

**COVER SHEET TO AMENDMENT 13-B**

**INTERNATIONAL STANDARDS  
AND RECOMMENDED PRACTICES**

# **AERODROMES**

**ANNEX 14  
TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION**

**VOLUME I  
AERODROME DESIGN AND OPERATIONS**

**SEVENTH EDITION — JULY 2016**

**INTERNATIONAL CIVIL AVIATION ORGANIZATION**

# Checklist of Amendments to Annex 14, Volume I

	<i>Effective date</i>	<i>Date of applicability</i>
Seventh Edition (incorporates Amendments 1 to 13-A)	11 July 2016	10 November 2016
Amendment 13-B (adopted by the Council on 22 February 2016) Replacement pages (viii), (ix), (xvi), 1-8 to 1-15, 2-1, 2-6 to 2-12, 3-2, 3-6, 3-7, 3-12, 3-14 and 3-18, 5-3, 5-28, 5-32 to 5-35, 5-39, 5-61, 7-4, 9-4, 9-10, 9-12, 9-16, 10-1 to 10-3, ATT A-8 to ATT A-20, ATT A-23 to ATT A-34 and 1 to 4.	11 July 2016	5 November 2020



*Transmittal note*

Amendment 13-B

to the

International Standards and  
Recommended Practices

**AERODROMES**

(Annex 14, Volume I, to the Convention on International Civil Aviation)

1. The following replacement pages in Annex 14, Volume I, (Seventh Edition) incorporate Amendment 13-B which becomes applicable on 5 November 2020:
  - a) Pages (viii) and (ix) — Table of Contents
  - b) Page (xxi) — Foreword
  - c) Pages 1-8 to 1-15 — Chapter 1
  - d) Pages 2-1, and 2-6 to 2-12 — Chapter 2
  - e) Page 3-2, 3-6, 3-7, 3-12, 3-14 and 3-18 — Chapter 3
  - f) Pages 5-3, 5-28, 5-32 to 5-35, 5-39 and 5-61 — Chapter 5
  - g) page 7-4 — Chapter 7
  - h) Page 9-4, 9-10, 9-12 and 9-16 — Chapter 9
  - i) Pages 10-1 to 10-3 — Chapter 10
  - j) Pages ATT A-8 to ATT A-20, ATT-23 to ATT-34 — Attachment A
  - k) Pages 1 to 4 — Index
2. These pages should be retained separately from the Annex proper until the applicability date is reached, at which time they should be incorporated into the Annex.
3. Record the entry of these amendments on page (iii).



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<i>Amendment</i>	<i>Source(s)</i>	<i>Subject(s)</i>	<i>Adopted/Approved Effective Applicable</i>
13-B	Third meeting of the Aerodromes Panel (AP/3) developed by the Friction Task Force	Enhanced global reporting format for assessing and reporting runway surface condition.	22 February 2016 11 July 2016 5 November 2020

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**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.

**Manoeuvring area.** That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, excluding aprons.

**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.

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

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

**Non-instrument runway.** A runway intended for the operation of aircraft using visual approach procedures 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 Annex 2 — Rules of the Air.*

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

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

- a) are located on an area intended for the surface movement of aircraft; or
- b) 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.

**Obstacle free zone (OFZ).** The airspace above the inner approach surface, inner transitional surfaces, and balked landing surface and that portion of the strip bounded by these surfaces, which is not penetrated by any fixed obstacle other than a low-mass and frangibly mounted one required for air navigation purposes.

**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*.

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

**Protected flight zones.** Airspace specifically designated to mitigate the hazardous effects of laser radiation.

**Road.** An established surface route on the movement area meant for the exclusive use of vehicles.

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

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

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

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

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

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

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

**Runway guard lights.** A light system intended to caution pilots or vehicle drivers that they are about to enter an active runway.

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

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

**Runway strip.** A defined area including the runway and stopway, if provided, intended:

- a) to reduce the risk of damage to aircraft running off a runway; and
- b) to protect aircraft flying over it during take-off or landing operations.

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

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

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

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

- a) **Dry runway.** A runway is considered dry if its surface is free of visible moisture and not contaminated within the area intended to be used.
- b) **Wet runway.** The runway surface is covered by any visible dampness or water up to and including 3 mm deep within the intended area of use.

