome operator has knowledge:

(a) in respect of obstacles, obstructions and hazards —

(i) any projections by an object through an obstacle limitation surface relating to the aerodrome; and

(ii) the existence of any obstruction or hazardous condition affecting aviation safety at or near the aerodrome;

(b) any change in the level of service at the aerodrome as set out in any publication by the Aeronautical Information Services provider referred to in paragraph 3.3.2.1 above or any variation (that has been accepted by the DGCA) from this Manual of Aerodrome Standards;

(c) closure of any part of the movement area of the aerodrome;

(d) any significant changes in any aerodrome facility or the physical layout of the aerodrome; and

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

3.3.2.5 When it is not feasible for an aerodrome operator to arrange for the air traffic control unit to receive notice of any circumstance referred to in paragraph 3.3.2.4 above, the aerodrome operator shall give immediate notice directly to the pilots who may be affected by that circumstance.

Section 3.4 – Changes to Aerodrome Certificate

3.4.1 Application for changes to Aerodrome Certificate

3.4.1.1 If an aerodrome operator wishes to apply for an amendment to its Aerodrome Certificate, e.g. a change of the Special Conditions under which the Aerodrome Certificate is initially subjected to, he shall write to the Division Head of Aerodrome and ANS Regulation giving full details of the proposed variation and justification. The minimum notice required is 30 days.

Section 3.5 – Routine liaison and inspections at a certified aerodrome

3.5.1 Provision of access for inspection and site safety audits

3.5.1.1 Paragraph 67G(1) of the Air Navigation Order makes provisions for the DGCA or any authorised person, before an Aerodrome Certificate is granted and subsequently at any other time, for the purpose of ensuring safety at an aerodrome, to

(a) inspect and carry out tests on the aerodrome facilities, equipment or services;

(b) inspect the aerodrome operator’s documents and records; or

(c) verify the aerodrome’s safety management system.

3.5.1.2 For the purposes mentioned in paragraph 3.5.1.1 above, an aerodrome operator shall, at the request of the DGCA or any authorised person, allow access to any part of the aerodrome or any aerodrome facility, including equipment, records and operator personnel.

3.5.1.3 An aerodrome operator shall co-operate in facilitating the activities referred to in paragraph 3.5.1.1 above.

3.5.1.4 Inspections and site safety audits may be conducted as required to assess the continuing suitability of an aerodrome operator's organisation, facilities and equipment, the aerodrome operator's overall standard of operation and maintenance as well as level of compliance with statutory and Aerodrome Manual requirements.

Section 3.6 – Refusal/Cancellation/Suspension/ Transfer of Aerodrome Certificate

3.6.1 Refusal of Aerodrome Certificate

3.6.1.1 If, for whatsoever reasons, the DGCA refuses to grant an Aerodrome Certificate to an applicant, the DGCA shall, within 14 days of the refusal, give the applicant a written notice of the refusal, stating the reasons for the refusal.

3.6.2 Cancellation of Aerodrome Certificate

3.6.2.1 If an aerodrome operator wishes to cancel its Aerodrome Certificate, e.g. due to closing down of his aerodrome, or as part of a process to transfer the aerodrome operator role to a new operator, he shall write to the Aerodrome and ANS Regulation Division giving full details of the proposed cancellation date and date of cessation of aerodrome operations. The minimum notice required for canceling an Aerodrome Certificate is 30 days.

3.6.2.2 The Aerodrome and ANS Regulation Division may make changes to the proposed cancellation date of the Aerodrome Certificate and/or date of cessation of aerodrome operations after taking into account public interests and other aviation considerations and the aerodrome operator shall abide by such changes.

3.6.3 Suspension/Revocation of Aerodrome Certificate

3.6.3.1 A suspension or cancellation of an Aerodrome Certificate shall take effect from the date specified in the notice of suspension or cancellation.

3.6.3.2 An Aerodrome Certificate shall remain in force for a period of 5 years after the date of the grant or renewal of the certificate, unless it is earlier suspended or cancelled.

3.6.3.3 Paragraph 67(8) of the Air Navigation Order makes provisions for the DGCA to suspend or cancel an Aerodrome Certificate if there are reasonable grounds for believing that

(a) a condition to which the Aerodrome Certificate is subject has been breached; or

(b) the aerodrome facilities, equipment, operations or maintenance are not of the standard necessary in the interests of the safety of air navigation.

3.6.3.4 Before suspending or cancelling an Aerodrome Certificate, the DGCA shall

(a) give the aerodrome operator holding the Aerodrome Certificate a notice which

(i) sets out the facts and circumstances that, in the opinion of the DGCA, justify the suspension or cancellation of that certificate; and

(ii) invites the aerodrome operator to show cause, in writing, within a reasonable period stated in the notice, as to why that certificate should not be suspended or cancelled; and

(b) take into account any reason that the aerodrome operator may give under sub-paragraph (a)(ii) of this clause.

3.6.3.5 An Aerodrome Certificate that has been suspended or cancelled must be returned immediately to the Aerodrome and ANS Regulation Division.

3.6.4 Transfer of Aerodrome Certificate

3.6.4.1 An Aerodrome Certificate shall not be transferable to any person without the prior consent in writing of the DGCA, and any purported transfer of an Aerodrome Certificate shall be void and of no effect.

Chapter 4 – AERODROME OPERATOR ORGANISATION AND DOCUMENT MANAGEMENT

Section 4.1 – Aerodrome operator organisation

4.1.1 Aerodrome organisation management and operational structure

4.1.1.1 An effective management structure is essential for the operation of aerodromes. The Accountable Executive of the aerodrome operator shall be satisfied that suitably qualified persons are appointed for at least the following positions, and their duties and responsibilities of must be clearly specified with clear chains of command:

(a) a Safety Manager, responsible for ensuring the effective implementation and maintenance of the aerodrome operator's SMS and also for liaising with the Authority for compliance matters; and

(b) an Airside Operations Manager, responsible for ensuring the safety of the aerodrome's operations

4.1.1.2 The number and nature of the appointments at an aerodrome will vary with the size and complexity of the aerodrome and organization. An excess of managers can lead to fragmentation of responsibility and control, and to as much difficulty and inefficiency as too few. In general, the appointment of deputies for managerial posts should be kept to a minimum and particular care should be taken in defining their functions and responsibilities. The aerodrome operator shall ensure that the management organization is adequate and properly matched to the operating environment and commitments.

4.1.1.3 It is important that the operational management has proper status in the organisation and that it is in suitably experienced and competent hands. The positions held by key operations and maintenance personnel shall be listed in the Aerodrome Manual. It is a condition under the issuance of the Aerodrome Certificate that the Division Head of Aerodrome and ANS Regulation shall be given notice of any intended change in the appointments or functions of these key personnel.

4.1.1.4 Where maintenance activities or aircraft ground handling services are performed by external contractors or agencies and not directly by the aerodrome operator, a senior post shall be established to coordinate arrangements and to provide continuous liaison with the maintenance contractors or handling agencies. It is responsibility of the aerodrome operator to ensure that his contractors and/or agencies are competent to perform their duties having regard to their experience, equipment, organization, staffing, training and other arrangements.

Note - Contractors and agencies refer to those who perform aerodrome maintenance services and inspections, construction works, and ground handling services at the aerodrome.

4.1.1.5 Attention is drawn to paragraph 67E(2) of the ANO, which requires the aerodrome operator to ensure proper and efficient maintenance of the aerodrome facilities and equipment. In addition, as part of the aerodrome organisation, paragraph 67E(3) of the Order stipulates that an aerodrome operator shall, in respect of his aerodrome, ensure that

(a) appropriate air traffic services are available to ensure the safety of aircraft in the airspace associated with the aerodrome; and

(b) aeronautical information services, meteorological services and provision of security and other services related to safety are available.

4.1.2 Aerodrome operational staff and competency

4.1.2.1 Under paragraph 67D(1) of the Air Navigation Order, an aerodrome operator shall employ an adequate number of qualified and skilled personnel to perform all critical activities for the operation and maintenance of his aerodrome.

4.1.2.2 Paragraph 67D(2) of the Order stipulates that if the DGCA requires the competency of personnel referred to in sub-paragraph 67D(1) to be certified, the aerodrome operator shall, for the purposes of sub-paragraph 67D(1), employ only persons possessing such certification.

4.1.2.3 In addition, paragraph 67D(3) of the Order stipulates that an aerodrome operator shall implement programmes to upgrade the competency of the personnel referred to in sub-paragraph 67D(1).

4.1.2.4 Aerodrome operational staff here refers to staff engaged in the day to day operation of the aerodrome whose duties have a bearing on aircraft safety. They include apron control staff, rescue and fire fighting personnel, bird control staff, airfield lighting and aircraft pavement maintenance personnel, aircraft movement area inspection staff, etc., who in the course of their duties are concerned with ensuring that the aerodrome is safe for use by aircraft, or are required to have access to the aerodrome manoeuvring areas or apron.

4.1.2.5 Pursuant to the requirements of the ANO mentioned in paragraphs 4.1.2.1 to 4.1.2.3 above, an aerodrome operator shall satisfy the DGCA that he has an adequate number of operational staff for the proposed aerodrome operations. This requirement will not be assessed against a set formula, as there will clearly be a wide variation according to particular circumstances.

4.1.2.6 Arrangements for the supervision of operational staff must be sensibly related to the size of the organisation and the nature of the operation, and must be in the hands of persons having the experience and qualities necessary to ensure that the maintenance are of high professional standards. The duties and responsibilities of these supervisory personnel and their supporting staff shall be well-defined.

4.1.2.7 All operational personnel shall be properly trained to perform their duties in an efficient and effective manner. Apart from initial training, refresher training shall also be provided at regular intervals to ensure that a high standard is maintained. Training provisions including any competency test required of staff shall be detailed in the Aerodrome Manual. A record of all such training and tests shall be kept up to date.

4.1.3 Aerodrome operations library

4.1.3.1 An aerodrome operator shall maintain an adequate library of maps, charts, guidance material, operations manuals and other documents needed for reference, planning and the effective operation of an airport. The library shall be kept in an orderly fashion and responsibility for its maintenance clearly defined.

4.1.3.2 Arrangements shall be made for the amendment of manuals, documents and guidance material, and for bringing the amendments to the notice of staff concerned. A record of the amendments shall be kept and a system derived to ensure the effective promulgation of information to staff concerned.

4.1.3.3 The minimum list of the documents and publications that must be kept and made available for access by staff is shown in Appendix F of this Manual of Aerodrome Standards.

4.1.4 Instructions to aerodrome operational staff

4.1.4.1 The Aerodrome Manual shall include a systematic procedure for bringing urgent or temporary information to the notice of aerodrome operations and maintenance staff.

Section 4.2 – Document and record management

4.2.1 Forms, documents and records

4.2.1.1 An aerodrome operator shall provide various official forms and records for use by his operational staff. Unless the use of such forms is self-explanatory, instructions for their completion shall be included in the Aerodrome Manual. Copies and records of the safety related forms such as forms for the inspection of runway, taxiway, apron, equipment, marking, lighting etc., the recording of wildlife strike occurrence and reporting of accidents and incidents shall be made available to all relevant staff who need to use them.

4.2.1.2 An aerodrome operator shall maintain a quality control system to ensure a systematic means of safekeeping safety records that would enable effective preservation of these records and allow ease of retrieval. A minimum list of the safety records to be kept together with the minimum period required for record preservation is shown in Appendix G of this Manual of Aerodrome Standards.

Chapter 5 – AERODROME WORK SAFETY, SAFETY MANAGEMENT SYSTEM AND ACCIDENT/INCIDENT REPORTING AND INVESTIGATION PROCEDURES

Section 5.1 – Aerodrome work safety

5.1.1 Introduction

5.1.1.1 From time to time, the aerodrome operator may intend to carry out works that affect the physical characteristics of the aerodrome and/or affect aerodrome operations. These works include development of new infrastructure, modifications or maintenance of existing infrastructure, at the airside. The aerodrome operator shall ensure that such developments and changes to the airside infrastructure comply with the requirements in the Manual of Aerodrome Standards. As hazards to aerodrome operations may be introduced in the process of these works, it is essential that the work process is well controlled.

5.1.2 Submission of documents for development and modification works

5.1.2.1 The aerodrome operator shall, before carrying out any works that affect the physical characteristics of a runway, taxiway or aircraft parking stand, notify the DGCA and submit the following documents to the DGCA at least 3 months before the commencement of works:

(a) a completed Notification Form;

(b) a compliance matrix demonstrating compliance of the design of the proposed infrastructure with relevant clauses in the Manual of Aerodrome Standards; and

(c) drawings, in sufficient detail, to enable the ascertainment of the compliance of the physical characteristics of the proposed infrastructure with the Manual of Aerodrome Standards.

5.1.2.2 The aerodrome operator shall provide all required documents as described in 5.1.2.1 at the point of submission and continuously provide updates as and when they become available in ensuring continued compliance with the Manual of Aerodrome Standards.

5.1.2.3 In cases where the development or modification works as described in 5.1.2.1 could result in any non-compliance with the Manual of Aerodrome Standards, the aerodrome operator shall submit the required documents as described in 5.1.2.1 not later than 6 months before the commencement of works. The aerodrome operator shall not commence works in the affected areas where any non-compliance is not resolved.

5.1.3 Aerodrome manual and submission of risk assessment

5.1.3.1 An aerodrome operator shall plan and implement works to be carried out at an aerodrome so as not to create any hazard to aircraft operations or confusion to pilots. The Aerodrome Manual submitted by an aerodrome operator shall include details of the procedures for planning and safe carrying out of such work activities at the aerodrome.

5.1.3.2 An aerodrome operator shall, in his Aerodrome Manual, address how aerodrome works are to be carried out so that:

(a) where the works are of a nature that they will disrupt operations, these works shall be carried out with proper planning in advance; and

(b) where the works are of a minor/maintenance nature, these works may be carried out as time-limited works where normal aircraft operations are not disrupted and the movement area can be restored to normal safety standards and any obstacle created by those works removed in not more than 10 minutes. Depending on the nature and extent of each activity, time-limited works may include minor maintenance of markings and lights, grass mowing, sweeping of aircraft pavements, surveys and inspections, etc.

Note - At a controlled aerodrome, the air traffic control unit may, at the request of the aerodrome operator, vary the time limits set put in paragraph 5.1.1.2 (b) above for restoring normal safety standards or resuming aerodrome works. A variation under this paragraph is subject to such conditions as the air traffic control unit may impose.

5.1.3.3 An aerodrome operator shall notify the Aerodrome and ANS Regulation Division of any significant aerodrome activities as early as practicable and submit associated risk assessments to the Aerodrome and ANS Regulation Division at least two weeks prior to the commencement of the works.

5.1.3.4 An aerodrome operator shall notify the Aerodrome and ANS Regulation Division of any finalised plan for major aerodrome activities, provide updates at significant junctures of the project and submit associated risk assessments to the Aerodrome and ANS Regulation Division as early as practicable, but at least two weeks prior to the commencement of each major phase of the project.

5.1.4 Aerodrome work plans

5.1.4.1 Unless an aerodrome is closed during works in progress, or the work is of an emergency nature, an aerodrome operator shall not carry out aerodrome works, other than time-limited works, without proper planning in advance.

5.1.4.2 A plan shall be established, setting out the arrangements for carrying out those aerodrome works in coordination with all other operational, maintenance and development activities at the aerodrome.

5.1.4.3 **Recommendation** – When preparing a work plan, an aerodrome operator should consult:

(a) commercial air transport operators using the aerodrome;

(b) the aerodrome's air traffic control unit; and

(c) if the work plan may affect its operations, the Rescue and Fire Fighting Service unit at the aerodrome

so that the scope and impact of work is understood by related aerodrome users and service providers and to ensure the safety of aircraft operations at the aerodrome.

5.1.4.4 The aerodrome operator shall ensure that clear and ample prior notification for works at the maneuvering area is provided to the Aeronautical Information Services, the aerodrome air traffic control unit, aircraft operators and other users or service providers of the aerodrome. Such notification shall include timely and accurate promulgation of AIP Supplements or NOTAMs, with clear details of the extent and period of works.

5.1.4.5 An aerodrome operator shall be required to provide an explanation of his work plan, and any alterations or updates thereof, to the Aerodrome and ANS Regulation Division upon request.

5.1.4.6 Aerodrome works, for which a work plan is required, shall be carried out in accordance with the arrangements set out in the work plan and any subsequent alterations or updates.

5.1.4.7 **Recommendation** – The work plan should address details of any special requirements or restrictions arising during or on completion of the works.

5.1.4.8 **Recommendation** – The work plan should outline details, if any, of special arrangements to be made during works if emergencies or adverse weather conditions occur.

5.1.4.9 A work plan may not be required if the aerodrome operator closes the aerodrome to aircraft operations while aerodrome works are being carried out. The Aerodrome and ANS Regulation Division, commercial air transport operators and all organizations and persons likely to be affected by the closure shall be given reasonable notice of intention to close the aerodrome.

5.1.4.10 An aerodrome operator shall not close the aerodrome to aircraft operations due to aerodrome works unless an AIP Supplement or a NOTAM giving notice of the closure has been issued not less than 14 days before the closure takes place.

5.1.4.11 **Recommendation** – A work plan is not required for emergency aerodrome works carried out to repair damage to part of the manoeuvring area, or to remove an obstacle, or if the works do not require any restrictions to aircraft operations. Where practicable, a NOTAM giving the nature and time and date of the commencement of the urgent repair works should be issued, as early as possible, before the commencement of the works.

5.1.5 Management and control of aerodrome works

5.1.5.1 An aerodrome operator shall ensure that aerodrome works are carried out in accordance with the requirements of this Manual.

5.1.5.2 An aerodrome operator shall appoint a person responsible for the safe and proper execution of each item of aerodrome works. This person shall be required to

(a) ensure the safety of aircraft operations is not affected by the aerodrome work plan;

(b) ensure that, where applicable, the aerodrome works are notified by the issue of an AIP Supplement or a NOTAM and that the text of each AIP Supplement or NOTAM pertaining to such notification conveys the information on operational restrictions accurately and clearly to aerodrome users and service providers;

(c) supply the air traffic control unit with whatever information necessary to ensure the safety of aircraft operations;

(d) discuss with the work organizations involved, on a regular basis, any matters necessary to ensure the safety of aircraft operations;

(e) ensure that unserviceable portions of the movement area, temporary obstructions and limits of the work areas are correctly marked and lit in accordance with the required standards and the work plan;

(f) ensure that vehicles, plant and equipment carrying out aerodrome works are properly marked and lit or are properly supervised;

(g) ensure that all requirements under the work plan pertaining to vehicles, plant and equipment and materials are complied with;

(h) ensure that access routes to work areas are in accordance with that designated in the work plan and are clearly identified and that access is restricted to these routes;

(i) ensure that excavation is carried out in accordance with the work plan and relevant requirements, and in particular, that sufficient precautions are taken so as to avoid damage or loss of calibration to any underground power or control cable, utilities or other services associated with a precision approach and landing system, any navigational aid or facility or equipment essential for the safety of aerodrome operations;

(j) report immediately to the aerodrome air traffic control unit and the aerodrome operator any incident, or damage to facilities, likely to affect air traffic control services or the safety of aircraft;

(k) provide adequate supervisors duty at the work areas while major works are in progress and the aerodrome is open to aircraft operations;

(l) ensure that the aerodrome air traffic control unit is kept informed of the radio callsigns of vehicles used by the work organizations that are operating in the aircraft movement areas;

(m) remove vehicles, plant and personnel from the movement area immediately, where necessary, to ensure the safety of aircraft operations;

(n) ensure that the movement area is safe for normal aircraft operations following the removal of vehicles, plant and equipment and personnel from the work areas;

(o) in the case of time-limited works, ensure that the work areas are restored to normal safety standards not less than 5 minutes before the time scheduled for opening the work areas to aircraft operations; and

(p) ensure that floodlighting or any other lighting required for carrying out aerodrome works is shielded so as not to present a hazard to aircraft operations.

5.1.5.3 The person responsible for the aerodrome works shall be satisfied that the work plan is adequately prepared and that sufficient safety measures are put in place on the work site at all times during the execution of the aerodrome works when the aerodrome is open to aircraft operations.

5.1.5.4 An aerodrome operator shall take all reasonable measures to ensure that aerodrome works are well-organized and that all work personnel carries out aerodrome works in a manner that will ensure the safety of aircraft operations.

5.1.5.5 Persons, vehicles, plant and equipment required for carrying out aerodrome works shall not be permitted to enter the movement area or remain on it except for the purpose of carrying out those works.

5.1.5.6 Procedures for entering the work areas shall be addressed in the work plan.

5.1.6 Markers, markings and lights

5.1.6.1 Aerodrome markers, markings, signs and lights required for, or affected by, aerodrome works shall be adjusted or installed in accordance with the appropriate aerodrome standards.

5.1.6.2 Parts of the movement area that are unserviceable as a result of the aerodrome works being carried out shall be marked and lit in accordance with the appropriate aerodrome standards.

5.1.6.3 All obstacles created as a result of aerodrome works being carried out shall be marked and lit in accordance with the appropriate aerodrome standards.

5.1.6.4 Vehicles and plant used in carrying out aerodrome works shall be marked and lit, where necessary, in accordance with the appropriate aerodrome standards.

5.1.7 Communications equipment

5.1.7.1 **Recommendation** – At a controlled aerodrome, a vehicle used by work parties carrying out aerodrome works on the movement area should be equipped with a radio for two-way communications with the aerodrome air traffic control unit.

5.1.7.2 **Recommendation** – For the purpose of communication with the air traffic control unit, each vehicle used for carrying out aerodrome works on the movement area should be given a callsign.

5.1.7.3 Any vehicle or plant that is not:

(a) marked or lit in accordance with section 5.1.4 above; or

(b) if applicable, equipped with a two-way radio;

shall only be used in carrying out aerodrome works if it is:

(i) used under the direct supervision of another vehicle that is equipped with a two-way radio set and which is responsible for escorting the vehicle or plant without radio when carrying out aerodrome works; or

(ii) used only within the limits of appropriately marked and lit work areas.

5.1.7.4 The drivers of vehicles equipped with a radio for two-way communications with the aerodrome air traffic control unit shall be properly trained and be responsible for checking that their radio sets are switched on and serviceable at all times when working on the movement area.

5.1.8 Works near aircraft movement areas

5.1.8.1 The aerodrome operator shall refer to chapters 7 and 8 of this Manual of Aerodrome Standards and ICAO Airport Services Manual (Doc 9137) Part 6 – Control of Obstacles to determine the extent of work allowed near aircraft movement areas.

5.1.8.2 **Recommendation** – Works on or near aircraft movement areas or runway strips should be carried out as quickly as practicable to minimise any potential risks arising out of changes associated with the works in progress.

5.1.8.3 Where works are to be undertaken in the vicinity of navigational or landing aids located within the runway strips, considerations shall be taken to ensure that neither the works nor vehicles or plant associated with the works may affect the performance of the aids.

5.1.9 Completion

5.1.9.1 The aerodrome operator shall not commence operations of any new or modified infrastructure, as described in paragraph 5.1.2.1, without the approval of the Authority.

5.1.9.2 On completion of these aerodrome works, but at least one month prior to operational use, the aerodrome operator shall submit evidence as required by the DGCA which include, but are not limited to, safety case, aeronautical studies, site survey reports, computer simulations, tests, demonstrations or inspection reports to the Authority to demonstrate compliance with the Manual of aerodrome standards.

5.1.9.3 On the completion of aerodrome works and restoration of normal safety standards to the movement area, the aerodrome operator shall cancel any AIP Supplement or NOTAM issued to advise of those works.

5.1.9.4 Attention is drawn to paragraphs 67 I(b) and 67 I(c) of the Air Navigation Order where an aerodrome operator shall be required to inspect his aerodrome, as circumstances require, to ensure aviation safety during and immediately after any period of construction or repair of an aerodrome facility or equipment that is critical to the safety of aircraft operations, and at any other time when there are conditions at the aerodrome that could affect aviation safety.

Section 5.2 – Safety management system

5.2.1 Introduction

5.2.1.1 A Safety Management System (SMS) shall be established by an aerodrome operator for operations and maintenance of its aerodrome.

5.2.1.2 Paragraph 67F of the Air Navigation Order stipulates that every aerodrome operator shall establish and implement an operating safety management system that complies with the standards and requirements specified in this Manual of Aerodrome Standards at each of his aerodromes to which the Order applies.

5.2.1.3 The information contained in this section is not intended to be a prescriptive formula but serves to provide basic explanation of the essential components of a SMS. An aerodrome operator shall start to develop its own SMS taking into account these regulatory guidelines and any other supplementary material that the Aerodrome and ANS Regulation Division may publish from time to time.

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. Annex 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).

5.2.1.4 Not in use.

5.2.1.5 The aerodrome safety performance indicators and targets shall be established by the aerodrome operator, approved by the Aerodrome and ANS Regulation Division. The aerodrome operator shall review the safety performance indicators and targets, at least annually and when necessary propose revision to the indicators and targets for approval by the Aerodrome and ANS Regulation Division.

Note – Guidance on establishing aerodrome safety performance indicators and targets is contained in the ICAO Safety Management Manual (SMM) (Doc 9859).

5.2.1.6 The certified aerodrome shall implement a safety management system acceptable to the Aerodrome and ANS Regulation Division that, as minimum:

(a) identifies safety hazards;

(b) ensures the implementation of remedial action necessary to maintain agreed safety performance;

(c) provides for continuous monitoring and regular assessment of the safety performance; and

(d) aims at a continuous improvement of the overall performance of the safety management system.

Note – Guidance on defining safety performance is contained in the ICAO Safety Management Manual (SMM) (Doc 9859).

5.2.1.7 A safety management system shall clearly defined lines of safety accountability throughout a certified aerodrome, including direct accountability for safety on the part of senior management.

Note – The framework for the implementation and maintenance of a safety management system is contained in ICAO Annex 19. Guidance on safety management system is contained in the ICAO Safety Management Manual (SMM) (Doc 9859), and in the Manual on Certification of Aerodromes (Doc 9774).

5.2.2 General description

5.2.2.1 A SMS is a systematic, explicit and comprehensive process for the management of safety risks, one that integrates operations and technical systems with financial and human resource management. For the purpose of this Manual, the SMS applies to all activities related to the requirements for aerodrome certification and for ensuring the continuous safe functioning of aerodrome operations.

5.2.2.2 The SMS shall be one that permeates throughout the aerodrome operator organisation, and be implemented through a continuing safety program based on a coherent policy that leads to well-designed work procedures. The SMS shall also extend to include interfaces between the aerodrome operator and its suppliers, sub-contractors, agents, business partners and other relevant external service providers.

5.2.2.3 The SMS shall focus principally on the hazards associated with the operation of the aerodrome and their effects upon those activities critical to safety. It shall provide for goal setting, planning and measuring performance, and shall place emphasis on organisational safety rather than conventional health and safety-at-work concerns. Active monitoring and auditing processes shall be applied to validate that the necessary controls identified through the hazard management process are effectively put in place so as to ensure continuing active commitment to safety and to achieve continuous improvement in safety performance.

5.2.2.4 An aerodrome operator's SMS defines how it intends to manage aerodrome safety as an integral part of its business management activities. The SMS shall be woven into the fabric of an aerodrome operator's organisation and become part of its culture – the way people do their jobs.

5.2.3 Key components

5.2.3.1 An aerodrome operator shall implement a SMS framework which commensurate with the size of the organisation and the complexity of the services provided. The SMS framework shall include, as a minimum, the following twelve elements:

(a) Safety policy and objectives

(i) Management commitment and responsibility

An aerodrome operator shall define its safety policy. The safety policy shall:

a) reflect organisational commitment regarding safety;

b) include a clear statement about the provision of the necessary resources for the implementation of the safety policy;

c) include safety reporting procedures;

d) clearly indicate which types of behaviours are unacceptable related to the aerodrome operator's activities and include the circumstances under which disciplinary action would not apply;

e) be signed by the accountable executive of the organisation;

f) be communicated, with visible endorsement, throughout the organisation; and

g) be periodically reviewed to ensure it remains relevant and appropriate to the aerodrome operator.

(ii) Safety accountabilities

An aerodrome operator shall:

a) identify the accountable executive who, irrespective of other functions, has ultimate responsibility and accountability, on behalf of the certified aerodrome, for the implementation and maintenance of the SMS, and also for the compliance of the certified aerodrome and its operations with the Manual of Aerodrome Standards;

b) clearly define lines of safety accountability throughout the organisation, including a direct accountability for safety on the part of senior management;

c) identify the accountabilities of all members of management, irrespective of other functions, as well as of employees, with respect to the safety performance of the SMS;

d) document and communicate safety responsibilities, accountabilities and authorities throughout the organisation; and

e) define the levels of management with authority to make decisions regarding safety risk tolerability.

(iii) Appointment of key safety personnel

An aerodrome operator shall appoint a safety manager who is responsible for the implementation and maintenance of an effective SMS.

(iv) Coordination of emergency response planning

An aerodrome operator shall ensure that an emergency response plan is properly coordinated with the emergency response plans of those organisations it must interface with during the provision of its services.

(v) SMS documentation

An aerodrome operator shall develop an SMS implementation plan, formally endorsed by senior management of the organisation that defines the organisation's approach to the management of safety in a manner that meets the organisation's safety objectives.

An aerodrome operator shall develop and maintain SMS documentation that describes its

a) safety policy and objectives;

b) SMS requirements;

c) SMS processes and procedures;

d) accountabilities, responsibilities and authorities for SMS processes and procedures; and

e) SMS outputs.

As part of the SMS documentation, an aerodrome operator shall develop and maintain a safety management system manual.

(b) Safety risk management

(i) Hazard identification

An aerodrome operator shall develop and maintain a process that ensures that hazards associated with aerodrome operations are identified.

Hazard identification shall be based on a combination of reactive, proactive and predictive methods of safety data collection.

(ii) Safety risk assessment and mitigation

An aerodrome operator shall develop and maintain a process that ensures analysis, assessment and control of the safety risks associated with identified hazards.

(c) Safety assurance

(i) Safety performance monitoring and measurement

An aerodrome operator shall develop and maintain the means to verify the safety performance of the organisation and to validate the effectiveness of safety risk controls.

An aerodrome operator's safety performance shall be verified in reference to the safety performance indicators and safety performance targets of the SMS.

(ii) The management of change

An aerodrome operator shall develop and maintain a process to identify changes which may affect the level of safety risk associated with its aerodrome operations and to identify and manage the safety risks that may arise from those changes.

(iii) Continuous improvement of the SMS

An aerodrome operator shall monitor and assess the effectiveness of its SMS processes to enable continuous improvement of the overall performance of the SMS

(d) Safety promotion

(i) Training and education

An aerodrome operator shall develop and maintain a safety training programme that ensures that personnel are trained and competent to perform their SMS duties.

The scope of the safety training programme shall be appropriate to each individual's involvement in the SMS.

(ii) Safety communication

An aerodrome operator shall develop and maintain a formal means for safety communication that:

a) ensures personnel are aware of the SMS to a degree commensurate with their positions;
b) conveys safety-critical information;
c) explains why particular safety actions are taken; and
d) explains why safety procedures are introduced or changed.

Section 5.3 – Aerodrome accident/incident reporting and investigation procedures

5.3.1 Aerodrome occurrence reporting

5.3.1.1 This section prescribes the requirements for reporting the occurrence or detection of defects, failures or malfunctions at an aerodrome, its components or equipment, which could jeopardize the safe operation of the aerodrome or cause it to become a danger to persons or property.

5.3.1.2 The objectives of the Aerodrome Occurrence Report as follows:

(a) To ensure that knowledge of these occurrences is disseminated so that other persons and organizations may learn from them.

(b) To enable an assessment to be made by those concerned (whether internal or external to the aerodrome operator) of the safety implications of each occurrence, both in itself and in relation to previous similar occurrences, so that they may take or initiate any necessary action.

5.3.2 Reportable occurrences and reporting procedures

5.3.2.1 An aerodrome operator shall, upon becoming aware of an accident, serious incident or incident involving an aircraft operating at his aerodrome, notify the Authority immediately through the most expeditious means available.

5.3.2.2 An aerodrome operator shall report to the Aerodrome and ANS Regulation Division of any aircraft accident, serious incident or serious injury occurring at his aerodrome within 12 hours of the occurrence.

5.3.2.3 An aerodrome operator shall report to the Aerodrome and ANS Regulation Division of any aircraft incident occurring at his aerodrome as soon as reasonably practicable but not more than 24 hours of the occurrence.

5.3.2.4 The definitions for aircraft accident, serious incident, incident and serious injury are as follows:

(a) Accident – See definition under section 1.2 of this Manual

(b) Serious incident – See definition under section 1.2 of this Manual

Examples are:

- A near collision requiring an avoidance manoeuvre to avoid a collision or an unsafe situation or where an avoidance action would have been appropriate.
- A controlled flight into terrain only marginally avoided.
- An aborted take-off on a closed or engaged runway.
- A take-off from a closed or engaged runway with marginal separation from an obstacle.
- A landing or attempted landing on a closed or engaged runway.
- A take-off or landing incident such as undershooting, overrunning or running off the side of runways.

- A major failure of any navigation aid when a runway is in use.