- c) *Slippery wet runway.* A wet runway where the surface friction characteristics of a significant portion of the runway have been determined to be degraded.
- d) *Contaminated runway.* A runway is contaminated when a significant portion of the runway surface area (whether in isolated areas or not) within the length and width being used is covered by one or more of the substances listed in the runway surface condition descriptors.

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

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

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

- i) *Compacted snow.* Snow that has been compacted into a solid mass such that aeroplane tires, at operating pressures and loadings, will run on the surface without significant further compaction or rutting of the surface.
- ii) *Dry snow.* Snow from which a snowball cannot readily be made.
- iii) *Frost.* Frost consists of ice crystals formed from airborne moisture on a surface whose temperature is below freezing. Frost differs from ice in that the frost crystals grow independently and therefore have a more granular texture.

*Note 1.— Below freezing refers to air temperature equal to or less than the freezing point of water (0 degree Celsius).*

*Note 2.— Under certain conditions frost can cause the surface to become very slippery and it is then reported appropriately as reduced braking action.*

- iv) *Ice.* Water that has frozen or compacted snow that has transitioned into ice, in cold and dry conditions.
- v) *Slush.* Snow that is so water-saturated that water will drain from it when a handful is picked up or will splatter if stepped on forcefully.
- vi) *Standing water.* Water of depth greater than 3 mm.

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

- vii) *Wet ice.* Ice with water on top of it or ice that is melting.

*Note.— Freezing precipitation can lead to runway conditions associated with wet ice from an aeroplane performance point of view. Wet ice can cause the surface to become very slippery. It is then reported appropriately as reduced braking action in line with procedures in the PANS-Aerodromes (Doc 9981).*

- viii) *Wet snow.* Snow that contains enough water content to be able to make a well-compacted, solid snowball, but water will not squeeze out.

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

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

**Safety management system (SMS).** A systematic approach to managing safety including the necessary organizational structure, accountabilities, policies and procedures.

**Segregated parallel operations.** Simultaneous operations on parallel or near-parallel instrument runways in which one runway is used exclusively for approaches and the other runway is used exclusively for departures.

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

**Sign.**

- a) *Fixed message sign.* A sign presenting only one message.
- b) *Variable message sign.* A sign capable of presenting several predetermined messages or no message, as applicable.

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

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

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

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

**Take-off runway.** A runway intended for take-off only.

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

- a) *Aircraft stand taxilane.* A portion of an apron designated as a taxiway and intended to provide access to aircraft stands only.
- b) *Apron taxiway.* A portion of a taxiway system located on an apron and intended to provide a through taxi-route across the apron.
- c) *Rapid exit taxiway.* A taxiway connected to a runway at an acute angle and designed to allow landing aeroplanes to turn off at higher speeds than are achieved on other exit taxiways thereby minimizing runway occupancy times.

**Taxiway intersection.** A junction of two or more taxiways.

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

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

**Touchdown zone.** The portion of a runway, beyond the threshold, where it is intended landing 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 crosswind component.

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

## 1.2 Applicability

1.2.1 The interpretation of some of the specifications in the Annex expressly requires the exercising of discretion, the taking of a decision or the performance of a function by the appropriate authority. In other specifications, the expression appropriate authority does not actually appear although its inclusion is implied. In both cases, the responsibility for whatever determination or action is necessary shall rest with the State having jurisdiction over the aerodrome.

1.2.2 The specifications, unless otherwise indicated in a particular context, shall apply to all aerodromes open to public use in accordance with the requirements of Article 15 of the Convention. The specifications of Annex 14, Volume I, Chapter 3, shall apply only to land aerodromes. The specifications in this volume shall apply, where appropriate, to heliports but shall not apply to stolports.

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

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

## 1.3 Common reference systems

### 1.3.1 Horizontal reference system

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

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

### 1.3.2 Vertical reference system

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

*Note 1.— The geoid globally most closely approximates MSL. It is defined as the equipotential surface in the 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); see Annex 15 — *Aeronautical Information Services*, Appendix 1.