(c) Incident - See definition under section 1.2 of this Manual

(d) Serious injury – See definition under section 1.2 of this Manual

5.3.2.5 An aerodrome operator shall report to the Aerodrome and ANS Regulation Division of the following occurrences at the airside not more than 1 week from the date of the occurrence which include, but are not limited to, the following:

(a) FOD found;

(b) Wildlife (excluding insects) sighted ;

(c) Confirmed and suspected FOD incidents;

(d) Any aircraft taxiing errors made by aircraft during taxiing such as aircraft failing to enter the correct bay, aircraft undershooting or overshooting the correct stop bar by more than the tolerable distance of 0.5m during docking; aircraft roll back at parking stands ; or miscommunication between ATC and pilots in the movement area that are made known to the aerodrome operator;

(e) Towed aircraft not adhering to ATC instructions or pushback SOPs;

(f) Vehicles failing to give way to aircraft;

(g) Infringement of vehicles into unauthorized areas;

(h) Fires on, or adjacent to, the aircraft movement area;

(i) Spillage or leakage of Hydraulic/Fuel/Petroleum, Oil, hazardous material and Lubricant;Vehicle accidents;

(j) Malfunction/failure of the following ground systems at the airside:

(i) Aircraft Docking Guidance system;

(ii) Passenger Loading Bridges;

(iii) Apron floodlights;

(iv) Fuel hydrant system; and

(v) Airfield lighting system

(k) Aviation fuel contamination and incorrect fuel specifications

5.3.2.6 An aerodrome operator shall submit monthly safety data in a manner acceptable to the Authority for the following:

(a) Aircraft related occurrences;

(b) Foreign object debris (FOD) occurrences;

(c) Wildlife occurrences;

(d) Airfield lighting system availability;

(e) Runway friction values;

(f) AES response time;

(g) Passenger loading bridge malfunctions/failures;

(h) Advanced Docking Guidance System malfunctions/failures; and

(i) Vehicles failing to give way to aircraft

5.3.2.7 Information to be provided in the reporting and notification of an aircraft accident, serious incident, incident or serious injury shall at least include, as far as possible, the following:

(a) the date and local time of occurrence;

(b) the exact location of the occurrence with reference to some easily defined geographical point ;

(c) detailed particulars of the parties involved, including the owner, operator, manufacturer, nationality, registration marks, serial numbers, assigned identities of aircraft and equipment;

(d) a detailed description of the sequence of events leading up to the incident;

(e) the physical characteristics, environment or circumstances of the area in which the incident occurred and an indication of the access difficulties or special requirements to reach the site;

(f) in the case of an aircraft accident, the number of crew members, passengers or other persons respectively killed or seriously injured as a result of the accident; and

(g) a description of the follow-up action being taken after the incident has occurred.

5.3.3 Aerodrome occurrence records

5.3.3.1 An aerodrome operator shall establish and maintain Aerodrome Occurrence Reports for any accident, serious incident, incident, serious injury or any occurrence or event that has a bearing on the safety of aerodrome operations.

5.3.3.2 Aerodrome Occurrence Reports shall be used by an aerodrome operator to monitor and improve the level of operational safety, including reviews of safety standards required.

5.3.3.3 The aerodrome operator shall, when required by the Aerodrome and ANS Regulation Division produce and provide information contained in the Aerodrome Occurrence Report relating to any safety occurrence or event.

5.3.4 Aerodrome accident/incident investigations

5.3.4.1 In the event of an accident or serious incident, an aerodrome operator shall carry out its own investigations. In addition, the aerodrome operator shall, when required by the Aerodrome and ANS Regulation Division, carry out investigations for any other incidents.

5.3.4.2 Not in use.

5.3.4.3 The investigator, or team of investigators, shall be technically competent and shall either possess or have access to the background information, so that the facts and events are interpreted accurately. The investigations shall be a search to understand how the mishap happened, why it occurred, including organizational contributing factors, and to recommend action to prevent a recurrence, and shall not be intended to apportion blame.

5.3.4.4 The lesson learnt derived from an aerodrome incident/accident investigation shall be disseminated to staff to provide feedback for safety improvement.

5.3.4.5 The aerodrome operator shall submit the aerodrome accident/incident investigation report. to the Aerodrome and ANS Regulation Division one month of the occurrence of the aerodrome accident/incident. In the event that the full investigation report cannot be completed in one month, an interim report with immediate actions taken to address safety concerns shall be prepared and submitted, and a full report shall be submitted at such time as determined by the Aerodrome and ANS Regulation Division.

5.3.4.6 Attention is also drawn to paragraph 67 I(a) of the Air Navigation Order that an aerodrome operator shall inspect his aerodrome, as circumstances require, to ensure safety as soon as practicable after any aircraft accident or incident.

Chapter 6 – AERODROME DATA

Section 6.1 – General

6.1.1 Introduction

6.1.1.1 This chapter contains specifications relating to the provision of aerodrome data to the Aeronautical Information Service (AIS) for publication in accordance with Annex 15 to the Convention on International Civil Aviation.

6.1.1.2 The Aeronautical Information Services or AIS is an unit of the Civil Aviation Authority of Singapore responsible for collecting, collating, editing and publishing aeronautical information. Aeronautical information is published by the AIS as an Integrated Aeronautical Information Package consisting of the following elements:

(a) **Aeronautical Information Publication (AIP)** – A publication issued by and with the authority of the AIS and containing aeronautical information of a lasting character essential to air navigation.

(b) **AIP Amendment** – Permanent changes to the information contained in the AIP.

(c) **AIP Supplement** – Temporary changes to the information contained in the AIP which are published by means of special pages.

(d) **NOTAM** – A notice distributed by means of telecommunication containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations.

(e) **Pre-flight information bulletin (PIB)** – A presentation of current NOTAM information of operational significance, prepared prior to flight.

(f) **Aeronautical Information Circular (AIC)** – a notice containing information which relates to flight safety, air navigation, technical, administrative or legislative matters.

Section 6.2 – Information to be reported to the AIS

6.2.1 Aeronautical data

6.2.1.1 Determination and reporting of aerodrome related aeronautical data shall be in accordance with the accuracy and integrity requirements set forth in Tables A5-1 to A5-5 contained in ICAO Annex 14 Vol. I Appendix 5 while taking into account the established quality system procedures. Accuracy requirements for aeronautical data are based on upon a 95 per cent confidence level and in that respect, three types of positional data shall be identified: surveyed points (e.g. runway threshold), calculated points (mathematical calculations from known surveyed points of points in space, fixes) and declared points (e.g. flight information region boundary points).

Note – Specifications governing the quality system are given in ICAO Annex 15, Chapter 3.

6.2.1.2 Not in use.

6.2.1.3 Not in use.

6.2.1.4 Not in use.

6.2.1.5 An aerodrome operator shall ensure that integrity of aeronautical data is maintained throughout the data process from survey/origin to the next intended user. Based on the applicable integrity classification, the validation and verification procedures shall:

a) For routine data: avoid corruption throughout the processing of the data;

b) For essential data: assure corruption does not occur at any stage of the entire process and may include additional processes as needed to address potential risks in the overall system architecture to further assure data integrity at this level; and

c) For critical data: assure corruption does not occur at any stage of the entire process and include additional integrity assurance procedures to fully mitigate the effects of faults identified by thorough analysis of the overall system architecture as potential data integrity risks.

Note – Guidance material in respect to the processing of aeronautical data and aeronautical information is contained in RTCA Document DO-200A and European Organization for Civil Aviation Equipment (EUROCAE) Document ED-76A – Standards for Processing Aeronautical Data.

6.2.1.6 Protection of electronic aeronautical data while stored or in transit shall be totally monitored by the cyclic redundancy check (CRC). To achieve protection of the integrity level of critical and essential aeronautical data as classified in paragraph 6.2.1.5 above, a 32 or 24 bit CRC algorithm shall apply respectively.

6.2.1.7 **Recommendation** – To achieve protection of the integrity level of routine aeronautical data as classified in paragraph 6.2.1.5 above, a 16 bit CRC algorithm should apply.

Note – Guidance material on the aeronautical data quality requirements (accuracy, resolution, integrity, protection and traceability) is contained in the ICAO World Geodetic System – 1984 (WGS-84) Manual (Doc 9674). Supporting material in respect of provisions of ICAO Annex 14 Vol. I, Appendix 5 related to accuracy and integrity of aeronautical data, is contained in RTCA Document DO-201A and European Organization for Civil Aviation Equipment (EUROCAE) Document ED-77, entitled Industry Requirements for Aeronautical Information.

6.2.1.8 Geographical coordinates indicating latitude and longitude shall be determined and reported to the Aeronautical Information Services in terms of the World Geodetic System – 1984 (WGS-84) geodetic reference datum, identifying those geographical coordinates which have been transformed into WGS-84 coordinates by mathematical means and whose accuracy of original field work does not meet the requirements in ICAO Annex 14 Vol. I Appendix 5, Table A5-1.

6.2.1.9 The order of accuracy of the field work shall be such that the resulting operational navigational data for the phases of flight will be within the maximum deviations, with respect to an appropriate reference frame, as indicated in tables contained in ICAO Annex 14 Vol. I Appendix 5.

6.2.1.10 In addition to the elevation (referenced to mean sea level) of the specific surveyed ground positions at aerodromes, geoid undulation (referenced to the WGS-84 ellipsoid) for those positions as indicated in ICAO Annex 14 Vol. I Appendix 5 shall be determined and reported to the Aeronautical Information Services.

Note 1 – An appropriate reference frame is that which enables WGS-84 to be realized on a given aerodrome and with respect to which all coordinate data are related.

Note 2 – Specifications governing the publication of WGS-84 coordinates are given in ICAO Annex 4, Chapter 2 and ICAO Annex 15, Chapter 3.

6.2.2 Aerodrome reference point

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

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

6.2.2.3 The position of the aerodrome reference point shall be measured and reported to the Aeronautical Information Services in degrees, minutes and seconds.

6.2.3 Aerodrome and runway elevations

6.2.3.1 The aerodrome elevation and geoid undulation at the aerodrome elevation position shall be measured to the accuracy of one-half metre and reported to the Aeronautical Information Services.

6.2.3.2 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 and reported to the Aeronautical Information Services.

6.2.3.3 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 and reported to the Aeronautical Information Services.

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

6.2.4 Aerodrome reference temperature

6.2.4.1 An aerodrome reference temperature shall be determined for an aerodrome in degrees Celsius.

6.2.4.2 **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.

6.2.5 Aerodrome dimensions and related information

6.2.5.1 The following data shall be measured or described, as appropriate, for each facility provided on an aerodrome:

a) runway – true bearing to one-hundredth of a degree, designation number, length, width, displaced threshold location to the nearest metre, 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 area, stopway – length, width to the nearest metre, surface type;

c) arresting system – location (which runway end) and description;

d) taxiway – designation, width, surface type;

e) apron – surface type, aircraft stands;

f) the boundaries of the air traffic control service;

g) clearway – length to the nearest metre, ground profile;

h) 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 and stopbars, and location and type of visual docking guidance systems;

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

j) location and designation of standard taxi-routes; and

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

6.2.5.2 The geographical coordinates of each threshold shall be measured and reported to the AIS in degrees, minutes, seconds and hundredths of seconds.

6.2.5.3 The geographical coordinates of appropriate taxiway centre line points shall be measured and reported to the AIS in degrees, minutes, seconds and hundredths of seconds.

6.2.5.4 The geographical coordinates of each aircraft stand shall be measured and reported to the AIS in degrees, minutes, seconds and hundredths of seconds.

6.2.5.5 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 AIS in degrees, minutes, seconds and tenths of seconds. In addition, the top elevation, type, marking and lighting (if any) of obstacles shall be reported to the aeronautical information services authority.

Note 1 – See Annex 15, Appendix 8, for graphical illustrations of obstacle data collection surfaces and criteria used to identify obstacles in Areas 2 and 3.

Note 2 – ICAO Annex 14 Vol. I Appendix 5 provides requirements for obstacle data determination in Areas 2 and 3.

Note 3 – Implementation of Annex 15, provisions 10.1.4 and 10.1.6, concerning the availability, as of 12 November 2015, of obstacle data according to Area 2 and Area 3 specifications would be facilitated by appropriate advanced planning for the collection and processing of such data.

6.2.6 Strength of pavements

6.2.6.1 The bearing strength of a pavement shall be determined.

6.2.6.2 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 number – pavement classification number (ACN-PCN) method by reporting all of the following information:

a) the pavement classification number (PCN);

b) pavement type of ACN-PCN determination;

c) subgrade strength category;

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

e) evaluation method.

Note – If necessary, PCNs may be published to an accuracy of one-tenth of a whole number.

6.2.6.3 The pavement classification number (PCN) reported shall indicate that an aircraft with an aircraft classification number (ACN) equal to or less than the reported PCN can operate on the pavement subject to any limitation on the tire pressure, or aircraft all-up mass for specified aircraft type(s).

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

6.2.6.4 The ACN of an aircraft shall be determined in accordance with the standard procedures associated with the ACN-PCN method.

Note – The standard procedures for determining the ACN of an aircraft are given in the ICAO Aerodrome Design Manual, Part 3. For convenience several aircraft types currently in use have been evaluated on rigid and flexible pavements founded on the four subgrade categories in paragraph 6.2.6.6 b) below and the results tabulated in that manual.

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

6.2.6.6 Information on pavement type for ACN-PCN determination, subgrade strength category, maximum allowable tire pressure category and evaluation method shall be reported using the following codes:

a) *Pavement type for ACN-PCN 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 K = 150 MN/m³ and representing all K values above 120 MN/m³ for rigid pavements, and by CBR = 15 and representing all CBR values above 13 for flexible pavements.	A
Medium strength: characterized by K = 80 MN/m³ and	B

representing a range in K of 60 to 120 MN/m³ for rigid pavements, and by CBR = 10 and representing a range in CBR of 8 to 13 for flexible pavements.	
Low strength: characterized by K = 40 MN/m³ and representing a range in K of 25 to 60 MN/m³ for rigid pavements, and by CBR = 6 and representing a range in CBR of 4 to 8 for flexible pavements.	C
Ultra low strength: characterized by K = 20 MN/m³ and representing all K values below 25 MN/m³ for rigid pavements, and by CBR = 3 and representing all CBR values below 4 for 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 14.2.2.1 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 application of pavement behaviour technology.	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 ACN-PCN method.

Example 1 – If the bearing strength of a rigid pavement, resting on a medium strength subgrade, has been assessed by technical evaluation to be PCN 80 and there is not tire pressure limitation, then the reported information would be:

PCN 80/ R / B / W / T

Example 2 – If the bearing strength of a composite pavement, behaving like a flexible pavement and resting on a high strength subgrade, has been assessed using aircraft experience to be PCN 50 and the maximum tire pressure allowable is 1.25 MPa, then the reported information would be:

PCN 50/ F / A / Y / U

Note – Composite construction.

Example 3 – If the bearing strength of a flexible pavement, resting on a medium strength subgrade, has been assessed by technical evaluation to be PCN 40 and the maximum allowable tire pressure is 0.80 MPa, then the reported information would be:

PCN 40 / F / B / 0.80 MPa / T

Example 4 – If a pavement is subject to a B747-400 all-up mass limitation of 390 000 kg, then the reported information would include the following note:

Note – The reported PCN is subject to a B747-400 all-up mass limitation of 390 000 kg.

6.2.6.7 **Recommendation –** When the magnitude of overload and/or frequency of use of pavement by aircraft with an ACN higher than the PCN reported for that pavement do not justify a detailed analysis, the following criteria should be used to determine the allowable extent of overload operations:

a) for flexible pavements, occasional movements by aircraft with ACN not exceeding 10 percent above the reported PCN should not adversely affect the pavement;

b) for rigid or composite pavements, in which a rigid pavement layer provides a primary element of the structure, occasional movements by aircraft with ACN not exceeding 5 per cent above the reported PCN should not adversely affect the pavement;

c) if the pavement structure is unknown, the 5 per cent limitation should apply; and

d) the annual number of overload movements should not exceed approximately 5 per cent of the total annual aircraft movements.

6.2.6.7A **Recommendation -** Such overloading movements should not normally be permitted on pavements exhibiting signs of distress or failure. Furthermore, it should be avoided when the strength of the pavement or its subgrade could be weakened by water. Where overload operations are conducted, the airport operator 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.

Note –ICAO Aerodrome Design Manual, Part 3 includes the descriptions of more detailed procedures for evaluation of pavements and their suitability for restricted overload operations.

6.2.6.8 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: 4 000 kg/0.50 MPa.

6.2.7 Pre-flight altimeter check location

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

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

Note 1 – Locating a pre-flight altimeter 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.

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

6.2.8 Declared distances

6.2.8.1 The following declared distances shall be calculated to the nearest metre for a runway intended for use by international commercial air transport:

a) take-off run available (TORA);

b) take-off distance available (TODA);

c) accelerate-stop distance available (ASDA); and

d) landing distance available (LDA).

6.2.8.2 **Recommendation -** 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.

6.2.8.3 Where a runway is provided with a clearway (CWY), then TODA shall include the length of clearway.

6.2.8.4 Where a runway is provided with a stopway (SWY), then ASDA shall include the length of stopway.

6.2.8.5 Where a runway has a displaced threshold, then the LDA shall be reduced by the distance the threshold is displaced. A displaced threshold affects only the LDA for approach made to that threshold; all declared distances for operations in the reciprocal direction are unaffected.

6.2.8.6 Where more than one of the features (a runway provided with a clearway or a stopway or having a displaced threshold) exist, then more than one of the declared distances shall be modified – but the modification shall follow the same principle.

6.2.8.7 **Recommendation -** 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.

Note – ICAO Annex 14, Attachment A, Figure A-1 contains illustration on declared distances.

6.2.9 Condition of the movement area and related facilities

6.2.9.1 Information on the condition of the movement area and the operational status of related facilities shall be provided to the Aeronautical Information Services, and similar information of operational significance to the air traffic service 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 – Nature, format and conditions of the information to be provided are specified in ICAO Annex 15 and PANS-ATM (Doc 4444).

6.2.9.2 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, 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 – Contaminants may include mud, dust, sand, volcanic ash, oil and rubber. ICAO Annex 6, Part 1, Attachment C provides guidance on the description of runway surface conditions. Additional guidance is included in the Airport Services Manual (Doc 9137), Part 2.

6.2.9.3 To facilitate compliance with paragraphs 6.2.9.1 and 6.2.9.2, inspections shall be carried out each day at least once where the code number is 1 or 2 and at least twice where the code number is 3 or 4

Note – Guidance on carrying out daily inspections of the movement area is given in the ICAO Airport Services Manual, Part 8 and in the Manual of Surface Movement Guidance and Control Systems (SMGCS) (Doc 9476).

6.2.9.4 Not in use.

Water on a runway

6.2.9.5 **Recommendation** – Whenever water is present on a runway, a description of the runway surface conditions on the centre half of the width of the runway, including the possible assessment of water depth, where applicable, should be made available using the following terms:

DAMP – the surface shows a change of colour due to moisture.
WET – the surface is soaked but there is no standing water.

WATER – significant patches of standing water are visible.
PATCHES
FLOODED – extensive standing water is visible

6.2.9.6 Information that a runway or portion thereof may be slippery when wet shall be made available

Note – The determination that a runway or portion thereof may be slippery when wet is not based solely on the friction measurement obtained using a continuous friction measuring device. Supplementary tools to undertake this assessment are described in the Airport Services Manual (Doc 9137), Part 2

6.2.9.7 Notification shall be given to aerodrome users when the friction level of a paved runway or portion thereof is less than that specified by CAAS in accordance with 14.2.2.3 of this manual.

Note – Guidance on conducting a runway surface friction characteristics evaluation programme that includes determining and expressing the minimum friction level is provided in ICAO Annex 14, Vol. I, Attachment A, Section 7.

6.2.9.8 Not in use.

6.2.9.9 Not in use.

6.2.9.10 Not in use.

6.2.9.11 Not in use.

6.2.9.12 Not in use.

6.2.10 Disabled aircraft removal

Note – See section 13.2.3 of this Manual for information on disabled aircraft removal services.

6.2.10.1 The telephone/telefax 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 shall be made available to aircraft operators.

6.2.10.2 **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.

6.2.11 Rescue and fire fighting

Note – See section 13.2.2 of this Manual for information on rescue and fire fighting services.

6.2.11.1 Information concerning the level of protection provided at an aerodrome for aircraft rescue and fire fighting purposes shall be made available.

6.2.11.2 The level of protection normally available at the aerodrome shall be expressed in terms of the category of the rescue and fire fighting services as described in section 13.2.2 of this Manual and in accordance with the types and amounts of extinguishing agents normally available at the aerodrome.

6.2.11.3 Changes in the level of protection normally available at an aerodrome for rescue and fire fighting shall be notified to the air traffic services unit and the Aeronautical Information Services to enable these 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.

6.2.11.4 **Recommendation** – A change should be expressed in terms of the new category of the rescue and fire fighting service available at the aerodrome.

6.2.12 Visual approach slope indicator systems

6.2.12.1 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 paragraph 9.2.3.5.2 of this Manual. For an AT-VASIS, PAPI or APAPI installation, the side of the runway on which the lights are installed, ie. 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 T-VASIS or an AT-VASIS this shall be angle θ according to the formula in Figure 5-18 of ICAO Annex 14 Vol. I and for a PAPI and an APAPI this shall be angle (B+C)/2 and (A+B)/2, respectively as in ICAO Annex 14 Vol. I Figure 5-20; and

e) minimum edge height(s) over the threshold of the on-slope signal(s). For a T-VASIS or an AT-VASIS this shall be the lowest height at which only the wing bar(s) are visible; however, the additional heights at which the wing bar(s) plus one, two or three fly down light units come into view may also be reported if such information would be of benefit to aircraft using the approach. 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’.

6.2.13 Coordination between the aerodrome operator and the Aeronautical Information Services

6.2.13.1 To ensure that the Aeronautical Information Services obtain information to enable them to provide up-to-date pre-flight information and to meet the need for in-flight information, the aerodrome operator shall establish arrangements with the Aeronautical Information Services to report, with a minimum of delay:

a) information on the status of certification of aerodromes and aerodrome conditions (reference sections 3.1, 6.2.9, 6.2.10, 6.2.11, 6.2.12 above);

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.

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

6.2.13.3 Of a particular importance are changes to aeronautical information that affects charts and/or computer-based navigation systems which qualify to be notified by the aeronautical information regulation and control (AIRAC) system, as specified in ICAO Annex 15, Chapter 6 and Appendix 4. The predetermined internationally agreed AIRAC effective dates in addition to 14 days postage time shall be observed by the responsible aerodrome operator when submitting the raw information/data to the Aeronautical Information Services.

6.2.13.4 The aerodrome operator 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 for aeronautical data as specified in ICAO Annex 14 Vol. I Appendix 5.

Note 1 – Specifications for the issue of a NOTAM are contained in ICAO Annex 15, Chapter 5, Appendix 6.

Note 2 – 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 3 – 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 ICAO Aeronautical Information Services Manual (ICAO Doc 8126, Chapter 2).

Chapter 7 – PHYSICAL CHARACTERISTICS

Section 7.1 – General

7.1.1 Introduction

7.1.1.1 This chapter contains specifications related to the physical characteristics required of aerodrome runway, taxiway, apron and related facilities.

Section 7.2 – Physical requirements of aerodrome facilities

7.2.1 Runways

Number and orientation of runways

Introductory Note — Many factors affect the determination of the orientation, siting and number of runways.

One important factor is the usability factor, as determined by the wind distribution, which is specified hereunder. Another important factor is the alignment of the runway to facilitate the provision of approaches conforming to the approach surface specifications of Chapter 8 of this Manual. In ICAO Annex 14 Vol. I, Attachment A, Section 1, information is given concerning these and other factors.

When a new instrument runway is being located, particular attention needs to be given to areas over which aeroplanes will be required to fly when following instrument approach and missed approach procedures, so as to ensure that obstacles in these areas or other factors will not restrict the operation of the aeroplanes for which the runway is intended.

7.2.1.1 **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.

7.2.1.2 **Recommendation —** The siting 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.

Note – Guidance on how to address noise problems is provided in the ICAO Airport Planning Manual *(Doc 9184) Part 2 and in the ICAO* Guidance on the Balanced Approach to Aircraft Noise Management *(Doc 9829).*

7.2.1.3 Choice of maximum permissible cross-wind components

Recommendation — In the application of paragraph 7.2.1.1 above, it should be assumed that landing or take-off of aeroplanes is, in normal circumstances, precluded when the cross-wind component exceeds:

— 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 cross-wind component not exceeding 24 km/h (13 kt) should be assumed;

— 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

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

Note — In ICAO Annex 14 Vol. I, Attachment A, Section 1, guidance is given on factors affecting the calculation of the estimate of the usability factor and allowances which may have to be made to take account of the effect of unusual circumstances.

7.2.1.4 Data to be used

Recommendation — 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.

Note — These winds are mean winds. Reference to the need for some allowance for gusty conditions is made in ICAO Annex 14 Vol. I, Attachment A, Section 1.

Location of threshold

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

Note — Guidance on the siting of the threshold is given in ICAO Annex 14 Vol. I, Attachment A, Section 11.

7.2.1.6 **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.

Note — Guidance on factors which may be considered in the determination of the location of a displaced threshold is given in ICAO Annex 14 Vol. I, Attachment A, Section 11.

Actual length of runways

7.2.1.7 Primary runway

Recommendation — Except as provided in paragraph 7.2.1.9 of this Manual, 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.

Note 1 — This specification does not necessarily mean providing for operations by the critical aeroplane at its maximum mass.

Note 2 — Both take-off and landing requirements need to be considered when determining the length of runway to be provided and the need for operations to be conducted in both directions of the runway.

Note 3 — Local conditions that may need to be considered include elevation, temperature, runway slope, humidity and the runway surface characteristics.

Note 4 — When performance data on aeroplanes for which the runway is intended are not known, guidance on the determination of the actual length of a primary runway by application of general correction factors is given in the ICAO Aerodrome Design Manual, Part 1.

7.2.1.8 Secondary runway

Recommendation — 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.

7.2.1.9 Runways with stopways or clearways

Recommendation — Where a runway is associated with a stopway or clearway, an actual runway length less than that resulting from application of paragraphs 7.2.1.7 or 7.2.1.8, 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.

Note — Guidance on use of stopways and clearways is given in ICAO Annex 14 Vol. I, Attachment A, Section 2.

Width of runways

7.2.1.10 The width of a runway shall not be less than the appropriate dimension specified in the following tabulation:

	Code letter					
Code number	A	B	C	D	E	F
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	45 m	60 m

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

Note 1 — The combinations of code numbers and letters for which widths are specified have been developed for typical aeroplane characteristics.

Note 2 — Factors affecting runway width are given in the ICAO Aerodrome Design Manual, Part 1.

Minimum distance between parallel runways

7.2.1.11 Where parallel non-instrument runways are intended for simultaneous use, the minimum distance between their centre lines shall be:

— 210 m where the higher code number is 3 or 4;

— 150 m where the higher code number is 2; and

— 120 m where the higher code number is 1.

Note — Procedures for wake turbulence categorization of aircraft and wake turbulence separation minima are contained in the Procedures for Air Navigation Services — Air Traffic Management (PANS-ATM), Doc 4444, Chapter 4, 4.9 and Chapter 5, 5.8, respectively.

7.2.1.12 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 shall be:

— 1 035 m for independent parallel approaches;

— 915 m for dependent parallel approaches;

— 760 m for independent parallel departures;

— 760 m for segregated parallel operations;

except that:

a) 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;

b) 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.

Note — Procedures and facilities requirements for simultaneous operations on parallel or near-parallel instrument runways are contained in the PANS-ATM (Doc 4444), Chapter 6 and the PANS-OPS (Doc 8168), Volume I, Part III, Section 2 and Volume II, Part I, Section 3; Part II, Section 1; and Part III, Section 3, and relevant guidance is contained in the ICAO Manual of Simultaneous Operations on Parallel or Near-Parallel Instrument Runways (Doc 9643).

Slopes on runways

7.2.1.13 Longitudinal slopes

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

— 1 per cent where the code number is 3 or 4; and

— 2 per cent where the code number is 1 or 2.

7.2.1.14 Along no portion of a runway shall the longitudinal slope exceed:

— 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 shall not exceed 0.8 per cent;

— 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 shall not exceed 0.8 per cent; and

— 2 per cent where the code number is 1 or 2.

7.2.1.15 Longitudinal slope changes

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

— 1.5 per cent where the code number is 3 or 4; and

— 2 per cent where the code number is 1 or 2.

Note — Guidance on slope changes before a runway is given in ICAO Annex 14 Vol. I, Attachment A, Section 4.

7.2.1.16 The transition from one slope to another shall be accomplished by a curved surface with a rate of change not exceeding:

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

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

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

7.2.1.17 Sight distance

Where slope changes cannot be avoided, they shall be such that there will be an unobstructed line of sight from:

— 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.

— 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

— 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.

Note — Consideration will have to be given to providing an unobstructed line of sight over the entire length of a single runway where a full-length parallel taxiway is not available. Where an aerodrome has intersecting runways, additional criteria on the line of sight of the intersection area would need to be considered for operational safety. See the ICAO Aerodrome Design Manual, Part 1.

7.2.1.18 Distance between slope changes

Undulations or appreciable changes in slopes located close together along a runway shall be avoided. The distance between the points of intersection of two successive curves shall not be less than:

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

— 30 000 m where the code number is 4;

— 15 000 m where the code number is 3; and

— 5 000 m where the code number is 1 or 2; or

b) 45 m;

whichever is greater.

Note — Guidance on implementing this specification is given in ICAO Annex 14 Vol. I, Attachment A, Section 4.

7.2.1.19 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:

— 1.5 per cent when the code letter is C, D, E or F; and

— 2 per cent when 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.

Note — On wet runways with cross-wind conditions the problem of aquaplaning from poor drainage is apt to be accentuated. In ICAO Annex 14 Vol. I, Attachment A, Section 7, information is given concerning this problem and other relevant factors.

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

Note — Guidance on transverse slope is given in the ICAO Aerodrome Design Manual, Part 3.

Strength of runways

7.2.1.21 A runway shall be capable of withstanding the traffic of aeroplanes the runway is intended to serve.

Surface of runways

7.2.1.22 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.

Note 1 — Surface irregularities may adversely affect the take-off or landing of an aeroplane by causing excessive bouncing, pitching, vibration, or other difficulties in the control of an aeroplane.

Note 2 — Guidance on design tolerances and other information is given in ICAO Annex 14 Vol. I, Attachment A, Section 5. Additional guidance is included in the ICAO Aerodrome Design Manual, *Part 3.*

7.2.1.23 A paved runway shall be so constructed or resurfaced as to provide surface friction characteristics at or above the minimum friction level specified in Table 14-1 of this Manual.

7.2.1.24 Not in use.

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

Note — Guidance on surface friction characteristics of new runway surfaces is given in ICAO Annex 14 Vol. I, Attachment A, Section 7. Additional guidance is included in the ICAO Airport Services Manual, Part 2.

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

Note 1 — This normally requires some form of special surface treatment.

Note 2 — Guidance on methods used to measure surface texture is given in the ICAO Airport Services Manual, Part 2.

7.2.1.27 **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.

Note — Guidance on methods for improving the runway surface texture is given in the ICAO Aerodrome Design Manual, Part 3.

7.2.2 Runway shoulders

General

Note — Guidance on characteristics and treatment of runway shoulders is given in ICAO Annex 14 Vol. I, Attachment A, Section 9, and in the ICAO Aerodrome Design Manual, Part 1.

7.2.2.1 Runway shoulders shall be provided for a runway where the code letter is D or E, and the runway width is less than 60 m.

7.2.2.2 Runway shoulders shall be provided for a runway where the code letter is F.

Width of runway shoulders

7.2.2.3 **Recommendation —** 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:

— 60 m where the code letter is D or E; and

— 75 m where the code letter is F.

Slopes on runway shoulders

7.2.2.4 The surface of the shoulder that abuts the runway shall be flush with the surface of the runway and its transverse slope shall not exceed 2.5 per cent.

Strength of runway shoulders

7.2.2.5 A runway shoulder shall 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.

Note — Guidance on strength of runway shoulders is given in the ICAO Aerodrome Design Manual, Part 1.

7.2.3 Runway turn pads

General

7.2.3.1 Where the end of a runway is not served by a taxiway or a taxiway turnaround and where the code is D, E or F, a runway turn pad shall be provided to facilitate a 180-degree turn for aeroplanes (See ICAO Annex 14 Vol. I, Figure 3-1)

7.2.3.2 **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.

Note 1 – Such areas may also be useful if provided along a runway to reduce taxiing time and distance for aeroplanes which may not require the full length of the runway.

Note 2 – Guidance on the design of the runway turn pads is available in ICAO Aerodrome Design Manual*, Part 1. Guidance on taxiway turnaround as an alternative facility is available in the ICAO* Aerodrome *Design Manual, Part 2.*

7.2.3.3 **Recommendation –** The runway turn pad may 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.

Note – The initiation of the turn would be facilitated by locating the turn pad on the left side of the runway, since the left seat is the normal position for the pilot-in-command.

7.2.3.4 **Recommendation –** The intersection angle of the runway turn pad should not exceed 30 degrees.

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

7.2.3.6 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 tabulations:

Code letter	Clearance
A	1.5m
B	2.25m
C	3m if the turn pad is intended to be used by

	aeroplanes with a wheel base of less than 18m; 4.5m if the turn pad is intended to be used by aeroplanes with a wheel base equal to or greater than 18m;
D	4.5m
E	4.5m
F	4.5m

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

7.2.3.7 **Recommendation –** Where severe weather conditions and resultant lowering of the surface friction characteristics prevail, a larger wheel-to-edge clearance of 6m should be provided where the code letter is E or F.

Slopes on runway turn pads

7.2.3.8 **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

7.2.3.9 **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 to the pavement.

Note. –Where a runway turn pad is provided with flexible pavement, the surface would need to be capable of withstanding the horizontal shear forces exerted by the main landing gear tires during turning manoeuvres.

Surface of runway turn pads

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

7.2.3.11 **Recommendation –** *The surface of a runway turn pad should be so constructed as to provide good friction characteristics for aeroplanes using the facility when the surface is wet.*

Shoulders of runway turn pads

7.2.3.12 **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.

Note – As a minimum, the width of the shoulders would need to cover the outer engine of the most demanding aeroplane and thus may be wider than the associated runway shoulders.

7.2.3.13 **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.*

7.2.4 Runway strips

General

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

Length of runway strips

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

— 60 m where the code number is 2, 3 or 4;

— 60 m where the code number is 1 and the runway is an instrument one; and

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

Width of runway strips

7.2.4.3 A strip including a precision approach runway shall extend laterally to a distance of at least:

— 150 m where the code number is 3 or 4; and

— 75 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.

7.2.4.4 A strip including a non-precision approach runway shall extend laterally to a distance of at least:

— 150 m where the code number is 3 or 4; and

— 75 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.

7.2.4.5 A strip including a non-instrument runway shall 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:

— 75 m where the code number is 3 or 4;

— 40 m where the code number is 2; and

— 30 m where the code number is 1.

Objects on runway strips

Note — See paragraph 13.2.9 of this Manual for information regarding siting of equipment and installations on runway strips.

7.2.4.6 An object situated on a runway strip which may endanger aeroplanes shall be regarded as an obstacle and shall 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 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 Note 1 to 7.2.4.16.

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. Guidance on Wildlife Control and Reduction can be found in the Airport Services Manual (Doc 9137), Part 3.

7.2.4.7 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 9 of this Manual, shall be permitted on a runway strip:

a) within 77.5 m of the runway centre line of a precision approach runway category I, II or III where the code number is 4 and the code letter is F; or

b) within 60 m of the runway centre line of a precision approach runway category I, II or III where the code number is 3 or 4; or

c) within 45 m of the runway centre line of a precision approach runway category I where the code number is 1 or 2.

No mobile object shall be permitted on this part of the runway strip during the use of the runway for landing or take-off.

Grading of runway strips

7.2.4.8 That portion of a strip of an instrument runway within a distance of at least:

— 75 m where the code number is 3 or 4; and

— 40 m where the code number is 1 or 2;

from the centre line of the runway and its extended centre line shall 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 ICAO Annex 14 Vol. I, Attachment A, Section 9.

7.2.4.9 That portion of a strip of a non-instrument runway within a distance of at least:

— 75 m where the code number is 3 or 4;

— 40 m where the code number is 2; and

— 30 m where the code number is 1;

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

7.2.4.10 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.

7.2.4.11 That portion of a strip to at least 30 m before the start of a runway shall 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 Aerodrome Design Manual (Doc 9157), Part 2.

7.2.4.12 Not in use.

Slopes on runway strips

7.2.4.13 Longitudinal slopes

A longitudinal slope along that portion of a strip to be graded shall not exceed:

— 1.5 per cent where the code number is 4;

— 1.75 per cent where the code number is 3; and

— 2 per cent where the code number is 1 or 2.

7.2.4.14 Longitudinal slope changes

Slope changes on that portion of a strip to be graded shall be as gradual as practicable and abrupt changes or sudden reversals of slopes avoided.

7.2.4.15 Transverse slopes

Transverse slopes on that portion of a strip to be graded shall be adequate to prevent the accumulation of water on the surface but shall not exceed:

— 2.5 per cent where the code number is 3 or 4; and

— 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, shoulder or stopway edge shall be negative as measured in the direction away from the runway and may be as great as 5 per cent.

7.2.4.16 The transverse slopes of any portion of a strip beyond that to be graded shall not exceed an upward slope of 5 per cent as measured in the direction away from the runway.

Note 1.— Where deemed necessary for proper drainage, an open-air storm water conveyance may be allowed in the non-graded portion of a runway strip and would be placed as far as practicable from the runway.

Note 2.— The aerodrome RFF procedure would need to take into account the location of open-air water conveyances within the non-graded portion of a runway strip.

Strength of runway strips

7.2.4.17 That portion of a strip of an instrument runway within a distance of at least:

— 75 m where the code number is 3 or 4; and

— 40 m where the code number is 1 or 2;

from the centre line of the runway and its extended centre line shall 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.

Note — Guidance on preparation of runway strips is given in the ICAO Aerodrome Design Manual, Part 1.

7.2.4.18 That portion of a strip containing a non-instrument runway within a distance of at least:

— 75 m where the code number is 3 or 4;

— 40 m where the code number is 2; and

— 30 m where the code number is 1;

from the centre line of the runway and its extended centre line shall 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.

7.2.5 Runway end safety areas

General

7.2.5.1 A runway end safety area shall be provided at each end of a runway strip where:

— the code number is 3 or 4; and

— the code number is 1 or 2 and the runway is an instrument one.

Note — Guidance on runway end safety areas is given in ICAO Annex 14 Vol. I, Attachment A, Section 10.

7.2.5.2 Not in use.

Dimensions of runway end safety areas

7.2.5.3 A runway end safety area shall extend from the end of a runway strip to a distance of at least 90 m where:

- the code number is 3 or 4; and

- 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 of CAAS.

Note – Guidance on arresting systems is given in ICAO Annex 14, Vol. I, Attachment A, Section 10.

7.2.5.4 **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; and

b) 120 m where the code number is 1 or 2

7.2.5.5 The width of a runway end safety area shall be at least twice that of the associated runway.

7.2.5.6 **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 section 13.2.9 for information regarding siting of equipment and installations on runway end safety areas.

7.2.5.7 An object situated on a runway end safety area which may endanger aeroplanes shall be regarded as an obstacle and shall be removed.

Clearing and grading of runway end safety areas

7.2.5.8 A runway end safety area shall 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.

Note — The surface of the ground in the runway end safety area does not need to be prepared to the same quality as the runway strip. See, however, paragraph 7.2.5.12 of this Manual.

Slopes on runway end safety areas

7.2.5.9 General

The slopes of a runway end safety area shall be such that no part of the runway end safety area penetrates the approach or take-off climb surface.

7.2.5.10 Longitudinal slopes

The longitudinal slopes of a runway end safety area shall not exceed a downward slope of 5 per cent. Longitudinal slope changes shall be as gradual as practicable and abrupt changes or sudden reversals of slopes avoided.

7.2.5.11 Transverse slopes

The transverse slopes of a runway end safety area shall not exceed an upward or downward slope of 5 per cent. Transitions between differing slopes shall be as gradual as practicable.

Strength of runway end safety areas

7.2.5.12 A runway end safety area shall 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 paragraphs 13.2.2.34 to 13.2.2.36 of this Manual.

Note — Guidance on strength of a runway end safety area is given in the ICAO Aerodrome Design Manual, Part 1.

7.2.6 Clearways

Note — The inclusion of detailed specifications for clearways in this section is not intended to imply that a clearway has to be provided. ICAO Annex 14 Vol. I, Attachment A, Section 2 provides information on the use of clearways.

Location of clearways

7.2.6.1 The origin of a clearway shall be at the end of the take-off run available.

Length of clearways

7.2.6.2 The length of a clearway shall not exceed half the length of the take-off run available.

Width of clearways

7.2.6.3 **Recommendation —** A clearway should extend laterally to a distance of at least 75 m on each side of the extended centre line of the runway.

Slopes on clearways

7.2.6.4 The ground in a clearway shall 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.

Note — Because of transverse or longitudinal slopes on a runway, shoulder or strip, in certain cases the lower limit of the clearway plane specified above may be below the corresponding elevation of the runway, shoulder or strip. It is not intended that these surfaces be graded to conform with the lower limit of the clearway plane nor is it intended that terrain or objects which are above the clearway plane beyond the end of the strip but below the level of the strip be removed unless it is considered they may endanger aeroplanes.

7.2.6.5 Abrupt upward changes in slope shall 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 shall generally conform with those of the runway with which the clearway is associated.

Objects on clearways

Note — See paragraph 13.2.9 of this Manual for information regarding siting of equipment and installations on clearways.

7.2.6.6 An object situated on a clearway which may endanger aeroplanes in the air shall be regarded as an obstacle and shall be removed.

7.2.7 Stopways

Note — The inclusion of detailed specifications for stopways in this section is not intended to imply that a stopway has to be provided. ICAO Annex 14 Vol. I, Attachment A, Section 2 provides information on the use of stopways.

Width of stopways

7.2.7.1 A stopway shall have the same width as the runway with which it is associated.

Slopes on stopways

7.2.7.2 Slopes and changes in slope on a stopway, and the transition from a runway to a stopway, shall comply with the specifications of paragraphs 7.2.1.13 to 7.2.1.19 of this Manual for the runway with which the stopway is associated except that:

a) the limitation in paragraph 7.2.1.14 of this Manual 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

7.2.7.3 A stopway shall 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.

Note — ICAO Annex 14 Vol. I, Attachment A, Section 2 presents guidance relative to the support capability of a stopway.

Surface of stopways

7.2.7.4 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.

7.2.8 Radio altimeter operating area

General

7.2.8.1 **Recommendation —** A radio altimeter operating area should be established in the pre-threshold area of a precision approach runway.

Length of the area

7.2.8.2 **Recommendation —** A radio altimeter operating area should extend before the threshold for a distance of at least 300 m.

Width of the area

7.2.8.3 **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

7.2.8.4 **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.

Note — Guidance on radio altimeter operating area is given in ICAO Annex 14 Vol. I, Attachment A, Section 4.3 and in the ICAO Manual of All-Weather Operations, (Doc 9365), Section 5.2. Guidance on the use of radio altimeter is given in the PANS-OPS, Volume II, Part II, Section 1.

7.2.9 Taxiways

Note 1.— Unless otherwise indicated the requirements in this section are applicable to all types of taxiways.

Note 2.— See ICAO Annex 14 Vol. I, 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 a known runway incursion safety risk.

General

7.2.9.1 Taxiways shall be provided to permit the safe and expeditious surface movement of aircraft.

Note — Guidance on layout of taxiways is given in the ICAO Aerodrome Design Manual (Doc 9157), Part 2.

7.2.9.2 **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.

7.2.9.3 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:

Code letter	Clearance
A	1.5 m
B	2.25 m
C	3 m on straight portions; 3m on curved portions if the taxiway is intended to be used by aeroplanes with a wheel base less than 18m; 4.5 m on curved portions if the taxiway is intended to be used by aeroplanes with a wheel base equal to or greater than 18 m
D	4.5 m
E	4.5 m
F	4.5 m

Note 1 — Wheel base means the distance from the nose gear to the geometric centre of the main gear.

Note 2 — Where the code letter is F and the traffic density is high, a wheel-to-edge clearance greater than 4.5 m may be provided to permit higher taxiing speeds.

Note 3 — This provision applies to taxiways first put into service on or after 20 November 2008.

Width of taxiways

7.2.9.4 A straight portion of a taxiway shall have a width of not less than that given by the following tabulation:

Code letter	Taxiway Width
A	7.5 m
B	10.5 m
C	15 m
D	18 m if the taxiway is intended to be used by aeroplanes with an outer main gear wheel span of less than 9 m; 23 m if the taxiway is intended to be used by aeroplanes with an outer main gear wheel span equal to or greater than 9 m.
E	23 m

F	25 m

Note — Guidance on width of taxiways is given in the ICAO Aerodrome Design Manual (Doc 9157), Part 2.

Taxiway curves

7.2.9.5 **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 7.2.9.3.

Note 1 — An example of widening taxiways to achieve the wheel clearance specified is illustrated in Figure 3-2 of ICAO Annex 14 Vol. I. Guidance on the values of suitable dimensions is given in the ICAO Aerodrome Design Manual (Doc 9157), Part 2.

Note 2 — The location of taxiway centre line markings and lights is specified in paragraphs 9.2.2.8.6 and 9.2.3.17.12 of this Manual.

Note 3 — Compound curves may reduce or eliminate the need for extra taxiway width.

Junctions and intersections

7.2.9.6 **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 7.2.9.3 are maintained when aeroplanes are manoeuvring through the junctions or intersections.

Note — Consideration will have to be given to the aeroplane datum length when designing fillets. Guidance on the design of fillets and the definition of the term aeroplane datum length are given in the ICAO Aerodrome Design Manual (Doc 9157), Part 2.

Taxiway minimum separation distances

7.2.9.7 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 shall not be less than the appropriate dimension specified in Table 7-1 (See next page), 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 ICAO Aerodrome Design Manual, 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 ICAO Annex 10, Volume I, Attachments C and G (respectively).

Note 3 — The separation distances of Table 7-1, 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 ICAO Aerodrome Design Manual, Part 2.

Note 4 — The separation distance between the centre line of an aircraft stand taxilane and an object shown in Table 7-1, column 13, may need to be increased when jet exhaust wake velocity may cause hazardous conditions for ground servicing.

Table 7-1 – Taxiway minimum separation distances

Code letter	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							
	1	2	3	4	1	2	3	4				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
A	82.5	82.5	-	-	37.5	47.5	-	-	23	15.5	19.5	12
B	87	87	-	-	42	52	-	-	32	20	28.5	16.5
C	-	-	168	-	-	-	93	-	44	26	40.5	22.5
D	-	-	176	176	-	-	101	101	63	37	59.5	33.5
E	-	-	-	182.5	-	-	-	107.5	76	43.5	72.5	40
F	-	-	-	190	-	-	-	115	91	51	87.5	47.5

Note 1 – The separation distances shown in columns (2) to (9) represent ordinary combinations of runways and taxiways. The basis for development of these distances is given in the ICAO Aerodrome Design Manual, Part2.

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 ICAO Aerodrome Design Manual, Part 2.

Slopes on taxiways

7.2.9.8 Longitudinal slopes

The longitudinal slope of a taxiway shall not exceed:

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

— 3 per cent where the code letter is A or B.

7.2.9.9 Longitudinal slope changes

Where slope changes on a taxiway cannot be avoided, the transition from one slope to another slope shall be accomplished by a curved surface with a rate of change not exceeding:

— 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

— 1 per cent per 25 m (minimum radius of curvature of 2 500 m) where the code letter is A or B.

7.2.9.10 Sight distance

Where a change in slope on a taxiway cannot be avoided, the change shall be such that, from any point:

— 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;

— 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

— 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.

7.2.9.11 Transverse slopes

The transverse slopes of a taxiway shall be sufficient to prevent the accumulation of water on the surface of the taxiway but shall not exceed:

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

— 2 per cent where the code letter is A or B.

Note — See paragraph 7.2.13.4 of this Manual regarding transverse slopes on an aircraft stand taxilane.

Strength of taxiways

7.2.9.12 The strength of a taxiway shall 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.

Note — Guidance on the relation of the strength of taxiways to the strength of runways is given in the ICAO Aerodrome Design Manual, Part 3.

Surface of taxiways

7.2.9.13 **Recommendation —** The surface of a taxiway should not have irregularities that cause damage to aeroplane structures.

7.2.9.14 **Recommendation —** The surface of a paved taxiway should be so constructed as to provide good surface friction characteristics when the taxiway is wet.

Rapid exit taxiways

Note — The following specifications detail requirements particular to rapid exit taxiways. See Figure 3-3 of ICAO Annex 14 Vol. I. 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 ICAO Aerodrome Design Manual, Part 2.

7.2.9.15 A rapid exit taxiway shall be designed with a radius of turn-off curve of at least:

— 550 m where the code number is 3 or 4; and

— 275 m where the code number is 1 or 2;

to enable exit speeds under wet conditions of:

— 93 km/h where the code number is 3 or 4; and

— 65 km/h where the code number is 1 or 2.

Note — The locations of rapid exit taxiways along a runway are based on several criteria described in the ICAO Aerodrome Design Manual, Part 2, in addition to different speed criteria.

7.2.9.16 **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.

7.2.9.17 **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.

7.2.9.18 **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°.

Taxiways on bridges

7.2.9.19 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.

7.2.9.20 Access shall 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.

Note — If aeroplane engines overhang the bridge structure, protection of adjacent areas below the bridge from engine blast may be required.

7.2.9.21 A bridge shall 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.

7.2.10 Taxiway shoulders

Note — Guidance on characteristics of taxiway shoulders and on shoulder treatment is given in the ICAO Aerodrome Design Manual, Part 2.

7.2.10.1 **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:

— 60 m where the code letter is F;

— 44 m where the code letter is E;

— 38 m where the code letter is D; and

— 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.

7.2.10.2 When a taxiway is intended to be used by turbine-engined aeroplanes, the surface of the taxiway shoulder shall be so prepared as to resist erosion and the ingestion of the surface material by aeroplane engines.

7.2.11 Taxiway strips

Note — Guidance on characteristics of taxiway strips is given in the ICAO Aerodrome Design Manual, Part 2.

General

7.2.11.1 A taxiway, other than an aircraft stand taxilane, shall be included in a strip.

Width of taxiway strips

7.2.11.2 A taxiway strip shall 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 7-1, column 11 of this Manual.

Objects on taxiway strips

Note — See paragraph 13.2.9 of this Manual for information regarding siting of equipment and installations on taxiway strips.

7.2.11.3 The taxiway strip shall provide an area clear of objects which may endanger taxiing aeroplanes.

Note 1 — Consideration will have to be given to the location and design of drains on a taxiway strip to prevent damage to an aeroplane accidentally running off a taxiway. Suitably designed drain covers may be required. For further guidance, see the Aerodrome Design Manual (Doc 9157), Part 2.

Note 2.— Where open-air or covered storm water conveyances are installed, consideration will have to be given to ensure that their structure do not extend above the surrounding ground so as not to be considered an obstacle. See also Note 1 to 7.2.11.6.

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. Guidance on Wildlife Control and Reduction can be found in the Airport Services Manual (Doc 9137), Part 3.

Grading of taxiway strips

7.2.11.4 The centre portion of a taxiway strip shall provide a graded area to a distance from the centre line of the taxiway of at least:

— 11 m where the code letter is A;

— 12.5 m where the code letter is B or C;

— 19 m where the code letter is D;

— 22 m where the code letter is E; and

— 30 m where the code letter is F.

Slopes on taxiway strips

7.2.11.5 The surface of the strip shall be flush at the edge of the taxiway or shoulder, if provided, and the graded portion shall not have an upward transverse slope exceeding:

— 2.5 per cent for strips where the code letter is C, D, E or F; and

— 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 shall not exceed 5 per cent measured with reference to the horizontal.

7.2.11.6 The transverse slopes on any portion of a taxiway strip beyond that to be graded shall not exceed an upward or downward slope of 5 per cent as measured in the direction away from the taxiway.

Note 1— Where deemed necessary for proper drainage, an open-air storm water conveyance may be allowed in the non-graded portion of a taxiway strip and would be placed as far as practicable from the taxiway.

Note 2 — The aerodrome RFF procedure would need to take into account the location of open-air storm water conveyances within the non-graded portion of a taxiway strip.

7.2.12 Holding bays, runway-holding positions, intermediate holding positions and road-holding positions

General

7.2.12.1 **Recommendation —** Holding bay(s) should be provided when the traffic density is medium or heavy.

7.2.12.2 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.

7.2.12.3 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.

7.2.12.4 **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.

7.2.12.5 A road-holding position shall be established at an intersection of a road with a runway.

Location

7.2.12.6 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 7-2 of this Manual (See next page) 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.

Table 7-2 – Minimum distance from the runway centre line to a holding bay, runway-holding position or road-holding position

	Code number			
Type of runway	1	2	3	4
Non-instrument	30 m	40 m	75 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,c]
Precision approach categories II and III	-	-	90 m [a,b]	90 m [a,b,c]
Take-off runway	30 m	40 m	75 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 every metre the bay or holding position is lower than the threshold, contingent upon not infringing the inner transitional surface.

b. This 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 areas of ILS and MLS is contained in ICAO Annex 10, Volume I, Attachments C and G, respectively (See also paragraph 7.2.12.6 of this Manual).

Note 1 — The distance of 90 m for code number 3 or 4 is based on an aircraft with a tail height of 20 m, a distance from the nose to the highest 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 highest 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.

c. Where the code letter is F, this distance should be 107.5 m.

Note — The distance of 107.5 m for code number 4 where the code letter is F is based on an aircraft with a tail height of 24 m, a distance from the nose to the highest 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.

7.2.12.7 Not in use.

7.2.12.8 **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 of 90 m or 107.5 m, as appropriate, specified in Table 7-2 of this Manual should be further increased 5 m for every metre the bay or position is higher than the threshold.

7.2.12.9 The location of a runway-holding position established in accordance with paragraph 7.2.12.3 of this Manual 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.

7.2.13 Aprons

General

7.2.13.1 Aprons shall 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.

Size of aprons

7.2.13.2 **Recommendation —** The total apron area should be adequate to permit expeditious handling of the aerodrome traffic at its maximum anticipated density.

Strength of aprons

7.2.13.3 Each part of an apron shall 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

7.2.13.4 **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.

7.2.13.5 On an aircraft stand the maximum slope shall not exceed 1 per cent.

Clearance distances on aircraft stands

7.2.13.6 An aircraft stand shall provide the following minimum clearances between an aircraft entering or exiting 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:

a) between the terminal, including any fixed passenger bridge, and the nose of an aircraft; and

b) over any portion of the stand provided with azimuth guidance by a visual docking guidance system.

Note — On aprons, consideration also has to be given to the provision of service roads and to manoeuvring and storage area for ground equipment (See the ICAO Aerodrome Design Manual, Part 2, for guidance on storage of ground equipment).

7.2.14 Isolated aircraft parking position

7.2.14.1 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.

7.2.14.2 **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.

7.2.15 Not in use

Chapter 8 – OBSTACLE RESTRICTION AND REMOVAL

Section 8.1 – General

8.1.1 Introduction

8.1.1.1 This chapter describes obstacle limitation surfaces around an aerodrome that are to be maintained free from obstacles.

8.1.1.2 The shielding principles to be used for assessing whether an existing obstacles shields another one or a new one is explained in section 8.3.

8.1.1.3 An aerodrome operator shall establish a systematic means of surveying and monitoring any object that penetrates these surfaces within the aerodrome itself and a radius of 5 km around the aerodrome and report any penetration immediately to the Aerodrome and ANS Regulation Division and appropriate air traffic services unit and to promulgate them through the Aeronautical Information Services and air traffic services unit so that aeroplane operations can be conducted safely at all times.

Note – Beyond the radius of 5 km around the aerodrome, the CAAS' ANS Policy Branch will survey and monitor any object that penetrates these surfaces and report any penetration immediately to the Aerodrome and ANS Regulation Division and to promulgate them through the Aeronautical Information Services and air traffic services unit so that aeroplane operations can be conducted safely at all times.

8.1.1.3A An aerodrome operator shall formalise an arrangement with CAAS' ANS Policy Branch to deal with the timely removal of obstacles.

8.1.1.4 An aerodrome operator shall consult CAAS' ANS Policy Branch, through Urban Redevelopment Authority (URA) to plan and determine the allowable height limits for new developments within the aerodrome and the type of instrument or visual flight operations that may be permitted.

Note – All new developments carried out beyond the aerodrome boundary will be referred to the CAAS' ANS Policy Branch, through the Urban Redevelopment Authority (URA), to determine the allowable heights limits that may be permitted for such developments.

Section 8.2 – Obstacle limitation

Note 1 – The objectives of the specifications in this chapter are to define the airspace around aerodromes to be maintained free from *obstacles so as to permit the intended aeroplane operations at the aerodromes to be conducted safely and to prevent the aerodromes from becoming unusable by the growth of obstacles around the aerodromes. This is achieved by establishing a series of obstacle limitation surfaces that define the limits to which objects may project into the airspace.*

Note 2 – Objects which penetrate the obstacle limitation surfaces contained in this chapter may in certain circumstances cause an increase in the obstacle clearance altitude/height for an instrument approach procedure or any associated visual circling procedure or have other operational impact on flight procedure design. Criteria for flight procedure design, are contained in Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS) (Doc 8168).

Note 3 – The establishment of, and requirements for, an obstacle protection surface for visual approach slope indicator systems are specified in paragraphs 9.2.3.5.41 to 9.2.3.5.45 of this Manual.

Note 4 – The establishment of OLS in Singapore is the responsibility of the CAAS' ANS Policy Branch.

8.2.1 Obstacle limitation surfaces

Note – See ICAO Annex 14 Vol. I Figure 4-1.

Outer horizontal surface

Note – Guidance on the need to provide an outer horizontal surface and its characteristics is contained in the ICAO Airport Services Manual (Doc 9137), Part 6.

Conical surface

8.2.1.1 Description – Conical surface. A surface sloping upwards and outwards from the periphery of the inner horizontal surface.

8.2.1.2 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.

8.2.1.3 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

8.2.1.4 Description – Inner horizontal surface. A surface located in a horizontal plane above an aerodrome and its environs.

8.2.1.5 Characteristics – The radius or outer limits of the inner horizontal surface shall be measured from a reference point or points established for such purpose.

Note - The shape of the inner horizontal surface need not necessarily be circular. Guidance on determining the extent of the inner horizontal *surface is contained in the ICAO Airport Services Manual (Doc 9137), Part 6.*

8.2.1.6 The height of the inner horizontal surface shall be measured above an elevation datum established for such purpose.

Note - Guidance on determining the elevation datum is contained in the ICAO Airport Services Manual (Doc 9137), Part 6.

Approach surface

8.2.1.7 Description – Approach surface. An inclined plane or combination of planes preceding the threshold.

8.2.1.8 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; and

c) an outer edge parallel to the inner edge.

8.2.1.8A The surfaces, mentioned in paragraph 8.2.1.8 (a) to (c) above, shall be varied when lateral offset, offset or curved approaches are utilised, 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.

8.2.1.9 The elevation of the inner edge shall be equal to the elevation of the mid-point of the threshold.

8.2.1.10 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.

Inner approach surface

8.2.1.11 Description – Inner approach surface. A rectangular portion of the approach surface immediately preceding the threshold.

8.2.1.12 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.

Transitional surface

8.2.1.13 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.

8.2.1.14 Characteristics – The limits of the 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 in the inner horizontal surface.

8.2.1.15 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.

Note – As a result of b) the transitional surface along the strip will be curved if the runway profile is curved, or a plane if the runway profile is a straight line. The intersection of the transitional surface with the inner horizontal surface will also be a curved or a straight line depending on the runway profile.

8.2.1.16 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

Note – It is intended that the inner transitional surface be the controlling obstacle limitation surface for navigation aids, aircraft and other vehicles that must be near the runway and which is not be penetrated except for frangible objects. The transitional surface described in paragraph 8.2.1.13 of this Manual is intended to remain as the controlling obstacle limitation surface for buildings, etc.

8.2.1.17 Description – Inner transitional surface. A surface similar to the transitional surface but closer to the runway.

8.2.1.18 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.

8.2.1.19 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.

Note – As a result of b) the inner transitional surface along the strip will be curved if the runway profile is curved or a plane if the runway profile is a straight line. The intersection of the inner transitional surface with the inner horizontal surface will also be a curved or a straight line depending on the runway profile.

8.2.1.20 The slope of inner transitional surface shall be measured in a vertical plane at right angles to the centre line of the runway.

Balked landing surface

8.2.1.21 Description – Balked landing surface. An inclined plane located at a specified distance after the threshold, extending between the inner transitional surface.

8.2.1.22 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.

8.2.1.23 The elevation of the inner edge shall be equal to the elevation of the runway centre line at the location of the inner edge.

8.2.1.24 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

8.2.1.25 Description – Take-off climb surface. An inclined plane or other specified surface beyond the end of a runway or clearway.

8.2.1.26 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.

8.2.1.27 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.

8.2.1.28 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.

8.2.1.29 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.

8.2.2 Obstacle limitation requirements

Note – The requirements for obstacle limitation surfaces are specified on the basis of the intended use of a runway, i.e. take-off or landing and type of approach, and are intended to be applied when such use is made of the runway. In case where operations are conducted to or from both directions of a runway; then the function of certain surfaces may be nullified because of more stringent requirements of another lower surface.

Non-instrument runways

8.2.2.1 The following obstacle limitation surfaces shall be established for a non-instrument runway.

— conical surface;

— inner horizontal surface;

— approach surface; and

— transitional surfaces.

8.2.2.2 The heights and slopes of the surfaces shall not be greater than and their other dimensions not less than, those specified in Table 8-1 of this Manual.

8.2.2.3 New objects or extensions of existing objects shall not be permitted above an approach or transitional surface except when the new object or extension would be shielded by an existing immovable object.

Note – Circumstances in which the shielding principle may reasonably be applied are described in the ICAO Airport Services Manual (Doc 9137), Part 6.

8.2.2.4 New objects or extensions of existing objects shall not be permitted above the conical surface or inner horizontal surface except when 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.

Table 8-1 – Dimensions and slopes of obstacle limitation surfaces – Approach runways

APPROACH RUNWAYS

Surface and dimensions[a]	RUNWAY CLASSIFICATION									
	Non-instrument				Non-precision approach			Precision approach category		
								I		II or III
	Code number				Code number			Code number		Code number
	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 m	150 m	150 m	300 m	300 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	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%

(continue next page)

Table 8-1 – Dimensions and slopes of obstacle limitation surfaces – Approach runways

APPROACH RUNWAYS (continued)

Surface and dimensions[a]	RUNWAY CLASSIFICATION									
	Non-instrument				Non-precision approach			Precision approach category		
								I		II or III
	Code number				Code number			Code number		Code number
	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)
APPROACH										
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 paragraph 8.2.2.9 or 8.2.2.17 of this Manual).

c. Distance to the end of strip.

d. Or end of runway whichever is less.

e. Where the code letter is F (Column (3) of Table 2-1 of this Manual), the width is increased to 155m. For information on code letter F aeroplanes equipped with digital avionics that provide steering commands to maintain an established track during the go-around manoeuvre, See Circular 301 – New Larger Aeroplanes – Infringement of the Obstacle Free Zone: Operational Measures and Aeronautical Study.

8.2.2.5 **Recommendation –** Existing objects above any of the surfaces required by paragraph 8.2.2.1 of this Manual should as far as practicable be removed except when, in the opinion of the Aerodrome and ANS Regulation Division, 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.

Note – Because of transverse or longitudinal slopes on a strip, in certain cases the inner edge or portions of the inner edge of the approach surface may be below the corresponding elevation of the strip. It is not intended that the strip be graded to conform with the inner edge of the approach surface, nor is it intended that terrain or objects which are above the approach surface beyond the end of the strip, but below the level of the strip, be removed unless it is considered they may endanger aeroplanes.

8.2.2.6 **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

8.2.2.7 The following obstacle limitation surfaces shall be established for a non-precision approach runway:

— conical surface;

— inner horizontal surface;

— approach surface; and

— transitional surfaces.

8.2.2.8 The heights and slopes of the surfaces shall not be greater than, and their other dimensions not less than, those specified in Table 8-1 of this Manual, except in the case of the horizontal section of the approach surface (See paragraph 8.2.2.9 of this Manual).

8.2.2.9 The approach surface shall be horizontal beyond the point at which the 2.5 per cent slope intersects:

a) a horizontal plane 150m 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.

8.2.2.10 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 the new object or extension would be shielded by an existing immovable object.

Note – Circumstances in which the shielding principle may reasonably be applied are described in the ICAO Airport Services Manual, Part 6.

8.2.2.11 **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 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 operations of aeroplanes..

8.2.2.12 **Recommendation –** Existing objects above any of the surfaces required by paragraph 8.2.2.7 should as far as practicable be removed except when, in the opinion of the Aerodrome and ANS Regulation Division, 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.

Note – Because of the transverse or longitudinal slopes on a strip, in certain cases the inner edge or portions of the inner edge of the approach surface may be below the corresponding elevation of the strip. It is not intended that the strip be graded to conform with the inner edge of the approach surface, nor is it intended that terrain or objects which are above the approach surface beyond the end of the strip, but below the level of the strip, be removed unless it is considered they may endanger aeroplanes.

Precision approach runways

Note 1 – See paragraph 13.2.9 for information regarding siting of equipment and installations on operational areas.

Note 2 – Guidance on obstacle limitation surfaces for precision approach runways is given in the ICAO Airport Services Manual, Part 6.

8.2.2.13 The following obstacle limitation surfaces shall be established for a precision approach runway category I, II and III:

- conical surface;
- inner horizontal surface;
- approach surface and inner approach surface;
- transitional surfaces;
- inner transitional surfaces; and
- balked landing surface.

8.2.2.14 Not in use.

8.2.2.15 Not in use.

8.2.2.16 The heights and slopes of the surfaces shall not be greater than, and their other dimensions not less than, those specified in Table 8-1 of this Manual, except in the case of the horizontal section of the approach surface (See paragraph 8.2.2.17 of this Manual).

8.2.2.17 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.

8.2.2.18 Fixed objects shall not be permitted above the inner approach surface, 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.