### 1.4 Certification of aerodromes

*Note.— The intent of these specifications is to ensure the establishment of a regulatory regime so that compliance with the specifications in this Annex can be effectively enforced. It is recognized that the methods of ownership, operation and surveillance of aerodromes differ among States. The most effective and transparent means of ensuring compliance with applicable specifications is the availability of a separate safety oversight entity and a well-defined safety oversight mechanism with support of appropriate legislation to be able to carry out the function of safety regulation of aerodromes. When an aerodrome is granted a certificate, it signifies to aircraft operators and other organizations operating on the aerodrome that, at the time of certification, the aerodrome meets the specifications regarding the facility and its operation, and that it has, according to the certifying authority, the capability to maintain these specifications for the period of validity of the certificate. The certification process also establishes the baseline for continued monitoring of compliance with the specifications. Information on the status of certification of aerodromes would need to be provided to the appropriate aeronautical information services for promulgation in the Aeronautical Information Publication (AIP). See 2.13.1 and Annex 15, Appendix 1, AD 1.5.*

1.4.1 States shall certify aerodromes used for international operations in accordance with the specifications contained in this Annex as well as other relevant ICAO specifications through an appropriate regulatory framework.

*Note.— Specific procedures on the stages of certifying an aerodrome are given in the PANS-Aerodromes (Doc 9981). Further guidance on aerodrome certification can be found in the Manual on Certification of Aerodromes (Doc 9774).*

1.4.2 **Recommendation.**— *States should certify aerodromes open to public use in accordance with these specifications as well as other relevant ICAO specifications through an appropriate regulatory framework.*

1.4.3 The regulatory framework shall include the establishment of criteria and procedures for the certification of aerodromes.

*Note.— Guidance on a regulatory framework is given in the Manual on Certification of Aerodromes (Doc 9774).*

1.4.4 As part of the certification process, States shall ensure that an aerodrome manual which will include all pertinent information on the aerodrome site, facilities, services, equipment, operating procedures, organization and management including a safety management system, is submitted by the applicant for approval/acceptance prior to granting the aerodrome certificate.

*Note 1.— Contents of an aerodrome manual, including procedures for its submission and approval/acceptance, verification of compliance and granting of an aerodrome certificate, are available in the PANS-Aerodromes (Doc 9981).*

*Note 2.— The intent of a safety management system is to have in place an organized 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 harmonized safety management system is given in the Safety Management Manual (SMM) (Doc 9859) and in the Manual on Certification of Aerodromes (Doc 9774). Procedures on the management of change, conduct of safety assessment, reporting and analyses 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).*

## 1.5 Airport design

1.5.1 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 (Doc 9184), Part 1.*

1.5.2 **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 is contained in the Airport Planning Manual (Doc 9184), Part 2.*

## 1.6 Reference code

*Introductory Note.— The intent of the reference code is to provide a simple method for interrelating the numerous specifications concerning the characteristics of aerodromes so as to provide a series of aerodrome facilities that are suitable for the aeroplanes that are intended to operate at the aerodrome. The code is not intended to be used for determining runway length or pavement strength requirements. The code is composed of two elements which are related to the aeroplane performance characteristics and dimensions. Element 1 is a number based on the aeroplane reference field length and element 2 is a letter based on the aeroplane wingspan 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. When applying Annex 14, Volume I, the aeroplanes which the aerodrome is intended to serve are first identified and then the two elements of the code.*

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

1.6.2 The aerodrome reference code numbers and letters shall have the meanings assigned to them in Table 1-1.

1.6.3 The code number for element 1 shall be determined from Table 1-1, 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.*

1.6.4 The code letter for element 2 shall be determined from Table 1-1, column 3, by selecting the code letter which corresponds to the greatest wingspan, or the greatest outer main gear wheel span, whichever gives the more demanding code letter of the aeroplanes for which the facility is intended.

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

**Table 1-1. Aerodrome reference code**  
(see 1.6.2 to 1.6.4)

Code element 1		Code element 2		
Code number (1)	Aeroplane reference field length (2)	Code letter (3)	Wingspan (4)	Outer main gear wheel span <sup>a</sup> (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 outside edges of the main gear wheels.

*Note.*— Guidance on planning for aeroplanes with wingspans greater than 80 m is given in the Aerodrome Design Manual (Doc 9157), Parts 1 and 2.

## 1.7 Specific procedures for aerodrome operations

*Introductory Note.*— This section introduces PANS-Aerodromes (Doc 9981) for use by an aerodrome undertaking an assessment of its compatibility with the type of traffic or operation it is intending to accommodate. The material in the PANS-Aerodromes addresses operational issues faced by existing aerodromes and provides the necessary procedures to ensure the continued safety of operations. Where alternative measures, operational procedures and operating restrictions have been developed, these are detailed in the aerodrome manual and reviewed periodically to assess their continued validity. The PANS-Aerodromes does not substitute nor circumvent the provisions contained in this Annex. It is expected that infrastructure on an existing aerodrome or a new aerodrome will fully comply with the requirements in this Annex. See Annex 15, 4.1.2 (c) on a State's responsibilities for the listing of its differences to the related ICAO Procedures in its Aeronautical Information Publication.