8.2.2.19 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 Aerodrome and ANS Regulation Division, the new object or extension would be shielded by an existing immovable object.

Note – Circumstances in which the shielding principle may reasonably be applied are described in the ICAO Airport Services Manual, Part 6.

8.2.2.20 **Recommendation –** New objects or extensions of existing objects should not be permitted above the conical surface and the inner horizontal surface except when 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.

8.2.2.21 **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 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.

Note – Because of transverse or longitudinal slopes on a strip, in certain cases the inner edge or portions of the inner edge of the approach surface may be below the corresponding elevation of the strip. It is not intended that the strip be graded to conform with the inner edge of the approach surface, nor is it intended that terrain or objects which are above the approach surface beyond the end of the strip, but below the level of the strip, be removed unless it is considered that may endanger aeroplanes.

Runways meant for take-off

8.2.2.22 The following obstacle limitation surface shall be established for a runway meant for take-off:

– take-off climb surface.

8.2.2.23 The dimension of the surface shall be not less than the dimensions specified in Table 8-2 of this Manual, except that a lesser length may be adopted or the take-off climb surface where such lesser length would be consistent with procedural measures adopted to govern the outward flight of aeroplanes.

8.2.2.24 **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 8-2 of this Manual when critical operating conditions are to be catered to. If the specified slope is reduced, corresponding adjustment in the length of take-off climb surface should be made so as to provide protection to a height of 300m.

Note – When local conditions differ widely from sea level standard atmospheric conditions, it may be advisable for the slope specified in Table 8-2 of this Manual to be reduced. The degree of this reduction depends on the divergence between local conditions and sea level standard atmospheric conditions, and on the performance characteristics and operational requirements of the aeroplanes for which the runway is intended.

Table 8-2 – 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 intended track includes changes of heading greater than			

15° for operations conducted in IMC, VMC by night.
d. See paragraphs 8.2.2.24 and 8.2.2.26 of this Manual.

8.2.2.25 New objects or extensions of existing objects shall not be permitted above a take-off climb surface except when, in the opinion of the Aerodrome and ANS Regulation Division, the new object or extension would be shielded by an existing immovable object.

Note – Circumstances in which the shielding principle may reasonably be applied are described in the ICAO Airport Services Manual, Part 6.

8.2.2.26 **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).

8.2.2.27 **Recommendation –** Existing objects that extend above a take-off climb surface should as far as practicable be removed except when 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.

Note – Because of transverse slopes on a strip or clearway, in certain cases portions of the inner edge of the take-off climb surface may be below the corresponding elevation of the strip or clearway. It is not intended that the strip or clearway be graded to conform with the inner edge of the take-off climb surface, nor it is intended that terrain or objects which are above the take-off climb surface beyond the end of the strip or clearway, but below the level of the strip or clearway, be removed unless it is considered that may endanger aeroplanes. Similar considerations apply at the junction of a clearway and strip where differences in transverse slopes exist.

8.2.3 Objects outside the obstacle limitation surfaces

8.2.3.1 **Recommendation** - Arrangements should be made to enable CAAS' ANS Policy Branch to be consulted concerning proposed construction beyond the limits of the obstacle limitation surfaces that extend above a height established by CAAS' ANS Policy Branch, in order to permit an aeronautical study of the effect of such construction on the operation of aeroplanes.

8.2.3.2 **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 – This study may have regard to the nature of operations concerned and may distinguish between day and night operations.

8.2.4 Other objects

8.2.4.1 **Recommendation –** Objects which do not project through the approach surface but which would nevertheless adversely affect the optimum siting or performance of visual or non-visual aids should, as far as practicable, be removed.

8.2.4.2 **Recommendation –** Anything which may, in the opinion of the Aerodrome and ANS Regulation Division 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 – In certain circumstances, objects that do not project above any of the surfaces enumerated in paragraph 8.2.1 may constitute a hazard to aeroplanes as, for example, where there are one or more isolated objects in the vicinity of an aerodrome.

Section 8.3 – Principles of shielding

8.3.1 General

8.3.1.1 A new obstacle located in the vicinity of an existing obstacle and assessed as not being a hazard to aircraft is deemed to be shielded.

8.3.1.2 Unless specifically directed by the Aerodrome and ANS Regulation Division, a shielded obstacle does not require removal, lowering, marking or lighting and should not impose any additional restrictions to aircraft operations.

8.3.1.3 The Aerodrome and ANS Regulation Division will assess and determine whether an obstacle is shielded. An aerodrome operator shall notify the Aerodrome and ANS Regulation Division of the presence of all obstacles and their detailed characteristics through the submission of its Aerodrome Manual.

8.3.1.4 Only existing permanent obstacles may be considered in assessing shielding of new obstacles.

8.3.2 Shielding principles

8.3.2.1 In assessing whether an existing obstacle shields an obstacle, the Aerodrome and ANS Regulation Division will be guided by the principles of shielding detailed below.

Obstacle penetrating the approach and take-off climb surfaces

8.3.2.2 (a) An existing obstacle within the approach and take-off climb area is called the critical obstacle. Where a number of obstacles exist closely together, the critical obstacle is the one which subtends the greatest vertical angle measured from the appropriate inner edge.

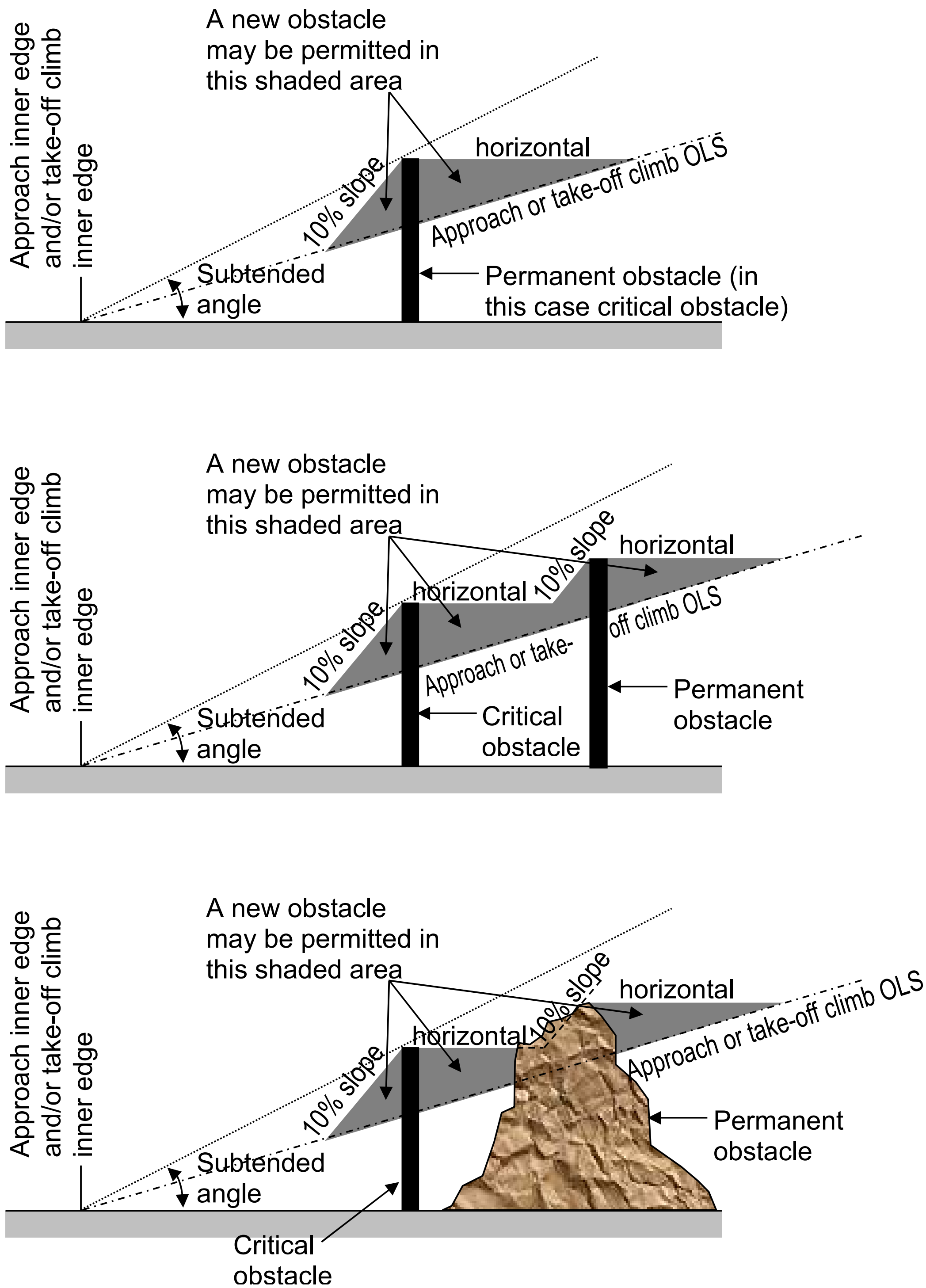
(b) As illustrated in Figure 8-1, a new obstacle may be assessed as not imposing additional restrictions if:

(i) when located between the inner edge end and the critical obstacle, the new obstacle is below a plane sloping downwards at 10% from the top of the critical obstacle toward the inner edge;

(ii) when located beyond the critical obstacle from the inner edge end, the new obstacle is not higher than the height of the permanent obstacle; and

(iii) where there is more than one critical obstacle within the approach and take-off climb area, and the new obstacle is located between two critical obstacles, the height of the new obstacle is not above a plane sloping downwards at 10% from the top of the next critical obstacle.

Figure 8-1 – Shielding of obstacles penetrating the approach and take-off climb surfaces



Obstacle penetrating the inner and outer horizontal and conical surfaces

8.3.2.3 A new obstacle may be accepted if it is in the vicinity of an existing obstacle, and does not penetrate a 10% downward sloping conical-shaped surface from the top of the existing obstacle, i.e. the new obstacle is shielded radially by the existing obstacle.

Obstacle penetrating the transitional surfaces

8.3.2.4 A new obstacle may be assessed as not imposing additional restrictions if it does not exceed the height of an existing obstacle which is closer to the runway strip and the new obstacle is located perpendicularly behind the existing obstacle relative to the runway centre line.

Chapter 9 – VISUAL AIDS FOR NAVIGATION

Section 9.1 – General

9.1.1 Introduction

9.1.1.1 This chapter details the specifications for aerodrome indicators and signaling devices, markings, lights, signs and markers to be provided at an aerodrome.

Section 9.2.1 – Indicators and signalling devices

9.2.1.1 Wind direction indicators

Application

9.2.1.1.1 An aerodrome shall be equipped with at least one wind direction indicator.

Location

9.2.1.1.2 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

9.2.1.1.3 **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.

9.2.1.1.4 **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.

9.2.1.1.5 **Recommendation —** Provision should be made for illuminating at least one wind indicator at an aerodrome intended for use at night.

9.2.1.2 Landing direction indicator

Location

9.2.1.2.1 Where provided, a landing direction indicator shall be located in a conspicuous place on the aerodrome.

Characteristics

9.2.1.2.2 **Recommendation —** The landing direction indicator should be in the form of a “T”.

9.2.1.2.3 The shape and minimum dimensions of a landing “T” shall be as shown in ICAO Annex 14 Vol. I, Figure 5-1. 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.

9.2.1.3 Signalling lamp

Application

9.2.1.3.1 A signalling lamp shall be provided at a controlled aerodrome in the aerodrome control tower.

Characteristics

9.2.1.3.2 **Recommendation —** A signalling lamp should be capable of producing red, green and white signals, and of:

a) being aimed manually at any target as required;

b) giving a signal in any one colour followed by a signal in either of the two other colours; and

c) 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 as specified in ICAO Annex 14 Vol. I, Appendix 1, 2.1.2.

9.2.1.3.3 **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.

9.2.1.4 Signal panels and signal area

Note — The inclusion of detailed specifications for a signal area in this section is not intended to imply that one has to be provided. ICAO Annex 14 Vol. I, Attachment A, Section 16 provides guidance on the need to provide ground signals. ICAO Annex 2, Appendix 1 specifies the shape, colour and use of visual ground signals. The ICAO Aerodrome Design Manual (Doc 9157), Part 4 provides guidance on their design.

Location of signal area

9.2.1.4.1 **Recommendation —** The signal area 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

9.2.1.4.2 The signal area shall be an even horizontal surface at least 9 m square.

9.2.1.4.3 **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.

Section 9.2.2 – Markings

9.2.2.1 General

Interruption of runway markings

9.2.2.1.1 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.

9.2.2.1.2 **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.

9.2.2.1.3 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.

Note — See paragraph 9.2.2.8.7 of this Manual regarding the manner of connecting runway and taxiway centre line markings.

Colour and conspicuity

9.2.2.1.4 Runway markings shall be white.

Note 1 — It has been found that, on runway surfaces of light colour, the conspicuity of white markings can be improved by outlining them in black.

Note 2 — It is preferable that the risk of uneven friction characteristics on markings be reduced in so far as practicable by the use of a suitable kind of paint.

Note 3 — Markings may consist of solid areas or a series of longitudinal stripes providing an effect equivalent to the solid areas.

9.2.2.1.5 Taxiway markings, runway turn pad markings and aircraft stand markings shall be yellow.

9.2.2.1.6 Apron safety lines shall be of a conspicuous colour which shall contrast with that used for aircraft stand markings.

9.2.2.1.7 **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 ICAO Aerodrome Design Manual (Doc 9157), Part 4.

Unpaved taxiways

9.2.2.1.8 **Recommendation —** An unpaved taxiway should be provided, so far as practicable, with the markings prescribed for paved taxiways.

9.2.2.2 Runway designation marking

Application

9.2.2.2.1 A runway designation marking shall be provided at the thresholds of a paved runway.

9.2.2.2.2 **Recommendation —** A runway designation marking should be provided, so far as practicable, at the thresholds of an unpaved runway.

Location

9.2.2.2.3 A runway designation marking shall be located at a threshold as shown in ICAO Annex 14 Vol. I, Figure 5-2 as appropriate.

Note — If the runway threshold is displaced from the extremity of the runway, a sign showing the designation of the runway may be provided for aeroplanes taking off.

Characteristics

9.2.2.2.4 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.

9.2.2.2.5 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”.

9.2.2.2.6 The numbers and letters shall be in the form and proportion shown in ICAO Annex 14 Vol. I, Figure 5-3. The dimensions shall be not less than those shown in ICAO Annex 14 Vol. I, 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.

9.2.2.3 Runway centre line marking

Application

9.2.2.3.1 A runway centre line marking shall be provided on a paved runway.

Location

9.2.2.3.2 A runway centre line marking shall be located along the centre line of the runway between the runway designation markings as shown in ICAO Annex 14 Vol. I, Figure 5-2, except when interrupted in compliance with paragraph 9.2.2.1.1 of this Manual.

Characteristics

9.2.2.3.3 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.

9.2.2.3.4 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.

9.2.2.4 Threshold marking

Application

9.2.2.4.1 A threshold marking shall be provided at the threshold of a paved instrument runway, and of a paved non-instrument runway where the code number is 3 or 4 and the runway is intended for use by international commercial air transport.

9.2.2.4.2 **Recommendation —** A threshold marking should be provided at the threshold of a paved non-instrument runway where the code number is 3 or 4 and the runway is intended for use by other than international commercial air transport.

9.2.2.4.3 **Recommendation —** A threshold marking should be provided, so far as practicable, at the thresholds of an unpaved runway.

Note — The ICAO Aerodrome Design Manual, Part 4, shows a form of marking which has been found satisfactory for the marking of downward slopes immediately before the threshold.

Location

9.2.2.4.4 The stripes of the threshold marking shall commence 6 m from the threshold.

Characteristics

9.2.2.4.5 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 ICAO Annex 14 Vol. I, 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
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 ICAO Annex 14 Vol. I, Figure 5-2 (C).

9.2.2.4.6 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

9.2.2.4.7 **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 ICAO Annex 14 Vol. I, Figure 5-4 (B) should be added to the threshold marking.

9.2.2.4.8 A transverse stripe shall be not less than 1.80 m wide.

Arrows

9.2.2.4.9 Where a runway threshold is permanently displaced, arrows conforming to ICAO Annex 14 Vol. I, Figure 5-4 (B) shall be provided on the portion of the runway before the displaced threshold.

9.2.2.4.10 When a runway threshold is temporarily displaced from the normal position, it shall be marked as shown in ICAO Annex 14 Vol. I, 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 paragraph 11.2.1.4 of this Manual, are required to be provided.

9.2.2.5 Aiming point marking

Application

9.2.2.5.1 Not in use.

9.2.2.5.2 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.

9.2.2.5.3 **Recommendation —** An aiming point marking should be provided at each approach end of:

a) a paved non-instrument runway where the code number is 3 or 4,

b) a paved instrument runway where the code number is 1,

when additional conspicuity of the aiming point is desirable.

Location

9.2.2.5.4 The aiming point marking shall commence no closer to the threshold than the distance indicated in the appropriate column of Table 9-1 of this Manual, 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.

9.2.2.5.5 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 9-1 of this Manual. Where a touchdown zone marking is provided, the lateral spacing between the markings shall be the same as that of the touch-down zone marking.

Table 9-1 – Location and dimensions of aiming point marking

Location and dimensions	Landing distance available			
	Less than 800 m	800 m up to but not including 1 200 m	1 200 m up to but not including 2 400 m	2 400 m and above
(1)	(2)	(3)	(4)	(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]	6-10m[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 space which is element 2 of the aerodrome reference code at Chapter 2, Table 2-1.				

9.2.2.6 Touchdown zone marking

Application

9.2.2.6.1 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.

9.2.2.6.2 **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.

Location and characteristics

9.2.2.6.3 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
900m up to but not including 1 200 m	2
1 200m up to but not including 1 500 m	3
1 500m up to but not including 2 400 m	4
2 400m or more	6

9.2.2.6.4 A touchdown zone marking shall conform to either of the two patterns shown in ICAO Annex 14 Vol. I, Figure 5-5. For the pattern shown in ICAO Annex 14 Vol. I, Figure 5-5 (A), the markings shall be not less than 22.5 m long and 3 m wide. For the pattern shown in ICAO Annex 14 Vol. I, 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 9-1 of this Manual (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.

9.2.2.6.5 **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.

9.2.2.7 Runway side stripe marking

Application

9.2.2.7.1 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.

9.2.2.7.2 **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

9.2.2.7.3 **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.

9.2.2.7.4 **Recommendation —** Where a runway turn pad is provided, the runway side stripe marking should be continued between the runway and the runway turn pad.

Characteristics

9.2.2.7.5 **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.

9.2.2.8 Taxiway centre line marking

Application

9.2.2.8.1 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.

9.2.2.8.2 **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.

9.2.2.8.3 Taxiway centre line marking shall be provided on a paved runway when the runway is part of a standard taxi-route and:

a) there is no runway centre line marking; or

b) where the taxiway centre line is not coincident with the runway centre line.

9.2.2.8.4 **Recommendation —** Where it is necessary to denote the proximity of a runway-holding position, enhanced taxiway centre line marking should be provided.

Note – The provision of enhanced taxiway centre line marking may form part of runway incursion prevention measures.

9.2.2.8.5 Where provided, enhanced taxiway centre line marking shall be installed at each taxiway/runway intersection.

Location

9.2.2.8.6 **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 paragraph 7.2.9.6 and ICAO Annex 14 Vol. I, Figure 3-2.

9.2.2.8.7 **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 ICAO Annex 14 Vol. I, 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.

9.2.2.8.8 **Recommendation —** Where taxiway centre line marking is provided on a runway in accordance with paragraph 9.2.2.8.3 of this Manual, the marking should be located on the centre line of the designated taxiway.

9.2.2.8.9 Where provided:

a) An enhanced taxiway centre line marking shall extend from the runway-holding position Pattern A (as defined In ICAO Annex 14 Vol. I, Figure 5-6, Taxiway markings) to a distance of up to 47m in the direction of travel away from the runway. See ICAO Annex 14, Vol. I, Figure 5-7(a).

b) 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 47m of the first runway-holding position marking, the enhanced taxiway centre line marking shall be interrupted 0.9m 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 47m from start to finish, whichever is greater. See ICAO Annex 14, Vol. I, Figure 5-7(b).

c) If the enhanced taxiway centre line marking continues through a taxiway/taxiway intersection that is located within 47m of the runway-holding position marking, the enhanced taxiway centre line marking shall be interrupted 1.5m 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 47m from start to finish, whichever is greater. See ICAO Annex 14, Vol. I, Figure 5-7(c).

d) Where two taxiway centre lines converge at or before the runway-holding position marking, the inner dashed line shall not be less than 3m in length. See ICAO Annex 14, Vol. I, Figure 5-7(d).

e) Where there are two opposing runway-holding position markings and the distance between the markings is less than 94m, 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 ICAO Annex 14, Vol. I, Figure 5-7(e).

Characteristics

9.2.2.8.10 A taxiway centre line marking shall be at least 15cm 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 ICAO Annex 14 Vol. I, Figure 5-6.

9.2.2.8.11 Enhanced taxiway centre line marking shall be as shown in ICAO Annex 14 Vol. I, Figure 5-7.

9.2.2.9 Runway turn pad marking

Application

9.2.2.9.1 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

9.2.2.9.2 **Recommendation. –** The runway turn pad markings 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.

9.2.2.9.3 **Recommendation. –** The runway turn pad markings should be extended parallel to the runway centre line marking or 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.

9.2.2.9.4 **Recommendation. –** The 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.

9.2.2.9.5 **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.

9.2.2.9.6 **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 that those specified in 7.2.3.6.

Note – For ease of manoeuvring, consideration may be given to providing a larger wheel-to-edge clearance for codes E and F aeroplanes. See 7.2.3.7.

Characteristics

9.2.2.9.7 A runway turn pad marking shall be at least 15cm in width and continuous in length.

9.2.2.10 Runway-holding position marking

Application and location

9.2.2.10.1 A runway-holding position marking shall be displayed along a runway-holding position.

Note — See 9.2.4.2 concerning the provision of signs at runway-holding positions.

Characteristics

9.2.2.10.2 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 ICAO Annex 14 Vol. I, Figure 5-6, pattern A.

9.2.2.10.3 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 ICAO Annex 14 Vol. I, 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 ICAO Annex 14 Vol. I, Figure 5-6, pattern A and the markings farther from the runway shall be as shown in ICAO Annex 14 Vol. I, Figure 5-6, pattern B.

9.2.2.10.4 The runway-holding position marking displayed at a runway-holding position established in accordance with paragraph 7.2.12.3 of this Manual shall be as shown in ICAO Annex 14 Vol. I, Figure 5-6, pattern A.

9.2.2.10.5 Until 26 November 2026, the dimensions of runway-holding position markings shall be as shown in ICAO Annex 14 Vol. I, Figure 5-8, pattern A1 (or A2) or pattern B1 (or B2), as appropriate.

9.2.2.10.6 From 26 November 2026, the dimensions of runway-holding position marking shall be as shown in ICAO Annex 14 Vol. I, Figure 5-8, pattern A2 or pattern B2, as appropriate.

9.2.2.10.7 **Recommendation —** Where increased conspicuity of the runway-holding position is required, the dimensions of runway-holding position marking should be as shown in ICAO Annex 14 Vol. I, Figure 5-8, pattern A2 or pattern B2, as appropriate.

Note.— An increased conspicuity of the runway-holding position can be required, notably to avoid incursion risks

9.2.2.10.8 **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.

9.2.2.10.9 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 ICAO Annex 14 Vol. I, Figure 5-8, pattern A2.

9.2.2.11 Intermediate holding position marking

Application and location

9.2.2.11.1 **Recommendation —** An intermediate holding position marking should be displayed along an intermediate holding position.

9.2.2.11.2 Not in use.

9.2.2.11.3 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.

9.2.2.11.4 Not in use.

Characteristics

9.2.2.11.5 An intermediate holding position marking shall consist of a single broken line as shown in ICAO Annex 14 Vol. I, Figure 5-6.

9.2.2.12 VOR aerodrome check-point marking

Application

9.2.2.12.1 When a VOR aerodrome check-point is established, it shall be indicated by a VOR aerodrome check-point marking and sign.

Note — See 9.2.4.4 for VOR aerodrome check-point sign.

9.2.2.12.2 Site selection

Note — Guidance on the selection of sites for VOR aerodrome check-points is given in ICAO Annex 10, Volume I, Attachment E.

Location

9.2.2.12.3 A VOR aerodrome check-point marking shall be centred on the spot at which an aircraft is to be parked to receive the correct VOR signal.

Characteristics

9.2.2.12.4 A VOR aerodrome check-point marking shall consist of a circle 6 m in diameter and have a line width of 15 cm (See ICAO Annex 14 Vol. I, Figure 5-9 (A)).

9.2.2.12.5 **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 ICAO Annex 14 Vol. I, Figure 5-9 (B)).

9.2.2.12.6 **Recommendation —** A VOR aerodrome check-point 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.

9.2.2.13 Aircraft stand markings

Note — Guidance on the layout of aircraft stand markings is contained in the ICAO Aerodrome Design Manual, Part 4.

Application

9.2.2.13.1 **Recommendation —** Aircraft stand markings should be provided for designated parking positions on a paved apron.

Location

9.2.2.13.2 **Recommendation —** Aircraft stand markings on a paved apron should be located so as to provide the clearances specified in paragraph 7.2.13.6 of this Manual, when the nose wheel follows the stand marking.

Characteristics

9.2.2.13.3 **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.

9.2.2.13.4 **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.

9.2.2.13.5 **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.

Note — Example: 2A-B747, 2B-F28.

9.2.2.13.6 **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.

9.2.2.13.7 **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.

9.2.2.13.8 **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.

9.2.2.13.9 **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.

Note — The distances to be maintained between the turn bar and the lead-in line may vary according to different aircraft types, taking into account the pilot's field of view.

9.2.2.13.10 **Recommendation —** If more than one turn bar and/or stop line is required, they should be coded.

9.2.2.13.11 **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.

9.2.2.13.12 **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 — The distances to be maintained between the stop line and the lead-in line may vary according to different aircraft types, taking into account the pilot's field of view.

9.2.2.14 Apron safety lines

Note — Guidance on apron safety lines is contained in the ICAO Aerodrome Design Manual, Part 4.

Application

9.2.2.14.1 **Recommendation —** Apron safety lines should be provided on a paved apron as required by the parking configurations and ground facilities.

Location

9.2.2.14.2 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.

Characteristics

9.2.2.14.3 **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.

9.2.2.14.4 **Recommendation —** An apron safety line should be continuous in length and at least 10 cm in width.

9.2.2.15 Road-holding position marking

Application

9.2.2.15.1 A road-holding position marking shall be provided at all road entrances to a runway.

Characteristics Location

9.2.2.15.2 The road-holding position marking shall be located across the road at the holding position.

9.2.2.15.3 The road-holding position marking shall be in accordance with the local road traffic regulations.

9.2.2.16 Mandatory instruction marking

Note — Guidance on mandatory instruction marking is given in the ICAO Aerodrome Design Manual, Part 4.

Application

9.2.2.16.1 Where it is impracticable to install a mandatory instruction sign in accordance with paragraph 9.2.4.2.1 of this Manual, a mandatory instruction marking shall be provided on the surface of the pavement.

9.2.2.16.2 **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

9.2.2.16.3 The mandatory instruction marking on taxiways, where the code letter is A, B, C, or D, shall be located across the taxiway equally placed about the taxiway centerline and on the holding side of the runway-holding position marking as shown in ICAO Annex 14, Vol. I, 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.

9.2.2.16.4 The mandatory instruction marking on taxiways, where the code letter E or F, 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 ICAO Annex 14 Vol. I, 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.

9.2.2.16.5 **Recommendation —** Except where operationally required, a mandatory instruction marking should not be located on a runway.

Characteristics

9.2.2.16.6 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.

9.2.2.16.7 A NO ENTRY marking shall consist of an inscription in white reading NO ENTRY on a red background.

9.2.2.16.8 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.

9.2.2.16.9 **Recommendation —** The character height should be 4 m for inscriptions where the code letter is C, D, E or F, and 2 m where the code letter is A or B. The inscriptions should be in the form and proportions shown in ICAO Annex 14 Vol. I, Appendix 3.

9.2.2.16.10 **Recommendation —** The background should be rectangular and extend a minimum of 0.5 m laterally and vertically beyond the extremities of the inscription.

9.2.2.17 Information marking

Note — Guidance on information marking is contained in the ICAO Aerodrome Design Manual (Doc 9157), Part 4.

Application

9.2.2.17.1 Where an information sign would normally be installed and is impractical to install, as determined by the aerodrome operator, an information marking shall be displayed on the surface of the pavement.

9.2.2.17.2 **Recommendation —** Where operationally required an information sign should be supplemented by an information marking.

9.2.2.17.3 **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.

9.2.2.17.4 **Recommendation —** An information (location) marking should be displayed on the pavement surface at regular intervals along taxiways of great length.

Location

9.2.2.17.5 **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

9.2.2.17.6 An information marking shall consist of:

a) an inscription in yellow upon a black background, when it replaces or supplements a location sign; and

b) an inscription in black upon a yellow background, when it replaces or supplements a direction or destination sign.

9.2.2.17.7 Where there is insufficient contrast between the marking background and the pavement surface, the marking shall include:

a) a black border where the inscriptions are in black; and

b) a yellow border where the inscriptions are in yellow.

9.2.2.17.8 **Recommendation —** The character height should be 4 m. The inscriptions should be in the form and proportions shown in ICAO Annex 14 Vol. I, Appendix 3.

Section 9.2.3 – Lights

9.2.3.1 General

Lights which may endanger the safety of aircraft

9.2.3.1.1 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

9.2.3.1.2 **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), and

— a laser-beam sensitive flight zone (LSFZ).

Note 1 — ICAO Annex 14 Vol. I, Figures 5-11, 5-12 and 5-13 may be used to determine the exposure levels and distances that adequately protect flights 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 air space, 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 Civil Aviation Authority and permission obtained.

Note 3 – The protected flight zones are established in order to mitigate the risks 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 ICAO Manual on Laser Emitters and Flights Safety (Doc 9815).

Note 5 – See also ICAO Annex 11 – Air Traffic Services, Chapter 2.

Note 6 – The establishment of the protected zones in Singapore is the responsibility of the CAAS' ANS Policy Branch.

Lights which may cause confusion

9.2.3.1.3 **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:

a) 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.

b) Instrument runway — code number 2 or 3:

   as in a), except that the length should be at least 3 000 m.

c) 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 13.2.9 for information regarding siting of equipment and installations on operational areas, and the ICAO Aerodrome Design Manual, Part 6 for guidance on frangibility of light fixtures and supporting structures.

Elevated approach lights

9.2.3.1.4 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:

a) where the height of a supporting structure exceeds 12 m, the frangibility requirement shall apply to the top 12 m only; and

b) 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.

9.2.3.1.5 Not in use.

9.2.3.1.6 When an approach light fixture or supporting structure is not in itself sufficiently conspicuous, it shall be suitably marked.

Elevated lights

9.2.3.1.7 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

9.2.3.1.8 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.

9.2.3.1.9 **Recommendation —** The temperature produced by conduction or radiation at the interface between an installed inset light and an aircraft tire should not exceed 160°C during a 10-minute period of exposure.

Note — Guidance on measuring the temperature of inset lights is given in the ICAO Aerodrome Design Manual, Part 4.

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 ICAO Annex 14 Vol. I, Attachment A, Section 14, and the ICAO Aerodrome Design Manual, Part 4)

9.2.3.1.10 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.

Note — While the lights of an approach lighting system may be of higher intensity than the runway lighting, it is good practice to avoid abrupt changes in intensity as these could give a pilot a false impression that the visibility is changing during approach.

9.2.3.1.11 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.

9.2.3.1.12 On the perimeter of and within the ellipse defining the main beam in ICAO Annex 14 Vol. 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 ICAO Annex 14 Vol. I, Appendix 2, collective notes for Figures A2-1 to A2-11, Note 2.

9.2.3.1.13 On the perimeter of and within the rectangle defining the main beam in ICAO Annex 14 Vol. 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 ICAO Annex 14 Vol. I, Appendix 2, collective notes for Figures A2-12 to A2-21, Note 2.

9.2.3.2 Emergency lighting

Application

9.2.3.2.1 **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.

Note — Emergency lighting may also be useful to mark obstacles or delineate taxiways and apron areas.

Location

9.2.3.2.2 **Recommendation —** When installed on a runway the emergency lights should, as a minimum, conform to the configuration required for a non-instrument runway.

Characteristics

9.2.3.2.3 **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.

9.2.3.3 Aeronautical beacons

Application

9.2.3.3.1 Where operationally necessary an aerodrome beacon or an identification beacon shall be provided at each aerodrome intended for use at night.

9.2.3.3.2 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

9.2.3.3.3 An aerodrome beacon shall be provided at an aerodrome intended for use at night if one or more of the following conditions exist:

a) aircraft navigate predominantly by visual means;

b) reduced visibilities are frequent; or

c) it is difficult to locate the aerodrome from the air due to surrounding lights or terrain.

Location

9.2.3.3.4 The aerodrome beacon shall be located on or adjacent to the aerodrome in an area of low ambient background lighting.

9.2.3.3.5 **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

9.2.3.3.6 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.

9.2.3.3.7 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 Aerodrome and ANS Regulation Division 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 required to be increased by a factor up to a value of 10.

Identification beacon

Application

9.2.3.3.8 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

9.2.3.3.9 The identification beacon shall be located on the aerodrome in an area of low ambient background lighting.

9.2.3.3.10 **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

9.2.3.3.11 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 Aerodrome and ANS Regulation Division 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 required to be increased by a factor up to a value of 10.

9.2.3.3.12 An identification beacon shall show flashing-green at a land aerodrome and flashing-yellow at a water aerodrome.

9.2.3.3.13 The identification characters shall be transmitted in the International Morse Code.

9.2.3.3.14 **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.

9.2.3.4 Approach lighting systems

Application

9.2.3.4.1 Application

A — Non-instrument runway

Recommendation — Where physically practicable, a simple approach lighting system as specified in paragraphs 9.2.3.4.2 to 9.2.3.4.9 of this Manual 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.

Note — A simple approach lighting system can also provide visual guidance by day.

B — Non-precision approach runway

Where physically practicable, a simple approach lighting system as specified in paragraphs 9.2.3.4.2 to 9.2.3.4.9 of this Manual 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.

Note — It is advisable to give consideration to the installation of a precision approach category I lighting system or to the addition of a runway lead-in lighting system.

C — Precision approach runway category I

Where physically practicable, a precision approach category I lighting system as specified in paragraphs 9.2.3.4.10 to 9.2.3.4.21 of this Manual 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 paragraphs 9.2.3.4.22 to 9.2.3.4.39 of this Manual shall be provided to serve a precision approach runway category II or III.

Simple approach lighting system

Location

9.2.3.4.2 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.

9.2.3.4.3 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.

Note 1 — Spacings for the crossbar lights between 1 m and 4 m are in use. Gaps on each side of the centre line may improve directional guidance when approaches are made with a lateral error, and facilitate the movement of rescue and fire fighting vehicles.

Note 2 — See ICAO Annex 14 Vol. I, Attachment A, Section 11 for guidance on installation tolerances.

9.2.3.4.4 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.

9.2.3.4.5 **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.

9.2.3.4.6 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

9.2.3.4.7 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.

Note 1 — When the barrette as in b) is composed of lights approximating to point sources, a spacing of 1.5 m between adjacent lights in the barrette has been found satisfactory.

Note 2 — It may be advisable to use barrettes 4 m in length if it is anticipated that the simple approach lighting system will be developed into a precision approach lighting system.

Note 3 — At locations where identification of the simple approach lighting system is difficult at night due to surrounding lights, sequence flashing lights installed in the outer portion of the system may resolve this problem.

9.2.3.4.8 **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.

9.2.3.4.9 **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

9.2.3.4.10 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.

Note — The installation of an approach lighting system of less than 900 m in length may result in operational limitations on the use of the runway. See ICAO Annex 14 Vol. I, Attachment A, Section 11.

9.2.3.4.11 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.

Note 1 — Spacings for the crossbar lights between 1 m and 4 m are in use. Gaps on each side of the centre line may improve directional guidance when approaches are made with a lateral error, and facilitate the movement of rescue and fire fighting vehicles.

Note 2 — See ICAO Annex 14 Vol. I, Attachment A, Section 11 for guidance on installation tolerances.

9.2.3.4.12 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.

9.2.3.4.13 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

9.2.3.4.14 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.

9.2.3.4.15 Where the serviceability level of the approach lights specified as a maintenance objective in 14.2.5.10 can be demonstrated, each centre line light position may consist of either:

a) a single light source; or

b) a barrette.

9.2.3.4.16 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.

9.2.3.4.17 **Recommendation —** If the centre line consists of barrettes as described in paragraph 9.2.3.4.14 b) or 9.2.3.4.15 b) of this Manual, each barrette 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.

9.2.3.4.18 Each flashing light as described in paragraph 9.2.3.4.17 of this Manual 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.

9.2.3.4.19 If the centre line consists of lights as described in paragraph 9.2.3.4.14 a) or 9.2.3.4.15 a) of this Manual, 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 ICAO Annex 14 Vol. I, Attachment A, Section 11 for detailed configuration.

9.2.3.4.20 Where the additional crossbars described in paragraph 9.2.3.4.19 of this Manual 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.

9.2.3.4.21 The lights shall be in accordance with the specifications of ICAO Annex 14 Vol. I, Appendix 2, Figure A2-1.

Note — The flight path envelopes used in the design of these lights are given in ICAO Annex 14 Vol. I, Attachment A, Figure A-4.

Precision approach category II and III lighting system

Location

9.2.3.4.22 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 ICAO Annex 14 Vol. I, Figure 5-14. Where the serviceability level of the approach lights specified as maintenance objectives in paragraph 14.2.5.7 of this Manual 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 ICAO Annex 14 Vol. I, Figure 5-15.

Note — The length of 900 m is based on providing guidance for operations under category I, II and III conditions. Reduced lengths may support category II and III operations but may impose limitations on category I operations. See ICAO Annex 14 Vol. I, Attachment A, Section 11.

9.2.3.4.23 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.

9.2.3.4.24 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 paragraph 14.2.5.7 of this Manual 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.

9.2.3.4.25 The crossbar provided at 150 m from the threshold shall fill in the gaps between the centre line and side row lights.

9.2.3.4.26 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.

9.2.3.4.27 If the centre line beyond a distance of 300 m from the threshold consists of lights as described in paragraph 9.2.3.4.31 b) or 9.2.3.4.32 b) of this Manual, additional crossbars of lights shall be provided at 450 m, 600 m and 750 m from the threshold.

9.2.3.4.28 Where the additional crossbars described in paragraph 9.2.3.4.27 of this Manual 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.

9.2.3.4.29 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.

Characteristics

9.2.3.4.30 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 paragraph 14.2.5.7 of this Manual can be demonstrated, 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 paragraph 9.2.3.4.32 a) of this Manual; 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 paragraph 9.2.3.4.32 b) of this Manual, 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.

9.2.3.4.31 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.

9.2.3.4.32 Where the serviceability level of the approach lights specified as maintenance objectives in paragraph 14.2.5.7 of this Manual 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.

9.2.3.4.33 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.

9.2.3.4.34 **Recommendation —** If the centre line beyond 300 m from the threshold consists of barrettes as described in paragraph 9.2.3.4.31 a) or 9.2.3.4.32 a) of this Manual, 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.

9.2.3.4.35 Each flashing light as described in paragraph 9.2.3.4.34 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.

9.2.3.4.36 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.

9.2.3.4.37 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.

9.2.3.4.38 The intensity of the red lights shall be compatible with the intensity of the white lights.

9.2.3.4.39 The lights shall be in accordance with the specifications of ICAO Annex 14 Vol. I, Appendix 2, Figures A2-1 and A2-2.

Note — The flight path envelopes used in the design of these lights are given in ICAO Annex 14 Vol. I, Attachment A, Figure A-4.

9.2.3.5 Visual approach slope indicator systems

Application

9.2.3.5.1 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.

Note — Guidance on the priority of installation of visual approach slope indicator systems is contained in ICAO Annex 14 Vol. I, Attachment A, Section 12.

9.2.3.5.2 The standard visual approach slope indicator systems shall consist of the following:

a) T-VASIS and AT-VASIS conforming to the specifications contained in 9.2.3.5.6 to 9.2.3.5.22 inclusive;

b) PAPI and APAPI systems conforming to the specifications contained in 9.2.3.5.23 to 9.2.3.5.40 inclusive;

as shown in ICAO Annex 14 Vol. I, Figure 5-16.

9.2.3.5.3 PAPI, T-VASIS or AT-VASIS shall be provided where the code number is 3 or 4 when one or more of the conditions specified in paragraph 9.2.3.5.1 of this Manual exist.

9.2.3.5.4 PAPI or APAPI shall be provided where the code number is 1 or 2 when one or more of the conditions specified in paragraph 9.2.3.5.1 of this Manual exist.

9.2.3.5.5 **Recommendation —** Where a runway threshold is temporarily displaced from the normal position and one or more of the conditions specified in paragraph 9.2.3.5.1 of this Manual exist, a PAPI should be provided except that where the code number is 1 or 2 an APAPI may be provided.

T-VASIS and AT-VASIS

Description

9.2.3.5.6 The T-VASIS shall consist of twenty light units symmetrically disposed about the runway centre line in the form of two wing bars of four light units each, with bisecting longitudinal lines of six lights, as shown in ICAO Annex 14 Vol. I, Figure 5-17.

9.2.3.5.7 The AT-VASIS shall consist of ten light units arranged on one side of the runway in the form of a single wing bar of four light units with a bisecting longitudinal line of six lights.

9.2.3.5.8 The light units shall be constructed and arranged in such a manner that the pilot of an aeroplane during an approach will:

a) when above the approach slope, see the wing bar(s) white, and one, two or three fly-down lights, the more fly-down lights being visible the higher the pilot is above the approach slope;

b) when on the approach slope, see the wing bar(s) white; and

c) when below the approach slope, see the wing bar(s) and one, two or three fly-up lights white, the more fly-up lights being visible the lower the pilot is below the approach slope; and when well below the approach slope, see the wing bar(s) and the three fly-up lights red.

When on or above the approach slope, no light shall be visible from the fly-up light units; when on or below the approach slope, no light shall be visible from the fly-down light units.

Siting

9.2.3.5.9 The light units shall be located as shown in ICAO Annex 14 Vol. I, Figure 5-17, subject to the installation tolerances given therein.

Note — The siting of T-VASIS will provide, for a 3° slope and a nominal eye height over the threshold of 15 m (See paragraphs 9.2.3.5.6 and 9.2.3.5.19 of this Manual), a pilot's eye height over threshold of 13m to 17 m when only the wing bar lights are visible. If increased eye height at the threshold is required (to provide adequate wheel clearance), then the approaches may be flown with one or more fly-down lights visible. The pilot's eye height over the threshold is then of the following order:

Wing bar lights and one fly-down light visible	17 m to 22 m
Wing bar lights and two fly-down lights visible	22 m to 28 m
Wing bar lights and three fly-down lights visible	28 m to 54 m

Characteristics of the light units

9.2.3.5.10 The systems shall be suitable for both day and night operations.

9.2.3.5.11 The light distribution of the beam of each light unit shall be of fan shape showing over a wide arc in azimuth in the approach direction.

The wing bar light units shall produce a beam of white light from 1°54’ vertical angle up to 6° vertical angle and a beam of red light from 0° to 1°54’ vertical angle. The fly-down light units shall produce a white beam extending from an elevation of 6° down to approximately the approach slope, where it shall have a sharp cut-off. The fly-up light units shall produce a white beam from approximately the approach slope down to 1°54’ vertical angle and a red beam below a 1°54’ vertical angle. The angle of the top of the red beam in the wing bar units and fly-up units may be increased to comply with paragraph 9.2.3.5.21 of this Manual.

9.2.3.5.12 The light intensity distribution of the fly-down, wing bar and fly-up light units shall be as shown in ICAO Annex 14 Vol. I, Appendix 2, Figure A2-22.

9.2.3.5.13 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 over a vertical angle of not more than 15’.

9.2.3.5.14 At full intensity the red light shall have a Y coordinate not exceeding 0.320.

9.2.3.5.15 A suitable intensity control shall be provided to allow adjustments to meet the prevailing conditions and to avoid dazzling the pilot during approach and landing.

9.2.3.5.16 The light units forming the wing bars, or the light units forming a fly-down or a fly-up matched pair, 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.

9.2.3.5.17 The light units shall be so designed that deposits of condensation, dirt, etc., on optically transmitting or reflecting surfaces shall interfere to the least possible extent with the light signals and shall in no way affect the elevation of the beams or the contrast between the red and white signals. The construction of the light units shall be such as to minimize the probability of the slots being wholly or partially blocked by snow or ice where these conditions are likely to be encountered.

Approach slope and elevation setting of light beams

9.2.3.5.18 The approach slope shall be appropriate for use by the aeroplanes using the approach.

9.2.3.5.19 When the runway on which a T-VASIS is provided is equipped with an ILS and/or MLS, the siting and elevations 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.

9.2.3.5.20 The elevation of the beams of the wing bar light units on both sides of the runway shall be the same. The elevation of the top of the beam of the fly-up light unit nearest to each wing bar, and that of the bottom of the beam of the fly-down light unit nearest to each wing bar, shall be equal and shall correspond to the approach slope. The cut-off angle of the top of the beams of successive fly-up light units shall decrease by 5' of arc in angle of elevation at each successive unit away from the wing bar. The cut-in angle of the bottom of the beam of the fly-down light units shall increase by 7' of arc at each successive unit away from the wing bar (See ICAO Annex 14 Vol. I, Figure 5-18).

9.2.3.5.21 The elevation setting of the top of the red light beams of the wing bar and fly-up light units shall be such that, during an approach, the pilot of an aeroplane to whom the wing bar and three fly-up light units are visible would clear all objects in the approach area by a safe margin if any such light did not appear red.

9.2.3.5.22 The azimuth spread of the light beam shall be suitably restricted where an object located outside the obstacle protection surface of the 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.

Note — See paragraphs 9.2.3.5.41 to 9.2.3.5.45 of this Manual concerning the related obstacle protection surface.

PAPI and APAPI

Description

9.2.3.5.23 The PAPI system shall consist of a wing bar of 4 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.

Note — Where a runway is used by aircraft requiring visual roll guidance which is not provided by other external means, then a second wing bar may be provided on the opposite side of the runway.

9.2.3.5.24 The APAPI system shall consist of a wing bar of 2 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.

Note — Where a runway is used by aircraft requiring visual roll guidance which is not provided by other external means, then a second wing bar may be provided on the opposite side of the runway.

9.2.3.5.25 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.

9.2.3.5.26 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

9.2.3.5.27 The light units shall be located as in the basic configuration illustrated in ICAO Annex 14 Vol. I, 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.

Characteristics of the light units

9.2.3.5.28 The system shall be suitable for both day and night operations.

9.2.3.5.29 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'.

9.2.3.5.30 At full intensity the red light shall have a Y coordinate not exceeding 0.320.

9.2.3.5.31 The light intensity distribution of the light units shall be as shown in ICAO Annex 14 Vol. I, Appendix 2, Figure A2-23.

Note — See the ICAO Aerodrome Design Manual, Part 4 for additional guidance on the characteristics of light units.

9.2.3.5.32 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.

9.2.3.5.33 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.

9.2.3.5.34 The light units shall be so designed that deposits of condensation, dirt, 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

9.2.3.5.35 The approach slope as defined in ICAO Annex 14 Vol. I, Figure 5-20 shall be appropriate for use by the aeroplanes using the approach.

9.2.3.5.36 When the runway is equipped with an ILS and/or MLS, the siting 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.

9.2.3.5.37 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.

9.2.3.5.38 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.

9.2.3.5.39 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.

Note — See paragraphs 9.2.3.5.41 to 9.2.3.5.45 concerning the related obstacle protection surface.

9.2.3.5.40 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 T-VASIS, AT-VASIS, PAPI and APAPI.

9.2.3.5.41 An obstacle protection surface shall be established when it is intended to provide a visual approach slope indicator system.

9.2.3.5.42 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 9-3 and in ICAO Annex 14 Vol. I, Figure 5-21.

Table 9-3 – Dimensions and slopes of the obstacles protection surface

Surface dimensions	Runway type/code number							
	Non-instrument				Instrument			
	Code number				Code number			
	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 the visual approach slope indicator system (e)	D_1 + 30 m	D_1 + 60 m	D_1 + 60 m	D_1 + 60 m	D_1 + 60 m	D_1 + 60 m	D_1 + 60 m	D_1 + 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 and AT-VASIS.

b. This length is to be increased to 15 000 m for a T-VASIS and 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 ICAO Annex 14 Vol. I Figure 5-19.

e. D1 is the distance of the visual approach slope indicator system from threshold prior to any displacement to remedy object penetration of the obstacle protection surface (refer to ICAO Annex 14, Vol. 1, Figure 5-19). The start of the obstacle protection surface is fixed to the visual approach slope indicator system location, such that displacement of the PAPI results in an equal displacement of the start of the obstacle protection surface. See 9.2.3.5.45(e).

9.2.3.5.43 New objects or extensions of existing objects shall not be permitted above an obstacle protection surface except when, in the opinion of the Aerodrome and ANS Regulation Division, the new object or extension would be shielded by an existing immovable object.

Note — Circumstances in which the shielding principle may reasonably be applied are described in the ICAO Airport Services Manual, Part 6.

9.2.3.5.44 Existing objects above an obstacle protection surface shall be removed except when, in the opinion of the Aerodrome and ANS Regulation Division, 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.

9.2.3.5.45 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) remove the object;

b) suitably raise the approach slope of the system;

c) reduce the azimuth spread of the system so that the object is outside the confines of the beam;

d) displace the axis of the system and its associated obstacle protection surface by no more than 5°; and

e) suitably displace the system upwind of the threshold such that the object no longer penetrates the obstacle protection surface.

Note 1 — Guidance on this issue is contained in the ICAO Aerodrome Design Manual, Part 4.

Note 2.— The displacement of the system upwind of the threshold reduces the operational landing distance.

9.2.3.6 Circling guidance lights

Application

9.2.3.6.1 **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

9.2.3.6.2 **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.

9.2.3.6.3 **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 ICAO Aerodrome Design Manual, Part 4.

Characteristics

9.2.3.6.4 **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.

9.2.3.6.5 **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.

9.2.3.7 Runway lead-in lighting systems

Application

9.2.3.7.1 **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, Part 4.

Location

9.2.3.7.2 **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.

Note — Runway lead-in lighting systems may be curved, straight or a combination thereof.

9.2.3.7.3 **Recommendation —** A runway lead-in lighting system should extend from a point as determined by the Aerodrome and ANS Regulation Division, up to a point where the approach lighting system, if provided, or the runway or the runway lighting system is in view.

Characteristics

9.2.3.7.4 **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.

9.2.3.7.5 **Recommendation —** The flashing lights should be white, and the steady burning lights gaseous discharge lights.

9.2.3.7.6 **Recommendation —** Where practicable, the flashing lights in each group should flash in sequence towards the runway.

9.2.3.8 Runway threshold identification lights

Application

9.2.3.8.1 **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

9.2.3.8.2 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

9.2.3.8.3 **Recommendation —** Runway threshold identification lights should be flashing white lights with a flash frequency between 60 and 120 per minute.

9.2.3.8.4 The lights shall be visible only in the direction of approach to the runway.

9.2.3.9 Runway edge lights

Application

9.2.3.9.1 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.

9.2.3.9.2 **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

9.2.3.9.3 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.

9.2.3.9.4 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.

9.2.3.9.5 **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.

9.2.3.9.6 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

9.2.3.9.7 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.

9.2.3.9.8 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 paragraph 9.2.3.6.1 of this Manual).

9.2.3.9.9 In all angles of azimuth required in paragraph 9.2.3.9.8 of this Manual, 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.

9.2.3.9.10 Runway edge lights on a precision approach runway shall be in accordance with the specifications of ICAO Annex 14 Vol. I, Appendix 2, Figure A2-9 or A2-10.

9.2.3.10 Runway threshold and wing bar lights

(See ICAO Annex 14 Vol. I, Figure 5-22)

Application of runway threshold lights

9.2.3.10.1 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

9.2.3.10.2 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.

9.2.3.10.3 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.

9.2.3.10.4 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.

9.2.3.10.5 **Recommendation —** The lights prescribed in paragraph 9.2.3.10.4 a) and b) of this Manual 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

9.2.3.10.6 **Recommendation —** Wing bar lights should be provided on a precision approach runway when additional conspicuity is considered desirable.

9.2.3.10.7 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

9.2.3.10.8 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.

Characteristics of runway threshold and wing bar lights

9.2.3.10.9 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.

9.2.3.10.10 Runway threshold lights on a precision approach runway shall be in accordance with the specifications of ICAO Annex 14 Vol. I, Appendix 2, Figure A2-3.

9.2.3.10.11 Threshold wing bar lights on a precision approach runway shall be in accordance with the specifications of ICAO Annex 14 Vol. I, Appendix 2, Figure A2-4.

9.2.3.11 Runway end lights

(See ICAO Annex 14 Vol. I, Figure 5-22)

Application

9.2.3.11.1 Runway end lights shall be provided for a run-way equipped with runway edge lights.

Note — When the threshold is at the runway extremity, fittings serving as threshold lights may be used as runway end lights.

Location

9.2.3.11.2 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.

9.2.3.11.3 **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

9.2.3.11.4 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.

9.2.3.11.5 Runway end lights on a precision approach run-way shall be in accordance with the specifications of ICAO Annex 14 Vol. I, Appendix 2, Figure A2-8.

9.2.3.12 Runway centre line lights

Application

9.2.3.12.1 Runway centre line lights shall be provided on a precision approach runway category II or III.

9.2.3.12.2 **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.

9.2.3.12.3 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.

9.2.3.12.4 **Recommendation —** Runway centre line lights should be provided on a runway intended to be used for take-off with an operating minimum of an RVR of the order of 400 m or higher when used by aeroplanes with a very high take-off speed, particularly where the width between the runway edge lights is greater than 50 m.

Location

9.2.3.12.5 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 paragraph 14.2.5.7 or 14.2.5.11 of this Manual, as appropriate, can be demonstrated and the runway is intended for use in runway visual range conditions of 350 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.

9.2.3.12.6 **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 length and spaced at uniform intervals of 30 m, as shown in ICAO Annex 14 Vol. I, 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

9.2.3.12.7 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 mid-point of the runway usable for landing to 300 m from the runway end.

Note — Care is required in the design of the electrical system to ensure that failure of part of the electrical system will not result in a false indication of the runway distance remaining.

9.2.3.12.8 Runway centre line lights shall be in accordance with the specifications of ICAO Annex 14 Vol. I, Appendix 2, Figure A2-6 or A2-7.

9.2.3.13 Runway touchdown zone lights

Application

9.2.3.13.1 Touchdown zone lights shall be provided in the touchdown zone of a precision approach runway category II or III.

Location

9.2.3.13.2 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.

Note — To allow for operations at lower visibility minima, it may be advisable to use a 30 m longitudinal spacing between barrettes.

Characteristics

9.2.3.13.3 A barrette shall be composed of at least three lights with a spacing between the lights of not more than 1.5m.

9.2.3.13.4 **Recommendation —** A barrette should be not less than 3 m nor more than 4.5 m in length.

9.2.3.13.5 Touchdown zone lights shall be fixed unidirectional lights showing variable white.

9.2.3.13.6 Touchdown zone lights shall be in accordance with the specifications of ICAO Annex 14 Vol. I, Appendix 2, Figure A2-5.

9.2.3.14 Not in use.

9.2.3.15 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

9.2.3.15.1 **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 350 m and/or where the traffic density is heavy.

Note – See ICAO Annex 14, Vol. I, Attachment A, Section 14

9.2.3.15.2 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 ICAO Annex 14, Vol. I, Figure 5-25, in full.

Location

9.2.3.15.3 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 ICAO Annex 14, Vol.1, 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.

9.2.3.15.4 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.

Characteristics

9.2.3.15.5 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.

9.2.3.15.6 Rapid exit taxiway indicator lights shall be in accordance with the specifications in ICAO Annex 14, Vol.1, Appendix 2, Figure A2-6 or Figure A2-7, as appropriate.

9.2.3.15.7 **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.

9.2.3.16 Stopway lights

Application

9.2.3.16.1 Stopway lights shall be provided for a stopway intended for use at night.

Location

9.2.3.16.2 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

9.2.3.16.3 Stopway lights shall be fixed unidirectional lights showing red in the direction of the runway.

9.2.3.17 Taxiway centre line lights

Application

9.2.3.17.1 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 350 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.

9.2.3.17.2 **Recommendation —** Taxiway centre line lights should be provided on a taxiway intended for use at night in runway visual range conditions of 350 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.

Note — Where there may be a need to delineate the edges of a taxiway, e.g. on a rapid exit taxiway or narrow taxiway, this may be done with taxiway edge lights or markers.

9.2.3.17.3 **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.

Note — Guidance on installation of taxiway centre line lights in surface movement guidance and control systems is given in the ICAO Aerodrome Design Manual (Doc 9157), Part 4 and the Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual (Doc 9830).

9.2.3.17.4 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 350 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 paragraph 12.2.2.3 of this Manual for provisions concerning the interlocking of runway and taxiway lighting systems.

9.2.3.17.5 **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.

Note — Guidance on installation of taxiway centre line lights in surface movement guidance and control systems is given in the ICAO Aerodrome Design Manual (Doc 9157), Part 4 and the Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual (Doc 9830).

Characteristics

9.2.3.17.6 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.

9.2.3.17.7 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 (See ICAO Annex 14 Vol. I, 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.

Note 1 — Care is necessary to limit the light distribution of green lights on or near a runway so as to avoid possible confusion with threshold lights.

Note 2 — For yellow filter characteristics see ICAO Annex 14 Vol. I, Appendix 1, 2.2.

Note 3 — The size of the ILS/MLS critical/sensitive area depends on the characteristics of the associated ILS/MLS and other factors. Guidance is provided in ICAO Annex 10, Volume I, Attachments C and G.

Note 4 — See paragraph 9.2.4.3 for specifications on runway vacated signs.

9.2.3.17.8 **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.

Note 1.— Care is necessary to limit the light distribution of green lights on or near a runway so as to avoid possible confusion with threshold lights.

Note 2.— The provisions of 9.2.3.17.8 can form part of effective runway incursion prevention measures

9.2.3.17.9 Taxiway centre line lights shall be in accordance with the specifications of:

a) ICAO Annex 14 Vol. I, Appendix 2, Figure A2-12, A2-13, or A2-14 for taxiways intended for use in runway visual range conditions of less than a value of 350 m; and

b) ICAO Annex 14 Vol. I, Appendix 2, Figure A2-15 or A2-16 for other taxiways.

9.2.3.17.10 **Recommendation —** Where higher intensities are required, from an operational point of view, taxiway centre line lights on rapid taxiways intended for use in runway visual range conditions less than a value of 350 m should be in accordance with the specifications of ICAO Annex 14, Vol.1, Appendix 2, Figure A2-12. The number of levels of brilliancy settings for these lights should be the same as that for the runway centre line lights.

9.2.3.17.11 **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 ICAO Annex 14 Vol. I, Appendix 2, Figure A2-17, A2-18 or A2-19.

Note — High-intensity centre line lights should only be used in case of an absolute necessity and following a specific study.

Location

9.2.3.17.12 **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

9.2.3.17.13 **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 350 m, the longitudinal spacing should not exceed 15 m.

9.2.3.17.14 **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.

9.2.3.17.15 **Recommendation —** On a taxiway intended for use in RVR conditions of less than a value of 350 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 350 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 paragraph 7.2.9.6 of this Manual and ICAO Annex 14 Vol.I, Figure 3-2.

Taxiway centre line lights on rapid exit taxiways

Location

9.2.3.17.16 **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 ICAO Annex 14 Vol. I, Figure 5-27.

9.2.3.17.17 **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

9.2.3.17.18 **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 ICAO Annex 14 Vol. I, Figure 5-27.

9.2.3.17.19 **Recommendation —** The lights should be spaced at longitudinal intervals of not more than 7.5 m.

Taxiway centre line lights on runways

Location

9.2.3.17.20 **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 350 m should be spaced at longitudinal intervals not exceeding 15 m.

9.2.3.18 Taxiway edge lights

Application

9.2.3.18.1 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.

Note — See paragraph 9.2.5.5 of this Manual for taxiway edge markers.

9.2.3.18.2 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.

Note — See paragraph 12.2.2.3 of this Manual for provisions concerning the inter-locking of runway and taxiway lighting systems.

Location

9.2.3.18.3 **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 Aerodrome Design Manual, Part 4.

9.2.3.18.4 **Recommendation —** Taxiway edge lights on a holding bay, apron, etc. should be spaced at uniform longitudinal intervals of not more than 60 m.

9.2.3.18.5 **Recommendation —** Taxiway edge lights on a runway turn pad should be spaced at uniform longitudinal intervals of not more than 30m.

9.2.3.18.6 **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

9.2.3.18.7 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.

9.2.3.18.8 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°.

9.2.3.19 Runway turn pad lights

Application

9.2.3.19.1 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 350 m, to enable an aeroplane to complete a 180-degree turn and align with the runway centre line.

9.2.3.19.2 **Recommendation –** Runway turn pad lights should be provided on a runway turn pad intended for use at night.

Location

9.2.3.19.3 **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.

9.2.3.19.4 **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.

9.2.3.19.5 **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

9.2.3.19.6 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.

9.2.3.19.7 Runway turn pad lights shall be in accordance with the specifications of ICAO Annex 14, Vol. I, Appendix 2, Figure A2-13, A2-14 or A2-15, as appropriate.

9.2.3.20 Stop bars

Application

Note 1 — A stop bar is intended to be controlled either manually or automatically by the 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 in visibility conditions greater than 550 m runway visual range can form part of effective runway incursion prevention measures.

9.2.3.20.1 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 350 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.

9.2.3.20.2 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 of values between 350 m and 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.

9.2.3.20.3 Where there is more than one stop bar associated with a taxiway/runway intersection, only one shall be illuminated at any given time.

9.2.3.20.4 **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.

9.2.3.20.5 **Recommendation —** Where the normal 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, then a pair of elevated lights should be added to each end of the stop bar.

Location

9.2.3.20.6 Stop bars shall be located across the taxiway at the point where it is desired that traffic stop. Where the additional lights specified in paragraph 9.2.3.20.5 of this Manual are provided, these lights shall be located not less than 3 m from the taxiway edge.

Characteristics

9.2.3.20.7 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.

Note – Where necessary to enhance conspicuity of an existing stop bar, extra lights are installed uniformly.

9.2.3.20.8 Stop bars installed at a runway-holding position shall be unidirectional and shall show red in the direction of approach to the runway.

9.2.3.20.9 Where the additional lights specified in paragraph 9.2.3.20.5 of this Manual 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.

9.2.3.20.10 The intensity in red light and beam spreads of stop bar lights shall be in accordance with the specifications in ICAO Annex 14 Vol. I, Appendix 2, Figures A2-12 through A2-16, as appropriate.

9.2.3.20.11 **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 ICAO Annex 14 Vol. I, Appendix 2, Figure A2-17, A2-18 or A2-19.

Note — High-intensity stop bars should only be used in case of an absolute necessity and following a specific study.

9.2.3.20.12 **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 ICAO Annex 14 Vol. I, Appendix 2, Figure A2-17 or A2-19.

9.2.3.20.13 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.

Note — Care is required in the design of the electrical system to ensure that all of the lights of a stop bar will not fail at the same time. Guidance on this issue is given in the ICAO Aerodrome Design Manual, Part 5.

9.2.3.21 Intermediate holding position lights

Note — See paragraph 9.2.2.11 of this Manual for specifications on intermediate holding position marking.

Application

9.2.3.21.1 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 350 m.

9.2.3.21.2 **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

9.2.3.21.3 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

9.2.3.21.4 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.

9.2.3.22 Not in use

9.2.3.23 Runway guard lights

Note — The purpose of runway guard lights is to warn pilots, and drivers of vehicles when they are operating on taxiways that that are about to enter a runway. There are two standard configurations of runway guard lights as illustrated in ICAO Annex 14, Vol. I, Figure 5-29.

Application

9.2.3.23.1 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.

9.2.3.23.2 **Recommendation —** Runway guard lights, Configuration A, should be provided at each taxiway/runway intersection associated with a runway intended for use in:

a) runway visual range conditions of values less than a value of 550 m where a stop bar is installed; and

b) runway visual range conditions of values between 550 m and 1 200 m where the traffic density is medium or light.

9.2.3.23.3 **Recommendation —** Runway guard lights, Configuration A or Configuration B or both, should be provided at each taxiway/runway intersection where enhanced conspicuity of the taxiway/runway intersection is needed, such as on a wide-throat taxiway, except that Configuration B should not be collocated with a stop bar.

Location

9.2.3.23.4 Runway guard lights, Configuration A, shall be located at each side of the taxiway at a distance from the runway centre line not less than that specified for a take-off runway in Table 7-2 of this Manual.

9.2.3.23.5 Runway guard lights, Configuration B, shall be located across the taxiway at a distance from the runway centre line not less than that specified for a take-off runway in Table 7-2 of this Manual.

Characteristics

9.2.3.23.6 Runway guard lights, Configuration A, shall consist of two pairs of yellow lights.

9.2.3.23.7 **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.

Note — Some other device or design, e.g. specially designed optics, may be used in lieu of the visor.

9.2.3.23.8 Runway guard lights, Configuration B, shall consist of yellow lights spaced at intervals of 3 m across the taxiway.

9.2.3.23.9 The light beam shall be unidirectional and aligned so as to be visible to the pilot of an aeroplane taxiing to the holding position.

9.2.3.23.10 **Recommendation —** The intensity in yellow light and beam spreads of lights of Configuration A should be in accordance with the specifications in ICAO Annex 14 Vol. I, Appendix 2, Figure A2-24.

9.2.3.23.11 **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 ICAO Annex 14 Vol. I, Appendix 2, Figure A2-25.

9.2.3.23.12 **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 ICAO Annex 14 Vol. I, Appendix 2, Figure A2-25.

Note — Higher light intensities may be required to maintain ground movement at a certain speed in low visibilities.

9.2.3.23.13 **Recommendation —** The intensity in yellow light and beam spreads of lights of Configuration B should be in accordance with the specifications in ICAO Annex 14 Vol. I, Appendix 2, Figure A2-12.