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

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

1.7.2 Information concerning alternative measures, operational procedures and operating restrictions implemented at an aerodrome arising from 1.7.1 shall be promulgated.

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

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

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## CHAPTER 2. AERODROME DATA

### 2.1 Aeronautical data

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 Appendix 5 while taking into account the established quality system procedures. Accuracy requirements for aeronautical data are based 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 the 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 Annex 15, Chapter 3.*

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

*Note.— Aerodrome mapping databases related provisions are contained in Annex 15, Chapter 11. See Attachment A, Section 22, for further details on aerodrome mapping data.*

2.1.3 Where made available in accordance with 2.1.2, the selection of the aerodrome mapping data features to be collected shall be made with consideration of the intended applications.

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

2.1.4 Where made available in accordance with 2.1.2, aerodrome mapping data shall comply with the accuracy and integrity requirements in Appendix 5.

*Note.— Aerodrome mapping databases can be provided at one of two levels of quality — fine or medium. These levels and the corresponding numerical requirements are defined in RTCA Document DO-272B and European Organization for Civil Aviation Equipment (EUROCAE) Document ED-99C — User Requirements for Aerodrome Mapping Information.*

2.1.5 Contracting States 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.*

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 2.1.5, a 32- or 24-bit CRC algorithm shall apply, respectively.

2.1.7 **Recommendation.**— *To achieve protection of the integrity level of routine aeronautical data as classified in 2.1.5, 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 World Geodetic System — 1984 (WGS-84) Manual (Doc 9674). Supporting material in respect of the provisions of 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 Standards for Aeronautical Information.*

2.1.8 Geographical coordinates indicating latitude and longitude shall be determined and reported to the aeronautical information services authority 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 Appendix 5, Table A5-1.

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

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 Appendix 5 shall be determined and reported to the aeronautical information services authority.

*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 Annex 4 — Aeronautical Charts, Chapter 2 and Annex 15, Chapter 1.*

## 2.2 Aerodrome reference point

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

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.

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

## 2.3 Aerodrome and runway elevations

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

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

*Note.— The standard procedures for determining the ACN of an aircraft are given in the Aerodrome Design Manual (Doc 9157), 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 2.6.6 b) below and the results tabulated in that manual.*

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.

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
<i>High strength:</i> characterized by $K = 150 \text{ MN/m}^3$ and representing all $K$ values above $120 \text{ MN/m}^3$ for rigid pavements, and by $\text{CBR} = 15$ and representing all $\text{CBR}$ values above 13 for flexible pavements.	A
<i>Medium strength:</i> characterized by $K = 80 \text{ MN/m}^3$ and representing a range in $K$ of 60 to $120 \text{ MN/m}^3$ for rigid pavements, and by $\text{CBR} = 10$ and representing a range in $\text{CBR}$ of 8 to 13 for flexible pavements.	B
<i>Low strength:</i> characterized by $K = 40 \text{ MN/m}^3$ and representing a range in $K$ of 25 to $60 \text{ MN/m}^3$ for rigid pavements, and by $\text{CBR} = 6$ and representing a range in $\text{CBR}$ of 4 to 8 for flexible pavements.	C
<i>Ultra low strength:</i> characterized by $K = 20 \text{ MN/m}^3$ and representing all $K$ values below $25 \text{ MN/m}^3$ for rigid pavements, and by $\text{CBR} = 3$ and representing all $\text{CBR}$ values below 4 for flexible pavements.	D

c) *Maximum allowable tire pressure category:*

	Code
<i>Unlimited:</i> no pressure limit	W
<i>High:</i> pressure limited to 1.75 MPa	X
<i>Medium:</i> pressure limited to 1.25 MPa	Y
<i>Low:</i> pressure limited to 0.50 MPa	Z

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

d) *Evaluation method:*

	Code
<i>Technical evaluation:</i> representing a specific study of the pavement characteristics and application of pavement behaviour technology.	T
<i>Using aircraft experience:</i> 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 no 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 by 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.