9.2.3.23.14 **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 ICAO Annex 14 Vol. I, Appendix 2, Figure A2-20.

9.2.3.23.15 **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 ICAO Annex 14 Vol. I, Appendix 2, Figure A2-20.

9.2.3.23.16 The lights in each unit of Configuration A shall be illuminated alternately.

9.2.3.23.17 For Configuration B, adjacent lights shall be alternately illuminated and alternative lights shall be illuminated in unison.

9.2.3.23.18 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.

Note — The optimum flash rate is dependent on the rise and fall times of the lamps used. Runway guard lights, Configuration A, installed on 6.6 ampere series circuits have been found to look best when operated at 45 to 50 flashes per minute per lamp. Runway guard lights, Configuration B, installed on 6.6 ampere series circuits have been found to look best when operated at 30 to 32 flashes per minute per lamp.

9.2.3.24 Apron floodlighting

(See also paragraphs 9.2.3.17.1 and 9.2.3.18.1 of this Manual)

Application

9.2.3.24.1 **Recommendation —** Apron floodlighting should be provided on an apron and on a designated isolated aircraft parking position intended to be used at night.

Note 1 — Not in use.

Note 2 — The designation of an isolated aircraft parking position is specified in paragraph 7.2.14 of this Manual.

Note 3 — Guidance on apron floodlighting is given in the ICAO Aerodrome Design Manual, Part 4.

Location

9.2.3.24.2 **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

9.2.3.24.3 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.

9.2.3.24.4 **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.

9.2.3.25 Visual docking guidance system

Application

9.2.3.25.1 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.

Note — The factors to be considered in evaluating the need for a visual docking guidance system are in particular: the number and type(s) of aircraft using the aircraft stand, weather conditions, space available on the apron and the precision required for manoeuvring into the parking position due to aircraft servicing installation, passenger loading bridges, etc. See the ICAO Aerodrome Design Manual, Part 4 — Visual Aids for guidance on the selection of suitable systems.

Characteristics

9.2.3.25.2 The system shall provide both azimuth and stopping guidance.

9.2.3.25.3 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.

Note — Care is required in both the design and on-site installation of the system to ensure that reflection of sunlight, or other light in the vicinity, does not degrade the clarity and conspicuity of the visual cues provided by the system.

9.2.3.25.4 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.

9.2.3.25.5 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.

9.2.3.25.6 The accuracy of the system shall be adequate for the type of loading bridge and fixed aircraft servicing installations with which it is to be used.

9.2.3.25.7 **Recommendation —** The system should be usable by all types of aircraft for which the aircraft stand is intended, preferably without selective operation.

9.2.3.25.8 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

9.2.3.25.9 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.

9.2.3.25.10 **Recommendation —** The azimuth guidance unit should be aligned for use by the pilots occupying both the left and right seats.

Characteristics

9.2.3.25.11 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.

9.2.3.25.12 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

9.2.3.25.13 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.

9.2.3.25.14 The stopping position indicator shall be usable at least by the pilot occupying the left seat.

9.2.3.25.15 **Recommendation —** The stopping position indicator should be usable by the pilots occupying both the left and right seats.

Characteristics

9.2.3.25.16 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.

9.2.3.25.17 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.

9.2.3.25.18 **Recommendation —** The stopping position indicator should provide closing rate information over a distance of at least 10 m.

9.2.3.25.19 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.

9.2.3.26 Advanced visual docking guidance system

Application

Note 1 — Advanced visual docking guidance systems (A-VDGS) include those systems that, in addition to basic and passive azimuth and stop position information, provide pilots with active (usually sensor-based) guidance information, such as aircraft type indication (in accordance with ICAO Document 8643), distance-to-go information and closing speed. Docking guidance information is usually provided on a single display unit.

Note 2 — An A-VDGS may provide docking guidance information in three stages: the acquisition of the aircraft by the system, the azimuth alignment of the aircraft, and the stopping position information.

9.2.3.26.1 **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.

9.2.3.26.2 The A-VDGS shall be suitable for use by all types of aircraft for which the aircraft stand is intended.

9.2.3.26.3 The A-VDGS shall only be used in conditions in which its operational performance is specified.

Note 1 — The use of the A-VDGS in conditions such as weather, visibility, and background lighting both by day and night would need to be specified.

Note 2 — Care is required in both the design and on-site installation of the system to ensure that glare, reflection of sunlight, or other light in the vicinity, does not degrade the clarity and conspicuity of the visual cues provided by the system.

9.2.3.26.4 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 unserviceable, shall be provided.

Location

9.2.3.26.5 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.

Note— Usually the pilot-in-command is responsible for the docking of the aircraft. However, in some circumstances, another person could be responsible and this person may be the driver of a vehicle that is towing the aircraft.

Characteristics

9.2.3.26.6 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.

9.2.3.26.7 The A-VDGS shall be capable of providing docking guidance information for all aircraft taxi speeds encountered during the docking manoeuvre.

Note — See the Aerodrome Design Manual, Part 4, for an indication of the maximum aircraft speeds relative to distance to the stopping position.

9.2.3.26.8 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 centreline greater than 1 m.

9.2.3.26.9 **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 9.4.

Table 9.4 - Recommended displacement accuracy

Guidance information	**max. deviation at stop position (stop area)**	**max. deviation at 9 m from stop position**	**max. deviation at 15 m from stop position**	**max. deviation at 25 m from stop position**
Azimuth	±250 mm	±340 mm	±400 mm	±500 mm
Distance	±500 mm	±1000 mm	±1300 mm	Not specified

9.2.3.26.10 Symbols and graphics used to depict guidance information shall be intuitively representative of the type of information provided.

Note— The use of colour would need to be appropriate and need to follow signal convention, i.e. red, yellow and green mean hazard, caution and normal/correct conditions, respectively. The effects of colour contrasts would also need to be considered.

9.2.3.26.11 Information on the lateral displacement of the aircraft relative to the stand centre line shall be provided at least 25m prior to the stop position.

Note — The indication of the distance of the aircraft from the stop position may be colour-coded and presented at a rate and distance proportional to the actual closure rate and distance of the aircraft approaching the stop point.

9.2.3.26.12 Continuous closure distance and closure rate shall be provided from at least 15 m prior to the stop position.

9.2.3.26.13 **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.

9.2.3.26.14 Throughout the docking manoeuvre, an appropriate means shall be provided on the AVDGS 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.

9.2.3.26.15 Provision to initiate an immediate halt to the docking procedure shall be made available to personnel responsible for the operational safety of the stand.

9.2.3.26.16 **Recommendation —** The word “STOP” in red characters should be displayed when an immediate cessation of the docking manoeuvre is required.

9.2.3.27 Aircraft stand manoeuvring guidance lights

Application

9.2.3.27.1 **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

9.2.3.27.2 Aircraft stand manoeuvring guidance lights shall be collocated with the aircraft stand markings.

Characteristics

9.2.3.27.3 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.

9.2.3.27.4 **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.

9.2.3.27.5 The lights indicating a stop position shall be fixed, unidirectional lights, showing red.

9.2.3.27.6 **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.

9.2.3.27.7 **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.

9.2.3.28 Road-holding position light

Application

9.2.3.28.1 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 350 m.

9.2.3.28.2 **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 350 m and 550 m.

Location

9.2.3.28.3 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 regulations.

Note — See paragraph 13.2.9 of this Manual for the mass and height limitations and frangibility requirements of navigation aids located on runway strips.

Characteristics

9.2.3.28.4 The road-holding position light shall comprise:

a) a controllable red (stop)/green (go) traffic light; or

b) a flashing-red light.

Note — It is intended that the lights specified in sub-paragraph a) be controlled by the air traffic services.

9.2.3.28.5 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.

9.2.3.28.6 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.

Note — The commonly used traffic lights are likely to meet the requirements in paragraphs 9.2.3.28.5 and 9.2.3.28.6.

9.2.3.28.7 The flash frequency of the flashing-red light shall be between 30 and 60 per minute.

9.2.3.29 Not in use.

9.2.3.30 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 may be installed by itself, but the two components are designed to be complementary to each other.

Location

9.2.3.30.1 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.

9.2.3.30.2 RELs shall consist of at least five light units and shall be spaced at a minimum of 3.8m and a maximum of 15.2m longitudinally, depending upon the taxiway length involved, except for a single light installed near the runway centre line.

9.2.3.30.3 Where provided, THLs shall be offset 1.8m on each side of the runway centre line lights and extend, in pairs, starting at a point

115m from the beginning of the runway and, thereafter, every 30m for at least 450m.

Note.— Additional THLs may be similarly provided at the starting point of the take-off roll.

Characteristics

9.2.3.30.4 Where provided, RELs shall consist of a single line of fixed in pavement lights showing red in the direction of aircraft approaching the runway.

9.2.3.30.5 RELs shall illuminate as an array at each taxiway/runway intersection where they are installed less than 2 seconds after the system determines a warning is needed.

9.2.3.30.6 Intensity and beam spread of runway entrance lights shall be in accordance with the specifications of ICAO Annex 14 Vol. I, Appendix 2, Figures A2-12 and A2-14.

Note.— Consideration for reduced beam width may be required for some runway entrance lights at acute angled runway/taxiway intersections to ensure the RELs are not visible to aircraft on the runway.

9.2.3.30.7 Where provided, THLs shall consist of two rows of fixed in pavement lights showing red facing the aircraft taking off.

9.2.3.30.8 THLs shall illuminate as an array on the runway less than 2 seconds after the system determines a warning is needed.

9.2.3.30.9 Intensity and beam spread of THLs shall be in accordance with the specifications of ICAO Annex 14 Vol. I, Appendix 2, Figure A2-26.

9.2.3.30.10 Not in use

Section 9.2.4 – Signs

9.2.4.1 General

Note — Signs shall be either fixed message signs or variable message signs. Guidance on signs is contained in the ICAO Aerodrome Design Manual, Part 4.

Application

9.2.4.1.1 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 paragraph 13.2.8.1 of this Manual.

Note — See paragraph 9.2.2.17 of this Manual for specifications on information marking.

9.2.4.1.2 **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 pre-determined information to be displayed on the sign to meet the requirements of paragraph 13.2.8.1 of this Manual.

Characteristics

9.2.4.1.3 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 9-5.

9.2.4.1.4 Signs shall be rectangular, as shown in ICAO Annex 14 Vol. I, Figures 5-30 and 5-31 with the longer side horizontal.

9.2.4.1.5 The only signs on the movement area utilizing red shall be mandatory instruction signs.

9.2.4.1.6 The inscriptions on a sign shall be in accordance with the provisions of ICAO Annex 14 Vol. I, Appendix 4.

9.2.4.1.7 Signs shall be illuminated in accordance with the provisions of ICAO Annex 14 Vol. I, Appendix 4 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.

Table 9-5 – 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	400	700	5-11 m	3-10 m
1 or 2	300	600	900	5-11 m	3-10 m
3 or 4	300	600	900	11-21 m	8-15 m
3 or 4	400	800	1 100	11-21 m	8-15 m

9.2.4.1.8 Signs shall be retroreflective and/or illuminated in accordance with the provisions of ICAO Annex 14, Vol. I, Appendix 4 when intended for use at night in association with non-instrument runways where the code number is 1 or 2.

9.2.4.1.9 A variable message sign shall show a blank face when not in use.

9.2.4.1.10 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.

9.2.4.1.11 **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.

9.2.4.2 Mandatory instruction signs

Note — See ICAO Annex 14 Vol. I, Figure 5-30 for pictorial representation of mandatory instruction signs and ICAO Annex 14 Vol. I, Figure 5-32 for examples of locating signs at taxiway/runway intersections.

Application

9.2.4.2.1 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.

9.2.4.2.2 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.

Note — See paragraph 9.2.4.7 of this Manual for specifications on road-holding position signs.

9.2.4.2.3 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.

9.2.4.2.4 A pattern “B” runway-holding position marking shall be supplemented with a category I, II or III holding position sign.

9.2.4.2.5 A pattern “A” runway-holding position marking at a runway-holding position established in accordance with paragraph 7.2.12.3 of this Manual shall be supplemented with a runway-holding position sign.

Note — See paragraph 9.2.2.10 of this Manual for specifications on runway-holding position marking.

9.2.4.2.6 **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.

Note — See paragraph 9.2.4.3 of this Manual for characteristics of location signs.

9.2.4.2.7 A NO ENTRY sign shall be provided when entry into an area is prohibited.

Location

9.2.4.2.8 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.

9.2.4.2.9 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.

9.2.4.2.10 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.

9.2.4.2.11 A runway-holding position sign shall be located on each side of the runway-holding position established in accordance with paragraph 7.2.12.3 of this Manual, facing the approach to the obstacle limitation surface or ILS/MLS critical/sensitive area, as appropriate.

Characteristics

9.2.4.2.12 A mandatory instruction sign shall consist of an inscription in white on a red background.

9.2.4.2.13 **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.

9.2.4.2.14 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.

9.2.4.2.15 The inscription on a category I, II, III, joint II/III or joint I/II/III holding position sign shall consist of the runway designator followed by CAT I, CAT II, CAT III,CAT II/III or CAT I/II/III, as appropriate.

9.2.4.2.16 The inscription on a NO ENTRY sign shall be in accordance with ICAO Annex 14 Vol. I, Figure 5-30.

9.2.4.2.17 The inscription on a runway-holding position sign at a runway-holding position established in accordance with paragraph 7.2.12.3 of this Manual shall consist of the taxiway designation and a number.

9.2.4.2.18 Where installed, the inscriptions/ symbol of ICAO Annex 14 Vol. I, Figure 5-30 shall be used.

9.2.4.3 Information signs

Note — See ICAO Annex 14 Vol. I, Figure 5-31 for pictorial representations of information signs.

Application

9.2.4.3.1 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.

9.2.4.3.2 Information signs shall include: direction signs, location signs, destination signs, runway exit signs, runway vacated signs and intersection take-off signs.

9.2.4.3.3 A runway exit sign shall be provided where there is an operational need to identify a runway exit.

9.2.4.3.4 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.

Note — See paragraph 9.2.3.17 of this Manual for specifications on colour coding taxiway centre line lights.

9.2.4.3.5 **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.

9.2.4.3.6 **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.

9.2.4.3.7 A combined location and direction sign shall be provided when it is intended to indicate routing information prior to a taxiway intersection.

9.2.4.3.8 A direction sign shall be provided when there is an operational need to identify the designation and direction of taxiways at an intersection.

9.2.4.3.9 **Recommendation —** A location sign should be provided at an intermediate holding position.

9.2.4.3.10 A location sign shall be provided in conjunction with a runway designation sign except at a runway/runway intersection.

9.2.4.3.11 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.

9.2.4.3.12 **Recommendation —** Where necessary, a location sign should be provided to identify taxiways exiting an apron or taxiways beyond an intersection.

9.2.4.3.13 **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

9.2.4.3.14 Except as specified in paragraphs 9.2.4.3.16 and 9.2.4.3.24 of this Manual information signs shall, wherever practicable, be located on the left-hand side of the taxiway in accordance with Table 9-5.

9.2.4.3.15 At a taxiway intersection, information signs shall be located prior to the intersection and in line with the intermediate holding position marking. Where there is no intermediate holding position marking, the signs shall be installed at least 60m from the centre line of the intersecting taxiway where the code number is 3 or 4 and at least 40m where the code number is 1 or 2.

Note — A location sign installed beyond a taxiway intersection may be installed on either side of a taxiway.

9.2.4.3.16 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 9-5.

9.2.4.3.17 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.

9.2.4.3.18 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.

9.2.4.3.19 Where provided in conjunction with a runway vacated sign, the taxiway location sign shall be positioned outboard of the runway vacated sign.

9.2.4.3.20 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.

9.2.4.3.21 A taxiway location sign installed in conjunction with a runway designation sign shall be positioned outboard of the runway designation sign.

9.2.4.3.22 **Recommendation —** A destination sign should not normally be collocated with a location or direction sign.

9.2.4.3.23 An information sign other than a location sign shall not be collocated with a mandatory instruction sign.

9.2.4.3.24 **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

9.2.4.3.25 An information sign other than a location sign shall consist of an inscription in black on a yellow background.

9.2.4.3.26 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.

9.2.4.3.27 The inscription on a runway exit sign shall consist of the designator of the exit taxiway and an arrow indicating the direction to follow.

9.2.4.3.28 The inscription on a runway vacated sign shall depict the pattern A runway-holding position marking as shown in ICAO Annex 14 Vol. I, Figure 5-31.

9.2.4.3.29 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 ICAO Annex 14 Vol. I, Figure 5-31.

9.2.4.3.30 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 ICAO Annex 14 Vol. I, Figure 5-31.

9.2.4.3.31 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 ICAO Annex 14 Vol. I, Figure 5-31.

9.2.4.3.32 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.

9.2.4.3.33 **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.

9.2.4.3.34 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 ICAO Annex 14 Vol. I, Figure 5-31.

9.2.4.3.35 A taxiway shall be identified by a designator comprising a letter, letters or a combination of a letter or letters followed by a number.

9.2.4.3.36 **Recommendation —** When designating taxiways, the use of the letters I, O or X and the use of words such as inner and outer should be avoided wherever possible to avoid confusion with the numerals 1, 0 and closed marking.

9.2.4.3.37 The use of numbers alone on the manoeuvring area shall be reserved for the designation of runways.

9.2.4.4 VOR aerodrome check-point sign

Application

9.2.4.4.1 When a VOR aerodrome check-point is established, it shall be indicated by a VOR aerodrome check-point marking and sign.

Note — See paragraph 9.2.2.12 for VOR aerodrome check-point marking.

Location

9.2.4.4.2 A VOR aerodrome check-point sign shall be located as near as possible to the check-point and so that the inscriptions are visible from the cockpit of an aircraft properly positioned on the VOR aerodrome check-point marking.

Characteristics

9.2.4.4.3 A VOR aerodrome check-point sign shall consist of an inscription in black on a yellow background.

9.2.4.4.4 **Recommendation —** The inscriptions on a VOR check-point sign should be in accordance with one of the alternatives shown in ICAO Annex 14 Vol. I, Figure 5-33 in which:

VOR	is an abbreviation identifying this as a VOR check-point;
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 should be indicated at the VOR check-point; and
4.3 NM	is an example of the distance in nautical miles

to a DME collocated with the VOR concerned.

Note — Tolerances for the bearing value shown on the sign are given in ICAO Annex 10, Volume I, Attachment E. It will be noted that a check-point can only be used operationally when periodic checks show it to be consistently within ± 2 degrees of the stated bearing.

9.2.4.5 Aerodrome identification sign

Application

9.2.4.5.1 **Recommendation —** An aerodrome identification sign should be provided at an aerodrome where there is insufficient alternative means of visual identification.

Location

9.2.4.5.2 **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

9.2.4.5.3 The aerodrome identification sign shall consist of the name of the aerodrome.

9.2.4.5.4 **Recommendation —** The colour selected for the sign should give adequate conspicuity when viewed against its background.

9.2.4.5.5 **Recommendation —** The characters should have a height of not less than 3 m.

9.2.4.6 Aircraft stand identification signs

Application

9.2.4.6.1 **Recommendation —** An aircraft stand identification marking should be supplemented with an aircraft stand identification sign where feasible.

Location

9.2.4.6.2 **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

9.2.4.6.3 **Recommendation —** An aircraft stand identification sign should consist of an inscription in black on a yellow background.

9.2.4.7 Road-holding position sign

9.2.4.7.1 A road-holding position sign shall be provided at all road entrances to a runway.

Location

9.2.4.7.2 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 regulations) at the holding position.

Characteristics

9.2.4.7.3 A road-holding position sign shall consist of an inscription in white on a red background.

9.2.4.7.4 The inscription on a road-holding position sign shall be in the English language, be in conformity with the local traffic regulations and include the following:

a) a requirement to stop; and

b) where appropriate:

   1) a requirement to obtain ATC clearance; and

   2) location designator.

Note — Examples of road-holding position signs are contained in the ICAO Aerodrome Design Manual (Doc 9157), Part 4.

9.2.4.7.5 A road-holding position sign intended for night use shall be retroreflective or illuminated.

Section 9.2.5 – Markers

9.2.5.1 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.

Note 1 — Anchors or chains, to prevent markers which have broken from their mounting from blowing away, are sometimes used.

Note 2 — Guidance on frangibility of markers is given in the ICAO Aerodrome Design Manual (Doc 9157), Part 6.

9.2.5.2 Unpaved runway edge markers

Application

9.2.5.2.1 **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

9.2.5.2.2 **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

9.2.5.2.3 **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.

9.2.5.3 Stopway edge markers

Application

9.2.5.3.1 **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

9.2.5.3.2 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.

Note — Markers consisting of small vertical boards camouflaged on the reverse side, as viewed from the runway, have proved operationally acceptable.

9.2.5.4 Not in use

9.2.5.5 Taxiway edge markers

Application

9.2.5.5.1 **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

9.2.5.5.2 **Recommendation —** Taxiway edge markers should be installed at least at the same locations as would the taxiway edge lights had they been used.

Characteristics

9.2.5.5.3 A taxiway edge marker shall be retroreflective blue.

9.2.5.5.4 **Recommendation —** The marked surface as viewed by the pilot should be a rectangle and should have a minimum viewing area of 150 cm^2.

9.2.5.5.5 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.

9.2.5.6 Taxiway centre line markers

Application

9.2.5.6.1 **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.

9.2.5.6.2 **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

9.2.5.6.3 **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 paragraph 9.2.3.17.12 of this Manual for the spacing of taxiway centre line lights.

9.2.5.6.4 **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

9.2.5.6.5 A taxiway centre line marker shall be retroreflective green.

9.2.5.6.6 **Recommendation —** The marked surface as viewed by the pilot should be a rectangle and should have a minimum viewing area of 20 cm^2.

9.2.5.6.7 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.

9.2.5.7 Unpaved taxiway edge markers

Application

9.2.5.7.1 **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

9.2.5.7.2 **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.

9.2.5.8 Boundary markers

Application

9.2.5.8.1 Boundary markers shall be provided at an aerodrome where the landing area has no runway.

Location

9.2.5.8.2 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 ICAO Annex 14 Vol. I, Figure 5-34 is used, or approximately 90 m, if the conical type is used with a marker at any corner.

Characteristics

9.2.5.8.3 **Recommendation —** Boundary markers should be of a form similar to that shown in ICAO Annex 14 Vol. I, 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.

Chapter 10 – VISUAL AIDS FOR DENOTING OBSTACLES

Section 10.1 – General

10.1.1 Introduction

10.1.1.1 This chapter describes the visual aids required to be provided for objects located and/or operating at and within a radius of 5km around the aerodrome.

10.1.1.1A An aerodrome operator shall formalise an arrangement with CAAS' ANS Policy Branch for the monitoring of these visual aids.

10.1.1.2 An aerodrome operator shall ensure that these visual aids are duly provided and properly maintained so as to ensure the safe operation of aircraft at its aerodrome.

10.1.1.2A An aerodrome operator shall make necessary arrangements to ensure that these visuals aids are duly provided and are operational so as to ensure the safe operation of aircraft within a radius of 5km around the aerodrome.

Section 10.2 – Marking and lighting of obstacles

10.2.1 Objects to be marked and/or lighted

Note - 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.

10.2.1.1 A fixed obstacle that extends above a take-off climb surface within 3000 m of the inner edge of the take-off climb 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.

10.2.1.2 **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.

10.2.1.3 A fixed obstacle that extends above an approach surface within 3 000 m of 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 lighting may be omitted where the obstacle is a lighthouse and an aeronautical study indicates the lighthouse light to be sufficient.

10.2.1.4 **Recommendation -** A fixed obstacle 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.

10.2.1.5 A fixed object that extends above an obstacle protection surface shall be marked and, if the runway is used at night, lighted.

Note - See paragraph 9.2.3.5 of this Manual for information on the obstacle protection surface.

10.2.1.6 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.

10.2.1.7 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.

10.2.1.8 All obstacles within the distance specified in Table 7-1, column 11 or 12 of this Manual, 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.

10.2.1.9 **Recommendation** - Obstacles in accordance with paragraph 8.2.3.2 should be marked and lighted, except that the marking may be omitted when the obstacle is lighted by high-intensity obstacle lights by day.

10.2.1.10 **Recommendation** - Overhead wires, cables, etc., crossing a river, 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, except that the marking of the supporting towers may be omitted when they are lighted by high-intensity obstacle lights by day.

10.2.1.11 **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.

10.2.2 Marking of objects

General

10.2.2.1 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.

10.2.2.2 All mobile objects to be marked shall be coloured or display flags.

Use of colours

10.2.2.3 **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 4.5m 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 ICAO Annex 14 Vol. I, Figure 6-1)

10.2.2.4 **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 ICAO Annex 14 Vol. I, Figures 6-1 and 6-2)

Note - Table 10-1 shows a formula for determining band widths and for having an odd number of bands, thus permitting both the top and bottom bands to be of the darker colour.

Table 10-1 – Marking band widths

Longest dimension		Band width
Greater than	Not exceeding	
1.5 m	210 m	1/7 of longest dimension
210 m	270 m	1/9 of longest dimension
270 m	330 m	1/11 of longest dimension
330 m	390 m	1/13 of longest dimension
390 m	450 m	1/15 of longest dimension
450 m	510 m	1/17 of longest dimension
510 m	570 m	1/19 of longest dimension
570 m	630 m	1/21 of longest dimension

10.2.2.5 **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.

10.2.2.6 **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.

Use of markers

10.2.2.7 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 1000 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 marked is not increased.

10.2.2.8 **Recommendation -** A marker displayed on an overhead wire, cable, etc., should be spherical and have a diameter of not less than 60 cm.

10.2.2.9 **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.

10.2.2.10 **Recommendation -** A marker should be of one colour. When installed, white and red, or white and orange marker should be displayed alternately. The colour selected should contrast with the background against which it will be seen.

Use of flags

10.2.2.11 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.

10.2.2.11A 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.

10.2.2.12 Flags used to mark fixed objects shall not be less than 0.6 m on each side.

10.2.2.13 **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.

10.2.2.14 Flags used to mark mobile objects shall not be less than 0.9m 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.

10.2.3 Lighting of Objects

Use of obstacle lights

10.2.3.1 The presence of objects which must be lighted, as specified in 10.2.1, shall be indicated by low-, medium- or high-intensity obstacle lights, or a combination of such lights.

10.2.3.2 Low-intensity obstacle lights, Type C, shall be displayed on vehicles and other mobile objects excluding aircraft.

Note – See ICAO Annex 14, Vol.I, Annex 2 for lights to be displayed by aircraft.

10.2.3.3 Low-intensity obstacle lights, Type D, shall be displayed on follow-me vehicles.

10.2.3.4 **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.

10.2.3.5 **Recommendation –** Where, in the opinion of the Authority, the use of high-intensity obstacle lights, Type A or B, or medium-intensity obstacle lights, Type A, at night may dazzle pilots in the vicinity of an aerodrome (within approximately 10000 m radius) or cause significant environmental concerns, a dual lighting system should be provided. This system should be composed of high-intensity obstacle lights, Type A, as appropriate, for daytime and twilight use and medium-intensity obstacle lights, Type B or C, for night-use.

Location of obstacle lights

Note – Recommendations on how a combination of low-, medium-, and/or high-intensity lights on obstacles should be displayed are given in ICAO Annex 14 Vol. I, Appendix 6.

10.2.3.6 In 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.

Note – Recommendations on how a combination of low-, medium-, and/or high-intensity lights on obstacles should be displayed are given in ICAO Annex 14 Vol. I, Appendix 6.

10.2.3.7 **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 ICAO Annex 14 Vol. I, Figures 6-2).

10.2.3.8 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 the highest practicable point and, if practicable, a medium-intensity light, Type A, mounted on the top.

10.2.3.9 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 obstacle limitation surface, 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.

10.2.3.10 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.

10.2.3.11 **Recommendation –** When the obstacle limitation surface concerned is sloping and the highest point above the obstacle limitation is not the highest point of the object, additional obstacle lights should be placed on the highest point of the object.

Lighting of objects with a height of less than 45m above ground level

10.2.3.12 **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.

10.2.3.13 **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

10.2.3.14 **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 paragraph 10.2.3.15 of this Manual.

10.2.3.15 **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.

Note.— A group of buildings is regarded as an extensive object.

Lighting of objects with a height 45 m to a height less than 150 m above ground level

10.2.3.16 **Recommendation -** Medium-intensity obstacle lights, Type A, B, or C, should be used. Medium-intensity obstacle lights, Type 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.

10.2.3.17 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

10.2.3.18 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 of tops of nearby buildings, as appropriate, with the spacing not exceeding 52 m.

10.2.3.19 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, Type B, and shall be spaced as equally as practicable between top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52 m.

10.2.3.20 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 paragraph 10.2.3.11 of this Manual 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

10.2.3.21 **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.

10.2.3.22 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 paragraph 10.2.3.11 of this Manual 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.

10.2.3.23 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.

10.2.3.24 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.

10.2.3.25 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.

10.2.3.26 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.

Note – In some cases, this may require locating the lights off the tower.

10.2.3.27 **Recommendation –** The installation setting angles for high-intensity obstacle lights, Type A and B, should be in accordance with Table 10-2.

10.2.3.28 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.

Table 10-2 – 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	
151m		0º
122 m	151 m	1º
92 m	122 m	2º
	92 m	3º

Low-intensity obstacle light – Characteristics

10.2.3.29 Low-intensity obstacle lights on fixed objects, Types A and B, shall be fixed red lights.

10.2.3.30 Low-intensity obstacle lights, Type A and B, shall be in accordance with the specifications in Table 10-3 of this Manual and ICAO Annex 14 Vol. I, Appendix 1.

10.2.3.31 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.

10.2.3.32 Low-intensity obstacle lights, Type D, displayed on follow-me vehicles shall be flashing-yellow.

10.2.3.33 Low-intensity obstacle lights, Types C ,D and E, shall be in accordance with the specifications in Table 10-3 of this Manual and ICAO Annex 14 Vol. I, Appendix 1.

10.2.3.34 Low-intensity obstacle lights on objects with limited mobility such as aerobridges shall be fixed-red. 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.

Note – See ICAO Annex 2 for lights to be displayed by aircraft.

10.2.3.35 Low-intensity obstacle lights on objects with limited mobility shall as a minimum be in accordance with the specifications for low-intensity obstacle lights, Type A, in Table 10-3 of this Manual.

Medium-intensity obstacle light – Characteristics

10.2.3.36 Medium-intensity obstacle lights, Type A, shall be flashing-white lights, Type B shall be flashing-red lights and Type C shall be fixed-red lights.

10.2.3.37 Medium-intensity obstacle lights, Type A, B and C, shall be in accordance with the specifications in Table 10-3 of this Manual and ICAO Annex 14 Vol. I, Appendix 1.

10.2.3.38 Medium -intensity obstacle lights, Types A and B, located on an object shall flash simultaneously.

High-intensity obstacle light – Characteristics

10.2.3.39 High-intensity obstacle lights, Types A and B, shall be flashing-white lights.

10.2.3.40 High-intensity obstacle lights, Types A and B, shall be in accordance with the specifications in Table 10-3 of this Manual and ICAO Annex 14 Vol. I, Appendix 1.

10.2.3.41 High-intensity obstacle lights, Type A, located on an object shall flash simultaneously.

10.2.3.42 **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

Table 10-3 – 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/m²)	**Twilight (50-500 cd/m²)**	**Night (Below 50 cd/m²)**	
Low-intensity, Type A (fixed obstacle)	Red	Fixed	N/A	N/A	10	Table 10-4
Low-intensity, Type B (fixed obstacle)	Red	Fixed	N/A	N/A	32	Table 10-4
Low-intensity, Type C (mobile obstacle)	Yellow/ Blue (a)	Flashing (60-90 fpm)	N/A	40	40	Table 10-4
Low-intensity, Type D (Follow-me Vehicle)	Yellow	Flashing (60-90 fpm)	N/A	200	200	Table 10-4
Low-intensity, Type E	Red	Flashing (c)	N/A	N/A	32	Table 10-4 (Type B)
Medium-intensity, Type A	White	Flashing (20-60 fpm)	20 000	20 000	2 000	Table 10-5
Medium-intensity, Type B	Red	Flashing (20-60 fpm)	N/A	N/A	2 000	Table 10-5
Medium-intensity, Type C	Red	Fixed	N/A	N/A	2 000	Table 10-5
High-intensity, Type A	White	Flashing (40-60 fpm)	200 000	20 000	2 000	Table 10-5
High-intensity, Type B	White	Flashing (40-60 fpm)	100 000	20 000	2 000	Table 10-5

a) See paragraph 10.2.3.31 of this Manual.

b) For flashing lights, effective intensity as determined in accordance with ICAO 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 10-4 – 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	10º	5 cd
Type B	32 cd (b)	N/A	10º	16 cd
Type C	40 cd (b)	400 cd	12º (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. 10.2.3.28 requires 360º 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 should be located at approximately 2.5° vertical.

(e) Peak intensity should 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 10-5 Light distribution for medium- and high-intensity obstacle lights according to benchmark intensities of Table 10-3

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 spread beam	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. 10.2.3.32 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.

10.2.4 Wind turbines

10.2.4.1 A wind turbine shall be marked and/or lighted if it is determined to be an obstacle.

Note 1.— Additional lighting or markings may be provided where in the opinion of the CAAS such lighting or markings are deemed necessary.

Note 2 — see 8.2.3.1 and 8.2.3.2

Markings

10.2.4.2 **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

10.2.4.3 **Recommendation** — When lighting is deemed necessary, medium intensity obstacle lights should be used. In the case of a wind farm, i.e. a group of two or more wind turbines, it should be regarded as an extensive object and the lights should be installed:

a) to identify the perimeter of the wind farm;

b) respecting the maximum spacing, in accordance with 10.2.3.10, 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; and

d) so that, within a wind farm, any wind turbines of significantly higher elevation are also identified wherever they are located.

10.2.4.4 **Recommendation** — The obstacle lights should be installed on the nacelle in such a manner as to provide an unobstructed view for aircraft approaching from any direction.

Chapter 11 – VISUAL AIDS FOR DENOTING RESTRICTED USE AREAS

Section 11.1 – General

11.1.1 Introduction

11.1.1.1 This chapter describes the visual aids required to mark restricted use areas at an aerodrome.

11.1.1.2 An aerodrome operator is required to adhere to these visual aids provisions so as to ensure that aircraft operations can be conducted safely on the aerodrome.

Section 11.2 – Marking and lighting of unserviceable areas

11.2.1 Closed runways and taxiways, or parts thereof

Application

Permanently closed runway or taxiway

11.2.1.1 A closed marking shall be displayed on a runway or taxiway, or portion thereof, which is permanently closed to the use of all aircraft.

Temporarily closed runway or taxiway

11.2.1.2. **Recommendation –** A closed 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 (less than 3 days) and adequate warning by air traffic services is provided.

Location

11.2.1.3 On a runway a closed marking shall be placed at each end 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. On a taxiway a closed marking shall be placed at least at each end of the taxiway or portion thereof closed.

Characteristics

11.2.1.4 The closed marking shall be of the form and proportions as detailed in ICAO Annex 14 Vol. I, Figure 7-1, Illustration a), when displayed on a runway, and shall be of the form and proportions as detailed in ICAO Annex 14 Vol. I, Figure 7-1, Illustration b), when displayed on a taxiway.

The marking shall be white when displayed on a runway and shall be yellow when displayed on a taxiway.

Note – 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.

11.2.1.5 When a runway or taxiway or portion thereof is permanently closed, all normal runway and taxiway markings shall be obliterated.

11.2.1.6 Lighting on a closed runway or taxiway or portion thereof shall not be operated, except as required for maintenance purposes.

11.2.1.7 In addition to closed markings, when the runway or taxiway or portion thereof closed is intercepted by a usable runway or taxiway which is used at night, unserviceability lights shall be placed across the entrance to the closed area at intervals not exceeding 3 m (See paragraph 11.2.4.4 of this Manual).

11.2.2 Non-load-bearing surfaces

Application

11.2.2.1 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.

Note – The marking of runway sides is specified in paragraph 9.2.2.7 of this Manual.

Location

11.2.2.2 A taxi side stripe marking shall 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

11.2.2.3 A taxi side stripe marking shall 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.

Note – Guidance on providing additional transverse stripes at an intersection or a small area on the apron is given in the ICAO Aerodrome Design Manual, Part 4.

11.2.3 Pre-threshold area

Application

11.2.3.1 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 shall be marked with a chevron marking.

Location

11.2.3.2 A chevron marking shall point in the direction of the runway and be placed as shown in ICAO Annex 14 Vol. I, Figure 7-2.

Characteristics

11.2.3.3 A chevron marking shall be of conspicuous colour and contrast with the colour used for the runway markings; it should preferably be yellow. It should have an over-all width of at least 0.9 m.

11.2.4 Unserviceable areas

Application

11.2.4.1 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. Unserviceability markers shall also be displayed at the entrances to a permanently or temporarily closed runway or taxiway, or part thereof. On a movement area used at night, unserviceability lights shall be used.

Note – Unserviceability markers and lights are used to guide aircraft to bypass a portion of a taxiway, apron or holding bay that is unfit for normal movement are intended 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

11.2.4.2 Unserviceability markers and 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 ICAO Annex 14 Vol. I, Attachment A, Section 13.

Characteristics of unserviceability markers

11.2.4.3 Unserviceability markers shall consist of conspicuous upstanding devices such as flags, cones or marker boards.

Characteristics of unserviceability lights

11.2.4.4 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.

Characteristics of unserviceability cones

11.2.4.5 **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.

Characteristics of unserviceability flags

11.2.4.6 **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.

Characteristics of unserviceability marker boards

11.2.4.7 **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 12 – ELECTRICAL SYSTEMS

Section 12.1 – General

12.1 Introduction

12.1.1 This chapter describes specific requirements for aerodrome equipment and installations covering secondary power supply for visual aids, electrical systems, monitoring of serviceability of lighting systems, aerodrome security fencing and lighting, airport design (siting of equipment), aerodrome vehicle operations and surface movement guidance and control systems.

12.1.2 An aerodrome operator shall take note and comply with the requirements stipulated in this chapter.

Section 12.2 – Electrical Systems

12.2.1 Electrical power supply systems for air navigation facilities

Introductory Note – The safety of operations at aerodromes depends on the quality of the supplied power. The total electrical power supply system may include connections to one or more external sources of electric power supply, one or more local generating facilities and to a distribution network including transformers and switchgear. Many other aerodrome facilities supplied from the same system need to be taken into account while planning the electrical power system at aerodromes.

12.2.1.1 Adequate primary power supply shall be available at aerodromes for the safe functioning of air navigation facilities.

12.2.1.2 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.

Note – The design and installation of the electrical systems need to take into consideration factors that can lead to malfunction, such as electromagnetic disturbances, line losses, power quality, etc. Additional guidance is given in the Aerodrome Design Manual, Part 5.

12.2.1.3 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.

12.2.1.4 The time interval between failure of the primary source of power and the complete restoration of the services required by paragraph 12.2.1.10 of this Manual shall be as short as practicable, except that for visual aids associated with non-precision, precision approach or take-off runways the requirements of Table 12-1 of this Manual for maximum switch-over times shall apply.

Note — A definition of switch-over time is given in Chapter 1 of this Manual.

12.2.1.5 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 12-1 for maximum switch-over times as defined in Chapter 1 of this Manual.

Table 12-1 - Secondary power supply requirements

(See Paragraph 12.2.1.4 of this Manual)

Runway	Lighting aids requiring power	Maximum switch-over time
Non-instrument	Visual approach slope indicators[a] Runway edge[b] Runway threshold[b] Runway end[b] Obstacle[a]	See 12.2.1.4 and 12.2.1.9
Non-precision approach	Approach lighting system Visual approach slope indicators[a, d] Runway edge[d] Runway threshold[d] Runway end Obstacle[a]	15 seconds 15 seconds 15 seconds 15 seconds 15 seconds 15 seconds
Precision approach category I	Approach lighting system Runway edge[d] Visual approach slope indicators[a, d] Runway threshold[d] Runway end Essential taxiway[a] Obstacle[a]	15 seconds 15 seconds 15 seconds 15 seconds 15 seconds 15 seconds 15 seconds
Precision approach category II/III	Inner 300 m of the approach lighting system Other parts of the approach lighting system Obstacle[a] Runway edge Runway threshold Runway end Runway centre line Runway touchdown zone All stop bars Essential taxiway	1 second 15 seconds 15 seconds 15 seconds 1 second 1 second 1 second 1 second 1 second 15 seconds
Runway meant for takeoff in runway visual range conditions less than a	Runway edge Runway end Runway centre line	15 seconds[c] 1 second 1 second

value of 800 m.	All stop bars Essential taxiway[a] Obstacle[a]	1 second 15 seconds 15 seconds
a. Supplied with secondary power when their operation is essential to the safety of flight operation. b. See Chapter 9, 9.2.3.2 of this Manual 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.		

Visual aids

Application

12.2.1.6 For a precision approach runway, a secondary power supply capable of meeting the requirements of Table 12-1 of this Manual 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.

12.2.1.7 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 12-1 of this Manual shall be provided.

12.2.1.8 At an aerodrome where the primary runway is a non-precision approach runway, a secondary power supply capable of meeting the requirements of Table 12-1 of this Manual shall be provided except that a secondary power supply for visual aids need not be provided for more than one non-precision approach runway.

12.2.1.9 At an aerodrome where the primary runway is a non-instrument runway, a secondary power supply capable of meeting the requirements of paragraph 12.2.1.4 of this Manual shall 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 paragraph 9.2.3.2 of this Manual is provided and capable of being deployed in 15 minutes.

12.2.1.10 The following aerodrome facilities shall be provided with secondary power supply capable of supplying power when there is a failure of primary power supply:

a) the signalling lamp and the minimum lighting necessary to enable air traffic services personnel to carry out their duties;

Note — The requirement for minimum lighting may be met by other than electrical means.

b) all obstacle lights which, in the opinion of the Aerodrome and ANS Regulation Division, are essential to ensure the safe operation of aircraft;

c) approach, runway and taxiway lighting as specified in paragraphs 12.2.1.6 to 12.2.1.9 of this Manual;

d) meteorological equipment;

e) essential security lighting, if provided in accordance with paragraph 13.2.11 of this Manual;

f) essential equipment and facilities for the aerodrome responding emergency agencies; and

g) floodlighting on a designated isolated aircraft parking position if provided in accordance with paragraph 9.2.3.24.1 of this Manual and

h) 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 ICAO Annex 10, Volume I, Chapter 2.

12.2.1.11 Requirements for a secondary power supply shall 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 secondary power supply is given in the ICAO Aerodrome Design Manual, Part 5.

12.2.2 System design

12.2.2.1 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 12-1 of this Manual shall be so designed that an equipment failure will not leave the pilot with inadequate visual guidance or misleading information.

Note — Guidance on means of providing this protection is given in the ICAO Aerodrome Design Manual, Part 5.

12.2.2.2 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.

12.2.2.3 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.

12.2.3 Monitoring

Note — Guidance on this subject is given in the ICAO Aerodrome Design Manual, Part 5.

12.2.3.1 A system of monitoring shall be employed to indicate the operational status of the lighting systems.

12.2.3.2 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.

12.2.3.3 **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.

12.2.3.4 **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 12-1 of this Manual 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 paragraphs 14.2.5.7 to 14.2.5.11 of this Manual, as appropriate. This information should be automatically relayed to the maintenance crew.

12.2.3.5 **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 12-1 of this Manual should be monitored automatically to provide an indication when the serviceability level of any element falls below the minimum level 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 ICAO Aerodrome Design Manual, Part 5.

Chapter 13 – AERODROME OPERATIONAL SERVICES, EQUIPMENT AND INSTALLATIONS

Section 13.1 – General

13.1.1 Introduction

13.1.1.1 This chapter covers aerodrome emergency services including aerodrome emergency planning, rescue and fire fighting and other responses to special circumstances occurring at an aerodrome.

13.1.1.2 An aerodrome operator shall take into account the requirement stipulated in this chapter and apply them, where relevant, to its aerodrome.

Section 13.2 – Provision of emergency services

13.2.1 Aerodrome emergency planning

General

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 aerodrome operator in establishing aerodrome emergency planning is given in the ICAO Airport Services Manual, Part 7.

13.2.1.1 An aerodrome emergency plan shall be established at an aerodrome, commensurate with the aircraft operations and other activities conducted at the aerodrome.

13.2.1.2 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 and address

a) aircraft crash emergencies;

b) aircraft crash at sea;

c) fires on the ground;

d) dangerous goods incidents; and

e) bomb warnings.

Note 1 — Examples of emergencies are: aircraft emergencies, sabotage including bomb threats, unlawfully seized aircraft, dangerous goods occurrences, building fires, and 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.

13.2.1.3 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 fire fighting services, aerodrome administration, medical and ambulance services, aircraft operators, 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 minimise adverse effects to the community from health related events and deal with population health issues rather than provision of health services to individuals.

13.2.1.4 **Recommendation —** The plan should provide for cooperation and coordination amongst the various organizations involved, including the rescue coordination centre, as necessary.

13.2.1.5 The aerodrome emergency plan document shall 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 crisis management 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.

13.2.1.6 The plan shall observe Human Factors principles to ensure optimum response by all existing agencies participating in emergency operations.

Note — Guidance material on Human Factors principles can be found in the Human Factors Training Manual.

Emergency operations centre and command post

13.2.1.7 A fixed crisis management centre and a mobile command post shall be available for use during an emergency.

13.2.1.8 The crisis management operations centre shall be a part of the aerodrome facilities and shall be responsible for the overall coordination and general direction of the response to an emergency.

13.2.1.9 The command post shall be a facility capable of being moved rapidly to the site of an emergency, when required, and shall undertake the local coordination of those agencies responding to the emergency.

13.2.1.10 A person shall be assigned to assume control of the crisis management centre and, when appropriate, another person the mobile command post.

Communication system

13.2.1.11 Adequate communication systems linking the command post and the crisis management centre with each other and with the participating agencies shall be provided in accordance with the plan and consistent with the particular requirements of the aerodrome.

Aerodrome emergency exercise

13.2.1.12 The plan shall contain procedures for periodic testing of the adequacy of the plan and for reviewing the results in order to improve its effectiveness.

Note — The plan includes all participating agencies and associated equipment.

13.2.1.13 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 ICAO Airport Services Manual (Doc 9137), Part 7.

Emergencies in difficult environments

13.2.1.14 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.

13.2.1.15 At those aerodromes located close to water and/or swampy areas, or difficult terrain, the aerodrome emergency plan shall include the establishment, testing and assessment at regular intervals of a pre-determined response for the specialist rescue services.

13.2.1.16 Not in use.

13.2.2 Rescue and fire fighting

General

The principal objective of a rescue and fire fighting 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 fire fighting 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 fire fighting 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 fire fighting purposes can be put into use.

Requirements to combat building and fuel farm fires are dealt with under separate emergency procedures.

Application

13.2.2.1 Rescue and fire fighting equipment and services shall be provided at an aerodrome.

Note — Public or private organizations, suitably located and equipped, may be designated to provide the rescue and fire fighting service. It is intended that the fire station housing these organizations be normally located on the aerodrome, although an off-aerodrome location is not precluded provided the response time can be met.

13.2.2.2 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 fire fighting 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 ICAO Airport Services Manual, Part 1.

Level of protection to be provided

13.2.2.3 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 13.2.2.5 and 13.2.2.6 of this Manual.

13.2.2.4 Not in use.

13.2.2.5 The aerodrome category shall be determined from Table 13-1 of this Manual and shall be based on the longest aeroplanes normally using the aerodrome and their fuselage width.

Note — To categorize the aeroplanes using the aerodrome, first evaluate their overall length and second, their fuselage width.

13.2.2.6 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 13-1 of this Manual, 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, Part 1 for categorizing aerodromes, including those for all-cargo aircraft operations, for rescue and fire fighting purposes.

Note 2 — Guidance on training of personnel, rescue equipment for difficult environment and other facilities and services for rescue and fire fighting is given in ICAO Annex 14, Vol.I, Attachment A, Section 18 and in the Airport Services Manual, Part 1.

Table 13-1 - Aerodrome category for rescue and fire fighting

Aerodrome Category	Aeroplane overall length	Maximum fuselage width
(1)	(2)	(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

13.2.2.7 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.

Extinguishing agents

13.2.2.8 Both principal and complementary agents shall be provided at an aerodrome.

Note — Descriptions of the agents may be found in the ICAO Airport Services Manual, Part 1.

13.2.2.9 **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 combination of these agents;

except that the principal extinguishing agent for aerodromes in categories 1 to 3 should preferably meet the minimum performance level B.

Note — Information on the required physical properties and fire extinguishing performance criteria needed for a foam to achieve an acceptable performance level A or B rating is given in the ICAO Airport Services Manual (Doc 9137), Part 1.

13.2.2.10 **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 fire fighting capability may be utilized. Additional information on extinguishing agents is given in the ICAO Airport Services Manual, Part 1.

13.2.2.11 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 paragraphs 13.2.2.3, 13.2.2.4, 13.2.2.5, 13.2.2.6 and Table 13-2 of this Manual, 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 1.0L 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/m^2 for a foam meeting performance level A, 5.5 L/min/m^2 for a foam meeting performance level B and 3.75L/min/m^2 for a foam meeting performance level C.

Note 2 – When any other complementary agent is used, the substitution ratios need to be checked.

13.2.2.12 **Recommendation —** At aerodromes where operation by aeroplanes larger than the average size in a given category are planned, the quantities of water should be recalculated and the amount of water for foam production and the discharge rates for foam solution should be increased accordingly.

Note — Additional guidance is available in Chapter 2 of the Airport Services Manual, Part 1.

13.2.2.13 From 1 January 2015, 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.

13.2.2.14 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.

13.2.2.15 **Recommendation —** The amount of foam concentrate provided on a vehicle should be sufficient to produce at least two loads of foam solution.

13.2.2.16 **Recommendation —** Supplementary water supplies, for the expeditious replenishment of rescue and fire fighting vehicles at the scene of an aircraft accident, should be provided.

13.2.2.17 **Recommendation —** When both a foam meeting performance level A and a foam meeting performance level B are to be used, the total amount of water to be provided for foam production should first be based on the quantity which would be required if only a foam meeting performance level A were used, and then reduced by 3 L for each 2 L of water provided for the foam meeting performance level B.

13.2.2.18 The discharge rate of the foam solution shall not be less than the rates shown in Table 13-2 of this Manual.

Table 13-2 - 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/sec
(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.

13.2.2.19 The complementary agents shall comply with the appropriate specifications of the International Organization for Standardization (ISO) [2] or equivalent.

Note – Compliance to the Singapore Standard for fire extinguishers (SS 232) can also be considered.

[2] See ISO Publication 7202(Powder).

13.2.2.20 **Recommendation —** The discharge rate of complementary agents should be no less than the rates shown in Table 13-2 of this Manual.

13.2.2.21 **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 – Part 1.

13.2.2.22 Not in use.

13.2.2.23 Not in use.

13.2.2.24 Not in use.

13.2.2.25 Not in use.

Rescue equipment

13.2.2.26 **Recommendation —** Rescue equipment commensurate with the level of aircraft operations should be provided on the rescue and fire fighting vehicle(s).

Note — Guidance on the rescue equipment to be provided at an aerodrome is given in the ICAO Airport Services Manual, Part 1.

Response time

13.2.2.27 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.

13.2.2.28 **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.

13.2.2.29 **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 fire fighting 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 13-2 of this Manual.

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.

13.2.2.30 **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.

Note — Additional guidance is available in the ICAO Airport Services Manual, Part 1.

13.2.2.31 Any vehicles, other than the first responding vehicle(s), required to deliver the amounts of extinguishing agents specified in Table 13-2 of this Manual shall ensure continuous agent application and shall arrive no more than four minutes from the initial call.

13.2.2.32 **Recommendation** — Any vehicles, other than the first responding vehicles(s), required to deliver the amounts of extinguishing agents specified in Table 13-2 of this Manual should ensure continuous agent application and should arrive no more than three minutes from the initial call.

13.2.2.33 **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

13.2.2.34 **Recommendation —** Emergency access roads should be provided on an aerodrome where terrain conditions permit their construction, 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.

Note — Aerodrome service roads may serve as emergency access roads when they are suitably located and constructed.

13.2.2.35 **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.

13.2.2.36 **Recommendation —** When the surface of the road is indistinguishable from the surrounding area, edge markers should be placed at intervals of about 10 m.

Fire stations

13.2.2.37 All rescue and fire fighting vehicles shall normally be housed in a fire station. Satellite fire stations shall be provided whenever the response time cannot be achieved from a single fire station.

13.2.2.38 The fire station shall 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

13.2.2.39 A discrete communication system shall be provided linking a fire station with the control tower, any other fire station on the aerodrome and the rescue and fire fighting vehicles.

13.2.2.40 An alerting system for rescue and fire fighting personnel, capable of being operated from that station, shall 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

13.2.2.41 The minimum number of rescue and fire fighting vehicles provided at an aerodrome shall 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

Note — Guidance on minimum characteristics of rescue and fire fighting vehicles is given in the ICAO Airport Services Manual, Part 1.

Personnel

13.2.2.42 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 1 — Guidance to assist the aerodrome operator in providing proper training is given in ICAO Annex 14 Vol. I, Attachment A, Section 18 and ICAO Airport Services Manual, Part 1.

Note 2 — Fires associated with fuel discharged under very high pressure from a ruptured fuel tank are known as “pressure-fed fuel fires”.

13.2.2.42A An aerodrome operator shall ensure that training in the following areas for all aerodrome rescue and fire fighting (ARFF) personnel is conducted by a training organisation that is approved (“approved ARFF training organisation”) or provided by the Authority.

a) basic firemanship;

b) recurrent training; and

c) leadership training, appropriate to their areas of responsibilities, for personnel performing supervisory roles.

Note 1 – Guidance on areas of training which constitutes basic firemanship is given in ICAO Annex 14 Vol. I, Attachment A, Section 18 and ICAO Airport Services Manual, Part 1.

Note 2 – Airport and aircraft familiarisation will, however, be covered under on-the-job training in the station the ARFF is posted to, and not during their basic firemanship training at the training organisation.

13.2.2.43 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 ICAO Human Factors Training Manual.

13.2.2.44 During flight operations, sufficient trained and competent personnel shall be designated to be readily available to ride the rescue and fire fighting vehicles and to operate the equipment at maximum capacity. These personnel shall 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 shall 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.

13.2.2.45 **Recommendation —** In determining the number of personnel required to provide for rescue, consideration should be given to the types of aircraft using the aerodrome.

13.2.2.46 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.

Other special services

13.2.2.47 **Recommendation —** An aerodrome operator should establish procedures to deal with fuel spillage, hot-works and other special services associated with fire risks.

Emergency hand signals

13.2.2.48 The signals shown in ICAO Annex 2, Appendix 1, Section 6 shall, when used, have the meaning indicated therein. They shall be used only for the purpose indicated and no other signals likely to be confused with them shall be used.

13.2.3 Disabled aircraft removal

Note — Guidance on removal of a disabled aircraft, including recovery equipment, is given in the ICAO Airport Services Manual, Part 5. See also ICAO Annex 13 concerning protection of evidence, custody and removal of aircraft.

13.2.3.1 Without prejudice to section 69 of the Civil Aviation Authority of Singapore Act (Cap. 41, Rev Ed 2014), the aerodrome operator shall establish a plan for the removal of an aircraft disabled on, or adjacent to, the movement area shall be established for an aerodrome, and a coordinator designated to implement the plan, when necessary.

13.2.3.2 The disabled aircraft removal plan shall take into account 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.

13.2.3.3 With effect from 1 January 2017, the aerodrome operator shall possess, or have access to the necessary capability and resources to execute the aircraft recovery plan to remove disabled aircraft as soon as practicable. If the execution of the recovery plan involves engaging services from external parties, then this arrangement shall be formalised.

13.2.4 Wildlife strike hazard reduction

Note — The presence of wildlife (birds and animals) on and in the airport vicinity poses a serious threat to aircraft operational safety.

13.2.4.1 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 information from aircraft operators, airport personnel and other sources on the presence of birds on or around the aerodrome constituting a potential hazard to aircraft operations; and

c) an ongoing evaluation of the wildlife hazard by competent personnel.

Note – See ICAO Annex 15, Chapter 8.

13.2.4.2 Wildlife strike reports shall be collected by the aerodrome operator. These reports shall include but not limited to the following information:

a) date and local time of occurrence,

b) aircraft type,

c) runway,

d) phase of flight,

e) wildlife species,

g) effect on flight, and

h) whether pilots warned of wildlife activity.

Hardcopies/ softcopies of these reports shall be submitted monthly to the Aerodrome and ANS Regulation Division for inclusion in ICAO Bird Strike Information System (IBIS) database. A sample of the wildlife strike reporting form is shown in Appendix H attached.

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).

13.2.4.3 The aerodrome operator shall take action to decrease the risk to aircraft operations by adopting measures to minimize the likelihood of collisions between wildlife and aircraft.

Note — Guidance on effective measures for establishing whether or not wildlife, on or near an aerodrome, constitute a potential hazard to aircraft operations, and on methods for discouraging their presence, is given in the ICAO Airport Services Manual, Part 3.

13.2.4.4 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 aerodrome operator shall ensure that any risk to aircraft posed by these sites is assessed and reduced to as low as reasonably practicable.

13.2.4.5 Not in use.

13.2.5 Apron management service

13.2.5.1 **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 regulation of other activities.

13.2.5.2 **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 — Guidance on an apron management service is given in the ICAO Airport Services Manual, Part 8 and in the ICAO 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).

13.2.5.3 An apron management service shall be provided with radiotelephony communications facilities.

13.2.5.4 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 ICAO 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).

13.2.5.5 An emergency vehicle responding to an emergency shall be given priority over all other surface movement traffic.

13.2.5.6 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 regulations.

13.2.5.7 An aircraft stand shall be visually monitored to ensure that the recommended clearance distances are provided to an aircraft using the stand.

13.2.6 Safety of ground handling operations

13.2.6.1 An aerodrome operator shall establish procedures for ground handling activities such as aircraft handling operations and require that these procedures be complied with by ground handling service providers, including fixed-base operators, ground handling agents and other organisations that perform aircraft handling operations, so that these activities are conducted safely at its aerodromes.

13.2.6.2 During ground servicing of aircraft,

a) 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, 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.

b) When aircraft refuelling operations take place while passengers are embarking, on board or disembarking, ground equipment shall be positioned so as to allow:

(i) the use of a sufficient number of exits for expeditious evacuation; and

(ii) a ready escape route from each of the exits to be used in an emergency.

13.2.7 Aerodrome vehicle operations

Note 1 — Guidance on aerodrome vehicle operations is contained in ICAO Annex 14 Vol. I, Attachment A, Section 19 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 2 — 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.

13.2.7.1 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.

13.2.7.2 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.

13.2.7.3 The driver of a vehicle on the movement area shall comply with all mandatory instructions conveyed by lights.

13.2.7.4 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.

13.2.7.5 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.

13.2.8 Surface movement guidance and control systems

Application

13.2.8.1 A surface movement guidance and control system shall be provided at an aerodrome.

Note — Guidance on surface movement guidance and control systems is contained in the ICAO Manual of Surface Movement Guidance and Control Systems (SMGCS) (Doc 9476). Guidance on advanced surface movement guidance and control systems is contained in the ICAO

Manual of Advanced Surface Movement Guidance and Control Systems (A-SMGCS) (Doc 9830).

Characteristics

13.2.8.2 **Recommendation —** The design of a surface movement guidance and control system 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.

13.2.8.3 The visual aid components of a surface movement guidance and control system, i.e. markings, lights and signs shall be designed to conform with the relevant specifications in sections 9.2.2, 9.2.3 and 9.2.4 of this Manual, respectively.

13.2.8.4 **Recommendation —** A surface movement guidance and control system should be designed to assist in the prevention of inadvertent incursions of aircraft and vehicles onto an active runway.

13.2.8.5 **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 ICAO Aerodrome Design Manual, Part 4.

13.2.8.6 Where a surface movement guidance and control system 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 9.2.3.17 and 9.2.3.20 of this Manual 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 surface movement guidance and control systems is given in the ICAO Aerodrome Design Manual, (Doc 9157), Part 4 and the Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual (Doc 9830).

13.2.8.7 **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.

13.2.8.8 **Recommendation —** Surface movement radar for the manoeuvring area should be provided at an aerodrome other than that in paragraph 13.2.8.7 of this Manual 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 ICAO Manual of Surface Movement Guidance and Control Systems (SMGCS) and in the ICAO Air Traffic Services Planning Manual (Doc 9426).

13.2.9 Siting of equipment and installations on operational areas

Note 1 — Requirements for obstacle limitation surfaces are specified in paragraph 8.2.2 of this Manual.

Note 2 — The design of light fixtures and their supporting structures, light units of visual approach slope indicators, signs, and markers, is specified in 9.2.3.1, 9.2.3.5, 9.2.4.1 and 9.2.5.1 of this Manual, respectively. Guidance on the frangible design of visual and non-visual aids for navigation is given in the ICAO Aerodrome Design Manual (Doc 9157), Part 6.

13.2.9.1 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 7-1 of this Manual, column 11, if it would endanger an aircraft; or

b) on a clearway if it would endanger an aircraft in the air.

13.2.9.2 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 7-1 of this Manual; or

c) on a clearway and which would endanger an aircraft in the air;

shall be frangible and mounted as low as possible.

13.2.9.3 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 shall be regarded as an obstacle and shall be frangible and mounted as low as possible.

Note — Guidance on the siting of navigation aids is contained in the ICAO Aerodrome Design Manual (Doc 9157), Part 6.

13.2.9.4 Unless its function requires it to be there for air navigation or for aircraft safety purposes, no equipment or installation shall 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.

13.2.9.5 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 on that portion of the strip within 77.5 m of the runway centre line where the code number is 4 and the code letter is F; or

b) 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

c) penetrates the inner approach surface, the inner transitional surface or the balked landing surface;

shall be frangible and mounted as low as possible.

13.2.9.6 **Recommendation —** Any equipment or installation required for air navigation purposes which is an obstacle of operational significance in accordance with paragraphs 8.2.2.4, 8.2.2.11, 8.2.2.20 or 8.2.2.27 of this Manual should be frangible and mounted as low as possible.

13.2.10 Fencing

Application

13.2.10.1 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.

13.2.10.2 Not in use.

13.2.10.3 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.

Note 1- This is intended to include the barring of sewers, ducts tunnels etc., where necessary to prevent access.

Note 2- Special measures may be required to prevent the access of an unauthorized person to runways or taxiways which overpass public roads.

13.2.10.4 Not in use.

13.2.10.5 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.

13.2.10.6 Not in use.

Location

13.2.10.7 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.

13.2.10.8 Not in use.

13.2.10.9 **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.

13.2.11 Security lighting

13.2.11.1 At an aerodrome where it is necessary for security reasons, a fence or other barrier provided for the protection of international civil aviation and its facilities shall be illuminated at a minimum essential level. Consideration shall be given to locating lights so that the ground area on both sides of the fence or barrier, particularly at access points, is illuminated.

13.2.12 Autonomous runway incursion warning system

Note 1.— The inclusion of detailed specification 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, CAAS and in coordination with the aircraft operators.

Note.3 — Attachment A, Section 21 of ICAO Annex 14 Vol. I, provides a description of an ARIWS and information on its use.

Characteristics

13.2.12.1 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 9.2.3; 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.

13.2.12.2 Where an ARIWS is installed at an aerodrome, information on its characteristics and status shall be provided to the Aeronautical Information Service (AIS) for promulgation in the AIP with the description of the aerodrome surface movement guidance and control system and markings as specified in Annex 15, Appendix 1, AD 2.9.

Section 13.3 – Aviation fuel quality at aerodromes

13.3.1 The aerodrome operator shall satisfy himself that the aviation fuel provided at its aerodrome is

(a) of the fuel specifications as agreed between the aerodrome operator and the airport fuel storage and hydrant system operator/into-plane service provider; and

(b) uncontaminated.

13.3.2 The aerodrome operator shall coordinate with the airport fuel storage and hydrant system operator or into-plane service provider to ensure that aviation fuel installations on the aerodrome are

(a) commissioned prior to operation; and

(b) properly maintained

13.3.3 The aerodrome operator shall satisfy himself that an organisation that carries out aircraft refueling or maintains the aviation fuel installation has the capability and adequate resources including appropriately trained staff.

Chapter 14 – AERODROME MAINTENANCE

Section 14.1 – General

14.1.1 Introduction

14.1.1.1 This chapter covers the maintenance of pavements, runway pavement overlays and visual aids.

14.1.1.2 An aerodrome operator shall take into account the requirement stipulated in this chapter and apply them, where relevant, to its aerodrome.

Section 14.2 – Provision of aerodrome maintenance

14.2.1 Maintenance

14.2.1.1 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, electrical systems and buildings.

14.2.1.2 **Recommendation** — The design and application of the maintenance programme should observe Human Factors principles.

Note — Guidance material on Human Factors principles can be found in the ICAO Human Factors Training Manual.

14.2.2 Pavements

14.2.2.1 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 foreign object debris (FOD) that might cause damage to aircraft or impair the operation of aircraft systems.

Note 1 — See Paragraph 6.2.9.3 for inspections of movement areas.

Note 2 — Procedures on carrying out daily inspections of the movement area and control of FOD are given in the ICAO PANS-Aerodromes (Doc 9981), Manual of Surface Movement Guidance and

Control Systems (SMGCS) and the Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual.

Note 3 — Additional guidance on sweeping/cleaning of surfaces is contained in the ICAO Airport Services Manual, Part 9.

Note 4 — Guidance on precautions to be taken in regard to the surface of shoulders is given in ICAO Annex 14 Vol. I, Attachment A, Section 9, and the ICAO Aerodrome Design Manual, Part 2.

Note 5 — Where the pavement is used by large aircraft or aircraft with tire pressures in the upper categories referred to in 6.2.6.6(c), particular attention should be given to the integrity of light fittings in the pavement and pavement joints.

14.2.2.2 The surface of a runway shall be maintained in a condition such as to preclude formation of harmful irregularities.

Note — See ICAO Annex 14 Vol. I, Attachment A, Section 5.

14.2.2.3 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 14-1 of this manual.

Note — The Airport Services Manual (Doc 9137), Part 2, contains further information on this subject, on improving surface friction characteristics of runways.

Runway friction measurement

14.2.2.4 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 friction characteristics of a runway is provided in ICAO Annex 14 Vol. I, Attachment A, Section 7.Additional guidance is included in the ICAO Airport Services Manual, Part 2.

Note 2.— The objective of 14.2.2.3 to 14.2.2.6 is to ensure that the surface friction characteristics for the entire runway remain at or above a minimum friction level specified in Table 14-1 of this manual.

Note 3.— Guidance for the determination of the required frequency is provided in ICAO Annex 14, Vol. 1, Attachment A, Section 7 and in the Airport Services Manual (Doc 9137), Part 2, Appendix 5.

14.2.2.5 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 14-1 of this Manual.

Note — A portion of runway in the order of 100 m long may be considered significant for maintenance or reporting action.

Table 14-1 – 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
GRIPTESTER Trailer	C	140	65	1.0	0.74	0.53	0.43
	C	140	95	1.0	0.64	0.36	0.24

14.2.2.6 **Recommendation —** When there is reason to believe that the drainage characteristics of a runway, or portions thereof, are poor due to slopes or depressions, then the runway surface friction characteristics should be assessed under natural or simulated conditions that are representative of local rain and corrective maintenance action should be taken as necessary.

14.2.2.7 **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 subject is given in the ICAO Aerodrome Design Manual, Part 2.

14.2.3 Removal of contaminants

14.2.3.1 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 – Guidance on removal of other contaminants is given in the ICAO Aerodrome Services Manual (Doc 9137), Parts 2 and 9.

14.2.3.2 Not in use.

14.2.3.3 Not in use.

14.2.3.4 Not in use.

14.2.3.5 Not in use.

14.2.3.6 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.

14.2.4 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 ICAO Aerodrome Design Manual, Part 3.

14.2.4.1 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.

14.2.4.2 **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.

14.2.4.3 **Recommendation —** The entire width of the runway should be overlaid during each work session.

14.2.4.4 Before a runway being overlaid is returned to a temporary operational status, a runway centre line marking conforming to the specifications in Section 9.2.2.3 of this Manual shall be provided. Additionally, the location of any temporary threshold shall be identified by a 3.6 m wide transverse stripe.

14.2.4.5 Not in use.

14.2.5 Visual aids

Note 1 — These specifications are intended to define the maintenance performance level objectives. They are not intended to define whether the lighting system is operationally out of service.

Note 2 — The energy savings of light emitting diodes (LEDs) are due in large part to the fact that they do not produce the infra-red heat signature of incandescent lamps.

Note 3 — Enhanced vision systems (EVS) technology relies on the infra-red heat signature provided by incandescent lighting. ICAO Annex 15 protocols provide an appropriate means of notifying aerodrome users of EVS when lighting systems are converted to LED.

14.2.5.1 A light shall be deemed to be unserviceable when the main beam average intensity is less than 50 per cent of the value specified in the appropriate figure in ICAO Annex 14 Vol. I, Appendix 2. For light units where the designed main beam average intensity is above the value shown in ICAO Annex 14 Vol. I, Appendix 2, the 50 per cent value shall be related to that design value.

14.2.5.2 A system of preventive maintenance of visual aids shall be employed to ensure lighting and marking system reliability.

Note — Guidance on preventive maintenance of visual aids is given in the ICAO Airport Services Manual, Part 9.

14.2.5.3 **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 the air traffic control unit.

14.2.5.4 **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 Vol. I, Appendix 2.

14.2.5.5 **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 analyze the characteristics of the individual lights.

14.2.5.6 **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.

14.2.5.7 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 per cent 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 per cent of the lights are serviceable in the touchdown zone lights;

c) 85 per cent of the lights are serviceable in the approach lighting system beyond 450 m; and

d) 75 per cent 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.

Note — With respect to barrettes, crossbars and runway edge lights, lights are considered to be adjacent if located consecutively and:

— *laterally: in the same barrette or crossbar; or*

— *longitudinally: in the same row of edge lights or barrettes.*

14.2.5.8 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 350 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.

14.2.5.9 The system of preventive maintenance employed for a taxiway intended for use in runway visual range conditions less than a value of 350 m shall have as its objective that no two adjacent taxiway centre line lights be unserviceable.

14.2.5.10 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 per cent 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.

Note — In barrettes and crossbars, guidance is not lost by having two adjacent unserviceable lights.

14.2.5.11 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 that, during any period of operations, all runway lights are serviceable and that in any event:

a) at least 95 per cent of the lights are serviceable in the runway centre line lights (where provided) and in the runway edge lights; and

b) at least 75 per cent 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.

14.2.5.12 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 per cent 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.

14.2.5.13 During low visibility procedures the aerodrome operator shall restrict construction or maintenance activities in the proximity of aerodrome electrical systems.

APPENDIX A – CROSS-REFERENCES BETWEEN THE STANDARDS AND RECOMMENDED PRACTICES OF THE MANUAL OF AERODROME STANDARDS AND THOSE OF ICAO ANNEX 14 VOL. I

Section in the Manual of Aerodrome Standards	Corresponding section in the ICAO Annex 14 Vol. I	Remarks
Section 1.2	Section 1.1	Definitions
Section 3.1.2	Paragraphs 1.4.1, 1.4.2 and 1.4.3	Requirement for Aerodrome Certification
Section 3.2	Paragraph 1.4.4	Requirement for Aerodrome Manual
Section 5.2	Paragraph 1.4.4	Requirement for Safety Management System
Section 2.2	Section 1.6	Aerodrome Reference Code
Chapter 6	Chapter 2	Aerodrome Data
Chapter 7	Chapter 3	Physical Characteristics
Chapter 8	Chapter 4	Obstacle Restriction and Removal
Chapter 9	Chapter 5	Visual Aids for Navigation
Chapter 10	Chapter 6	Visual Aids for denoting Obstacles
Chapter 11	Chapter 7	Visual Aids for denoting Restricted Use Areas
Chapter 12	Chapter 8	Electrical Systems
Chapter 13	Chapter 9	Aerodrome Operational Services, Equipment and Installations
Chapter 14	Chapter 10	Aerodrome Maintenance

Table A-1 Cross-references between the standards and recommended practices of the MOAS and those of ICAO Annex 14 Vol I.

APPENDIX B – LIST OF RELATED REFERENCE DOCUMENTS

No.	Document
1	ICAO Annex 14 Vol. I
2	ICAO Aerodrome Design Manual (Doc 9157) Part 1 – Runways Part 2 – Taxiways, Aprons and Holding Bays Part 3 – Pavements Part 4 – Visuals Aids Part 5 – Electrical Systems Part 6 – Frangibility
3	ICAO Airport Planning Manual (Doc 9184) Part 1 – Master Planning Part 2 – Land Use and Environment Control Part 3 – Guidelines for Consultant/Construction Services
4	ICAO Airport Services Manual (Doc 9137) Part 1 – Rescue and Fire Fighting Part 2 – Pavement Surface Conditions Part 3 – Wildlife Control and Reduction Part 5 – Removal of Disabled Aircraft Part 6 – Control of Obstacles Part 7 – Airport Emergency Planning Part 8 – Airport Operational Services Part 9 – Airport Maintenance Practices
5	ICAO Manual on ICAO Bird Strike Information System (Doc 9332)
6	ICAO Manual of Surface Movement Guidance and Control Systems (Doc 9476)
7	ICAO Safety Management Manual (Doc 9859)
8	Aeronautical Information Services Manual (Doc 8126)
9	Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual (Doc 9830)
10	Procedures for Air Navigation Services – Aerodromes (PANS-Aerodromes) (Doc 9981)

APPENDIX C – FORM FOR APPLICATION/ RENEWAL OF AN AERODROME CERTIFICATE

FORM FOR APPLICATION/RENEWAL OF AN AERODROME CERTIFICATE

☐ Application ☐ Renewal

1 Particulars of the Applicant

Full Name: ……………………………………………………………………………………

Address: ……………………………………………………………………………………
……………………………………………………………………………………
…………………………………………… Postal Code: ……………

Position: ……………………………………………………………………………………

Phone: …………………… Fax: …………………… E-mail: ……………………………………

2 Particulars of the Aerodrome Site

Aerodrome Name: ……………………………………………………………………………

Real Property Description: ……………………………………………………………………
……………………………………………………………………
……………………………………………………………………

Geographical Coordinates of the Aerodrome Reference Point:

Latitude: ……………………………… Longitude: ………………………………………

(in degrees, minutes and tenths of minutes and in WGS-84 format)

3 Is the Applicant the Owner of the Aerodrome Site?

Yes ☐ No ☐

If No, please provide:

(a) Details of rights held in relation to the site; and

(b) Name and address of the owner of the site and written evidence that permission has been obtained for the site to be used by the applicant as an aerodrome.

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4 Details of Aerodrome

Intended commencement date of aerodrome operations: ………………………………………

Operating hours: ………………………………………………………………………………….

Largest type of aircraft expected to operate at aerodrome: ………………………………………

Intended aerodrome reference code[3]: ……………………………………………………………

Intended type of runway: Non-instrument ☐ Non-precision ☐

Precision CAT I ☐ CAT II ☐ CAT III ☐

Aerodrome traffic density: ……………………………………………………………………….

Intended rescue & fire-fighting category[4]: ………………………………………………………..

5 Is the aerodrome to be used for regular public transport operations?

Yes ☐ No ☐

6 Details to be shown on the Aerodrome Certificate

Aerodrome Name: ……………………………………………………………………………….

Aerodrome Operator: ……………………………………………………………………………

Address: …………………………………………………………………………………………..

…………………………………………………………………………………………..

On behalf of the Aerodrome Operator shown above, I hereby apply for a certificate to operate the aerodrome.

My authority to act on behalf of the applicant is:

……..

……….

Signed: ……………………………… Date: ……………………………..

Name of person making the declaration: …………………………………………

NOTES:

1 One copy of the Aerodrome Manual, prepared in accordance with the Eighteenth Schedule of the Air Navigation Order and CAAS Manual of Aerodrome Standards commensurate with the aircraft activities expected at the aerodrome, is required as part of this application.

2 Documentary evidence in support of all matters in this application may be requested.

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[3] Refer to CAAS Manual of Aerodrome Standards Table 2-1.
[4] Refer to CAAS Manual of Aerodrome Standards Table 13-1.

APPENDIX D – NOT IN USE

APPENDIX D1 – NOT IN USE

APPENDIX E – PARTICULARS TO BE INCLUDED IN AN AERODROME MANUAL

PART 1

GENERAL

General information, including the following:

a) A table of contents;
b) A list of corrigenda/amendments, including the updates and/or corrections made to the aerodrome manual;
c) A distribution list;
d) The purpose and scope of the Aerodrome Manual;
e) The legal requirement for an Aerodrome Certificate and an Aerodrome Manual as prescribed in the national regulations;
f) The conditions for use of the aerodrome – a statement to indicate that the aerodrome shall at all times when it is available for the take-off and landing of aircraft, be so available to all persons on equal terms and conditions;
g) The available aeronautical information services and procedures for timely and accurate effecting promulgation of AIP Amendment, AIP Supplement or NOTAM;
h) The system for recording aircraft movements;
i) A description of the SMS (See Section 5.2 of this manual);
j) A description of the intended operations, including:
    1) the critical aeroplanes the aerodrome is intended to serve;
    2) the category of runway(s) provided (non-instrument, instrument including non-precision and precision);
    3) the different runways and their associated levels of service;
    4) the nature of aviation activities (commercial, passenger, air transport, cargo, aerial work, general aviation);
    5) the type of traffic permitted to use the aerodrome (international/national, IFR/VFR, scheduled/nonscheduled); and
    6) the minimum RVR that aerodrome operations can be permitted;
k) The obligations of the aerodrome operator; and
l) A table presented in the format shown below to indicate the aerodrome and aerodrome operator's compliance status with EACH clause of this Manual of Aerodrome Standards and exemptions, if any, shall be listed together with their validity and references to the related documents (including any safety assessment).

Table of Compliance with the clauses in the Manual of Aerodrome Standards			
Clause No. in the Manual of Aerodrome Standards	To indicate whether Standard or Recommended	To indicate whether fully compliant, partially compliant, or non-compliant	To provide remarks or brief explanation when partially compliant

	Practice		or non-compliant

PART 2

PARTICULARS OF THE AERODROME SITE

General information, including the following:

a) a plan of the aerodrome showing the main aerodrome facilities for the operation of the aerodrome including, particularly, the location of each wind direction indicator;
b) a plan of the aerodrome showing the aerodrome boundaries;
c) a plan showing the distance of the aerodrome from the city or other populous area, and the location of any aerodrome facilities and equipment outside the boundaries of the aerodrome; and
d) particulars of the title of the aerodrome site. If the boundaries of the aerodrome are not defined in the title documents particulars of the title to, or interest in, the property on which the aerodrome is located and a plan showing the boundaries and position of the aerodrome.

PART 3

PARTICULARS OF THE AERODROME REQUIRED TO BE REPORTED TO THE AERONAUTICAL INFORMATION SERVICE (AIS)

3.1 GENERAL INFORMATION

a) the name of the aerodrome;
b) the location of the aerodrome;
c) the geographical coordinates of the aerodrome reference point determined in terms of the World Geodetic System – 1984 (WGS-84) reference datum;
d) the aerodrome elevation and geoid undulation;
e) the elevation of each threshold and geoid undulation, the elevation of the runway end and any significant high and low points along the runway, and the highest elevation of the touchdown zone of a precision approach runway;
f) the aerodrome reference temperature;
g) details of the aerodrome beacon; and
h) the name of the aerodrome operator and the address and telephone number at which the aerodrome operator may be contacted at all times.

3.2 AERODROME DIMENSIONS AND RELATED INFORMATION

General information, including the following:

a) runway – true bearing, designation number, length, width, displaced threshold location, slope, surface type, type of runway and, for a precision approach runway, the existence of an obstacle free zone;
b) length, width and surface type of strip, runway end safety areas, stopways;
c) length, width and surface type of taxiways;
d) apron surface type and aircraft stands;
e) clearway length and ground profile;
f) visual aids for approach procedures, *viz*, approach lighting type and visual approach slope indicator system (PAPI/APAPI and T-VASIS/AT-VASIS); marking and lighting of runways, taxiways, and aprons; other visual guidance and control aids on taxiways (including runway holding positions, intermediate holding positions and stop bars) and aprons, location and type of visual docking guidance system; availability of standby power for lighting.
g) the location and radio frequency of VOR aerodrome checkpoints;
h) the location and designation of standard taxi routes;
i) the geographical coordinates of each threshold;
j) the geographical coordinates of appropriate taxiway centre line points;
k) the geographical coordinates of each aircraft stand;
l) the geographical coordinates and the top elevation of significant obstacles in the approach and take-off areas, in the circling area and in the vicinity of the aerodrome. (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 Annexes 4 and 15 to the Convention);
m) pavement surface type and bearing strength using the Aircraft Classification Number – Pavement Classification Number (ACN-PCN) method;
n) one or more pre-flight altimeter check locations established on and apron and their elevation;
o) declared distances: take-off run available (TORA), take-off distance available (TODA), accelerate-stop distance available (ASDA), landing distance available (LDA);
p) disabled aircraft removal plan: the telephone/telex/facsimile numbers and e-mail address of the aerodrome coordinator for the removal of a disabled aircraft on or adjacent to the movement area, information on the capability to remove a disabled aircraft, expressed in terms of the largest type of aircraft which the aerodrome is equipped to remove; and
q) rescue and fire-fighting: the level of protection provided, expressed in terms of the category of the rescue and fire-fighting services, which should be in accordance with the longest aeroplane normally using the aerodrome and the type and amounts of extinguishing agents normally available at the aerodrome.
r) width and surface type of taxiway shoulders;
s) location, markings lighting and the largest aircraft type that can use the runway turnpad;
t) location, dimensions and largest helicopter that can use the Final Approach and Takeoff area (FATO);

Note – The accuracy of the information in Part 3 is critical to aircraft safety. Information requiring engineering survey and assessment should be gathered or verified by qualified technical persons.

PART 4

PARTICULARS OF THE AERODROME OPERATING PROCEDURES AND SAFETY MEASURES

4.1 AERODROME REPORTING

Particulars of the procedures for reporting any changes to the aerodrome information set out in the AIP and procedures for requesting the issue of NOTAMS, including the following:

a) arrangement for reporting any changes to the Aerodrome and ANS Regulation Division and recording the reporting of changes during and outside the normal hours of aerodrome operations;
b) the names and roles of persons responsible for notifying the changes, and their telephone numbers during and outside the normal hours of aerodrome operations; and
c) the address and telephone numbers, as provided by the Aerodrome and ANS Regulation Division, of the place where changes are to be reported to the Aerodrome and ANS Regulation Division.

4.2 ACCESS TO THE AERODROME MOVEMENT AREA

Particulars of the procedures that have been developed and are to be followed in coordination with the agency responsible for preventing unlawful interferences in civil aviation at the aerodrome and for preventing unauthorized entry of persons, vehicles, equipment, animals or other things into the *movement area*, including the following:

a) the role of the aerodrome operator, the aircraft operator, aerodrome fixed-base operators, the aerodrome security entity, the Aerodrome and ANS Regulation Division and other government departments, as applicable; and
b) the names and roles of the personnel responsible for controlling access to the aerodrome, and the telephone numbers for contacting them during and after working hours.

4.3 AERODROME EMERGENCY PLAN

Particulars of the aerodrome emergency plan, including the following:

a) plans for dealing with emergencies occurring at the aerodrome or in its vicinity, including the malfunction of aircraft in flight; structural fires; sabotage, including bomb threats (aircraft or structure); unlawful seizure of aircraft; and incidents on the airport covering “during the emergency” and “after the emergency” considerations;
b) details of test for aerodrome facilities and equipment to be used in emergencies, including the frequency of those tests;

c) details of exercises to test emergency plans, including the frequency of those exercises;
d) a list of organizations, agencies and persons of authority, both on- and off-airport, for site roles; their telephone and facsimile numbers, e-mail and SITA addresses and the radio frequencies of their offices;
e) the establishment of an aerodrome emergency committee to organize training and other preparations for dealing with emergencies; and
f) the appointment of an on-scene commander for the overall emergency operation.

4.4 RESCUE AND FIRE-FIGHTING

Particulars of the facilities, equipment, personnel and procedures for meeting the rescue and fire-fighting requirements, including the names and roles of the persons responsible for dealing with the rescue and fire-fighting services at the aerodrome.

Note – This subject should also be covered in appropriate detail in the aerodrome emergency plan.

4.5 INSPECTION OF THE AERODROME MOVEMENT AREA AND OBSTACLE LIMITATION SURFACE BY THE AERODROME OPERATOR

Particulars of the procedures for the inspection of the aerodrome movement area and obstacle limitation surfaces, including the following:

a) arrangement for carrying out inspections, including runway friction and water-depth measurements on runways and taxiways, during and outside the normal hours of aerodrome operations;
b) arrangement and means of communicating with the aerodrome air traffic control unit during an inspection;
c) arrangements for keeping an inspection logbook, and the location of the logbook;
d) details of inspection intervals and times;
e) inspection checklist;
f) arrangement for reporting the results of inspections and for taking prompt follow-up actions to ensure correction of unsafe conditions; and
g) the names and roles of persons responsible for carrying out inspections, and their telephone number during and after working hours.

4.6 VISUAL AIDS AND AERODROME ELECTRICAL SYSTEMS

Particulars of the procedures for the inspection and maintenance of aeronautical lights (including obstacle lighting), signs, markers and aerodrome electrical systems, including the following:

a) arrangement for carrying out inspections during and outside the normal hours of aerodrome operation, and the checklist for such inspection;

b) arrangements for recording the results of inspections and for taking follow-up action to correct deficiencies;
c) arrangements for carrying out routine maintenance and emergency maintenance;
d) arrangements for secondary power supplies, if any, and, if applicable, the particulars of any other method of dealing with partial or total system failure; and
e) the names and roles of the persons responsible for the inspection and maintenance of the lighting, and the telephone numbers for contacting those persons during and after working hours.

4.7 MAINTENANCE OF THE MOVEMENT AREA

Particulars of the facilities and procedures for the maintenance of the movement area, including:

a) arrangements for maintaining the paved areas;
b) arrangements for maintaining the unpaved runways and taxiways;
c) arrangements for maintaining the runway and taxiway strips; and
d) arrangements for the maintenance of aerodrome drainage.

4.8 AERODROME WORK SAFETY

Particulars of the procedures for planning and carrying out construction and maintenance work safely (including work that may have to be carried out at short notice) on or in the vicinity of the movement area which may extend above an obstacle limitation surface, including the following:

a) arrangements for communicating with the aerodrome air traffic control unit during the progress of such work;
b) the names, telephone numbers and roles of the persons and organizations responsible for planning and carrying out the work, and arrangements for contacting those persons and organizations at all times;
c) the names and telephone numbers, during and after working hours, of the aerodrome fixed-based operators, ground handling agents and aircraft operators who are to be notified of the work.
d) a distribution list for work plans, if required.

4.9 APRON MANAGEMENT

Particulars of the apron management procedures, including the following:

a) arrangements between air traffic control and the apron management units;
b) arrangements for allocating aircraft parking positions;
c) arrangements for initiating engine start and ensuring clearance of aircraft push-back; and
d) marshalling service.

4.10 APRON SAFETY MANAGEMENT

Procedures to ensure apron safety include:

a) protection from jet blasts;
b) enforcement of safety precautions during aircraft refuelling operations including specifying the type and size of fire extinguishers at suitable intervals along the length of the apron;
c) apron sweeping;
d) apron cleaning;
e) arrangements for reporting incidents and accidents on an apron;
f) arrangements for auditing the safety compliance of all personnel working on the apron; and
g) management of safety of ground handling operations which include, but are not limited to the following:
    (i) Operation of ground support equipment associated with aircraft handling and loading;
    (ii) Operation of passenger loading bridge;
    (iii) Aircraft fuelling;
    (iv) Aircraft pushback;
    (v) Aircraft powerback;
    (vi) Aircraft towing;
    (vii) Aircraft power-in arrival and power-out departure; and
    (viii) Aircraft marshalling.

4.11 AIRSIDE VEHICLE CONTROL

Particulars of the procedure for the control of surface vehicles on or in the vicinity of the movement area, including the following:

a) details of the application traffic rules (including speed limits and the means of enforcing the rules); and
b) the method of issuing driving permits for operating vehicles in the movement area.

4.12 WILDLIFE HAZARD MANAGEMENT

Particulars of the procedures to deal with the danger posed to aircraft operations by the presence of bird or mammals in the aerodrome flight pattern or movement area, including the following:

a) arrangements for assessing wildlife hazards;
b) arrangements for implementing wildlife control programmes; and
c) the names and roles of the persons responsible for dealing with wildlife hazards, and their telephone numbers during and after working hours.

4.13 OBSTACLE CONTROL

Particulars setting out the procedures for:

a) monitoring the obstacle limitation surfaces and Type A Chart for obstacle in the take-off surface;
b) controlling obstacles within the authority of the operator;
c) monitoring the height of buildings or structures within the boundaries of the obstacle limitation surfaces;
d) controlling new developments in the vicinity of aerodromes; and
e) notifying the Aerodrome and ANS Regulation Division of the nature and location of obstacles and any subsequent addition or removal of obstacles for action as necessary, including amendment of the AIS publications.

4.14 REMOVAL OF DISABLED AIRCRAFT

Particulars of the procedures for removing a disabled aircraft on or adjacent to the movement area, including the following:

a) the roles of the aerodrome operator and the holder of the aircraft certificate of registration;
b) arrangements for notifying the holder of the certificate of registration;
c) arrangements for liaising with the aerodrome air traffic control unit;
d) arrangements for obtaining equipment and personnel to remove the disabled aircraft; and
e) the names, role and telephone numbers of persons responsible for arranging for the removal of disabled aircraft.

4.15 HANDLING OF DANGEROUS GOODS

Particulars of the procedures for the safe handling and storage of dangerous goods on the aerodrome, including the following:

a) arrangements for special areas on the aerodrome to be set up for the storage of inflammable liquids (including aviation fuels) and any other dangerous goods; and
b) the method to be followed for the delivery, storage, dispensing and handling of dangerous goods.

Note – Dangerous goods include inflammable liquids and solid, corrosive liquids, compressed gases and magnetized or radioactive materials. Arrangements for dealing with the accidental spillage of dangerous goods should be included in the aerodrome emergency plan.

4.16 LOW-VISIBILITY OPERATIONS

Particulars of procedures to be introduced for low-visibility operations, including the measurement and reporting of runway visual range as and when required, and the names and telephone numbers, during and after working hours, of the persons responsible for measuring the runway visual range.

4.17 PROTECTION OF SITES FOR RADAR AND NAVIGATIONAL AIDS

Particulars of the procedures for the protection of sites for radar and radio navigational aids located on the aerodrome to ensure that their performance will not be degraded, including the following:

a) arrangements for the control of activities in the vicinity of radar and navaids installations;
b) arrangements for ground maintenance in the vicinity of these installations; and
c) arrangements for the supply and installation of signs warning hazardous microwave radiation.

Note 1 – In writing the procedures for each category, clear and precise information should be included on:

- *when, or in what circumstances, an operating procedure is to be activated*
- *how an operating procedure is to be activated;*
- *actions to be taken;*
- *the persons who are to carry out the actions; and*
- *the equipment necessary for carrying out the actions, and access to such equipment.*

Note 2 – If any of the procedures specified above are not relevant or applicable, the reason should be given.

4.18 RUNWAY INCURSION PREVENTION

Particulars of the facilities, equipment and procedures in place to prevent runway incursion, including integration of markings, lights and signs as a whole into the runway incursion prevention plan, taking account of different traffic intensities and visibility conditions.

4.19 HAZARDOUS METEOROLOGICAL CONDITIONS

Particulars of the procedures to deal with hazardous meteorological conditions, include the following:

a) the role of the aerodrome operator, the aircraft operator, the aerodrome air traffic control unit, the ground handling service providers and other relevant stakeholders, as applicable; and
b) the names and roles of the personnel responsible for dealing with hazardous meteorological conditions , and the telephone numbers for contacting them during and after working hours.

4.20 AVIATION FUEL QUALITY AT AERODROMES

Particulars of the procedures to deal with aviation fuel quality at aerodromes.

PART 5

DETAILS OF THE AERODROME ADMINISTRATION AND SAFETY MANAGEMENT SYSTEM

Aerodrome administration

Particulars of the aerodrome administration, include the following:

a) an aerodrome organisation chart showing the names and positions of key personnel, including their safety responsibilities;
b) the name, position and telephone number of the person who has overall responsibility for aerodrome safety;
c) airport committees; and
d) particulars of staff training and competency, including the specifications of staff qualifications and experience, training and programme for upgrading of skills provided to staff on safety-related duties, and where necessary, the certification system for testing their competency; and
e) Responsibilities attributed to other aerodrome stakeholders

APPENDIX F – DOCUMENTS AND PUBLICATIONS THAT MUST BE KEPT AND MADE AVAILABLE FOR REFERENCE BY AERODROME OPERATOR STAFF

Publishing Organisation	Name of Document	Reference
Aerodrome Operator	Aerodrome Manual	
	Airport Emergency Plan	
	Airport Security Programme	
Aerodrome and ANS Regulation Division	Manual of Aerodrome Standards	
Civil Aviation Authority of Singapore	Aeronautical Information Publication, Singapore	
	Air Navigation Order	
ICAO	Annex 9 – Facilitation	
	Annex 10 – Aeronautical Telecommunication Vol. I and II	
	Annex 13 – Aircraft Accident and Incident Investigation	
	Annex 14 – Aerodromes Vol. I and II	
	Annex 15 – Aeronautical Information Services	
	Annex 16 – Environmental Protection Vol. I and II	
	Annex 17 – Security	
	Aeronautical Information Services Manual	Doc 8126
	ICAO Abbreviation and Codes	Doc 8400
	Aircraft Type Designators	Doc 8643

Publishing Organisation	Name of Document	Reference
ICAO	ICAO Airport Services Manual Part 1 – Rescue and Fire Fighting Part 2 – Pavement Surface Conditions Part 3 – Wildlife Control and Reduction Part 5 – Removal of Disabled Aircraft Part 6 – Control of Obstacles Part 7 – Airport Emergency Planning Part 8 – Airport Operational Services Part 9 – Airport Maintenance Practices	Doc 9137
	ICAO Aerodrome Design Manual Part 1 – Runways Part 2 – Taxiways, Aprons and Holding Bays Part 3 – Pavements Part 4 – Visuals Aids Part 5 – Electrical Systems Part 6 – Frangibility	Doc 9157
	ICAO Airport Planning Manual (Doc 9184) Part 1 – Master Planning Part 2 – Land Use and Environment Control Part 3 – Guidelines for Consultant/Construction Services	Doc 9184
	ICAO Manual on ICAO Bird Strike Information System	Doc 9332
	ICAO Manual of Surface Movement Guidance and Control Systems	Doc 9476
	Human Factors Training Manual	Doc 9683
	Guidance on the Balanced Approach to Aircraft Noise Management	Doc 9829
	Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual	Doc 9830
	ICAO Safety Management Manual	Doc 9859
	Procedures for Air Navigation Services – Aerodromes (PANS-Aerodromes)	Doc 9981

APPENDIX G – DOCUMENT AND RECORDS THAT MUST BE MAINTAINED BY THE AERODROME CERTIFICATE HOLDER

Item	Safety Records	Retention Period
1	Aircraft Ground Incident Records	Minimum retention periods for these documents and records shall be established by the aerodrome operator and documented in the Aerodrome Manual.
2	Aircraft Pavement Inspection Log and Maintenance Records	
3	Airfield Lighting Inspection Log and Maintenance Records	
4	Aerodrome Engineering Facilities (related to aircraft operations) Maintenance Records	
5	Apron Control Tower Log	
6	Wildlife Control Activities Records	
7	Safety Audit Records (in conjunction with the implementation of Safety Management System)	
8	Vehicular Accident Records	

APPENDIX H – WILDLIFE STRIKE REPORTING FORM

WILDLIFE STRIKE REPORTING FORM

(This information is required for aviation safety)

OPERATOR or CALL SIGN

AIRCRAFT TYPE [ ]

ENGINE TYPE [ ]

AIRCRAFT REGISTRATION [ ]

DATE **Day** [ ] **Month** [ ] **Year** [ ]

TIME OF INCIDENT [ ] **(UTC)** [ ]

Dawn ☐ Day ☐ Dusk ☐ Night ☐

AERODROME NAME [Aerodrome]

RUNWAY USED [RWY]

HEIGHT AGL [Height]

APPROX. GEOGRAPHICAL LOCATION

SPEED (IAS) **kt**

PHASE OF FLIGHT

☐ Unknown ☐ En-route
☐ Taxi ☐ Descend
☐ Take-off run ☐ Approach
☐ Climb ☐ Landing Roll

SKY CONDITION

☐ No Cloud
☐ Some Cloud
☐ Overcast

PRECIPITATION

☐ Fog
☐ Rain

PART(S) OF AIRCRAFT

	Struck	Damage
Radome	☐	☐
Windshield	☐	☐
Nose (excluding above)	☐	☐
Engine No. 1	☐	☐
2	☐	☐
3	☐	☐
4	☐	☐
Propeller	☐	☐
Wing/Rotor	☐	☐
Fuselage	☐	☐
Landing gear	☐	☐
Tail	☐	☐
Lights	☐	☐
Other	☐	☐

Specify: [Specify here]

WILDLIFE SPECIES * [ ]

NUMBER OF WILDLIFE SPECIES **Seen** **Struck**

SIZE OF WILDLIFE SPECIES ☐ Small ☐ Medium ☐ Large

PILOT WARNED OF WILDLIFE SPECIES ☐ Yes ☐ No

LIGHTS USED :

Landing ☐ Yes ☐ No

Strobe Anti-Collision ☐ Yes ☐ No

EFFECT ON FLIGHT

☐ None
☐ Aborted take-off
☐ Precautionary landing
☐ Engines shut down
☐ Other (Specify)

REMARKS

** Send all wildlife species remains to :*

APPENDIX J - REQUEST FOR GRANT OF EXEMPTION

Request for Grant of Exemption(s)		
Aerodrome Name:	Date:	
Aerodrome Operator:		
Aerodrome Address:		
Geographical Coordinates of the Aerodrome Reference Point: Latitude: ……………………. Longitude: …..……………….. (in degrees, minutes and tenths of minutes and in WGS-84 format)		
Reference clause(s) in MOAS:		
Reason(s) for exemption:		
Date for complying with the stated MOAS clause(s), if applicable:		
Comments:		
A copy of appropriate risk assessment and/ or aeronautical studies attached with the request:	□ Yes	□ No

DECLARATION

(1) I give my consent for the CAAS to obtain and verify from or with any source, as CAAS deem appropriate for the assessment of my request.

(2) I declare that the particulars given by me in this application and the attached sheets are true to the best of my knowledge and understanding, and I have not wilfully suppressed any material fact. I accept that if any of the information given by me in this application is any way false or incorrect, I shall be disqualified from exemption process.

Name of Applicant/Signature:	Designation:
Contact number/Fax:	E-mail:
For official use only:	
Verified by:	
Name of Aerodrome Inspector/Signature:	Date:
Designation	Contact number/Fax/E-mail:
Comments:	
Supported by:	
Name of Supporting Officer/Signature:	Date:
Designation	Contact number/Fax/E-mail:
Comments:	