**2.6.7 Recommendation.**— Criteria should be established to regulate the use of a pavement by an aircraft with an ACN higher than the PCN reported for that pavement in accordance with 2.6.2 and 2.6.3.

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

**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.

## 2.7 Pre-flight altimeter check location

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

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

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

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

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

## 2.8 Declared distances

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

- a) take-off run available;
- b) take-off distance available;
- c) accelerate-stop distance available; and
- d) landing distance available.

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

## 2.9 Condition of the movement area and related facilities

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

*Note.— Nature, format and conditions of the information to be provided are specified in Annex 15 and PANS-ATM (Doc 4444).*

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, a taxiway or an apron;
- c) water, snow, slush, ice, or frost on a runway, a taxiway or an apron;
- d) anti-icing or de-icing liquid chemicals or other contaminants on a runway, taxiway or apron;
- e) snow banks or drifts adjacent to a runway, a taxiway or an apron;
- f) other temporary hazards, including parked aircraft;

- g) failure or irregular operation of part or all of the aerodrome visual aids; and
- h) failure of the normal or secondary power supply.

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

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

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

2.9.3 To facilitate compliance with 2.9.1 and 2.9.2, the following inspections shall be carried out each day:

- a) for the movement area, at least once where the aerodrome reference code number is 1 or 2 and at least twice where the aerodrome reference code number is 3 or 4; and
- b) for the runway(s), inspections in addition to a) whenever the runway surface conditions may have changed significantly due to meteorological conditions.

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

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

2.9.4 Personnel assessing and reporting runway surface conditions required in 2.9.2 and 2.9.5 shall be trained and competent to perform their duties.

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

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

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

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

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

COMPACTED SNOW  
DRY  
DRY SNOW  
DRY SNOW ON TOP OF COMPACTED SNOW  
DRY SNOW ON TOP OF ICE  
FROST  
ICE  
SLUSH  
STANDING WATER  
WATER ON TOP OF COMPACTED SNOW  
WET  
WET ICE  
WET SNOW  
WET SNOW ON TOP OF COMPACTED SNOW  
WET SNOW ON TOP OF ICE  
CHEMICALLY TREATED  
LOOSE SAND

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

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

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

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

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

2.9.7 When friction measurements are used as part of the overall runway surface assessment on compacted snow- or ice-covered surfaces, the friction measuring device shall meet the standard set or agreed by the State.

2.9.8 **Recommendation.**— *Friction measurements made on runway surface conditions with contaminants other than compacted snow and ice should not be reported.*

*Note.— Friction measurements on loose contaminants such as snow and slush, in particular, are unreliable due to drag effects on the measurement wheel.*

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

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

*Note 2.— See 2.9.1 and 2.13 concerning the provision of information to, and coordination between, appropriate authorities.*

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

*Note 1.— Guidance on determining and expressing the minimum friction level is provided in the ICAO Circular 329 – Assessment, Measurement and Reporting of Runway Surface Conditions.*

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

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

## 2.10 Disabled aircraft removal

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

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

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.*

## 2.11 Rescue and firefighting

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

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

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

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

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

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

## 2.12 Visual approach slope indicator systems

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

- a) associated runway designation number;
- b) type of system according to 5.3.5.2. For an AT-VASIS, PAPI or APAPI installation, the side of the runway on which the lights are installed, i.e. left or right, shall be given;
- c) where the axis of the system is not parallel to the runway centre line, the angle of displacement and the direction of displacement, i.e. left or right, shall be indicated;
- d) nominal approach slope angle(s). For a T-VASIS or an AT-VASIS this shall be angle  $\Theta$  according to the formula in Figure 5-18 and for a PAPI and an APAPI this shall be angle  $(B + C) \div 2$  and  $(A + B) \div 2$ , respectively as in Figure 5-20; and
- e) minimum eye 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  $2'$ .

## 2.13 Coordination between aeronautical information services and aerodrome authorities

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

- a) information on the status of certification of aerodromes and aerodrome conditions (ref. 1.4, 2.9, 2.10, 2.11 and 2.12);
- 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.

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

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

2.13.4 The aerodrome services responsible for the provision of raw aeronautical information/data to the aeronautical information services shall do that while taking into account accuracy and integrity requirements for aeronautical data as specified in Appendix 5 to this Annex.

*Note 1.— Specifications for the issue of NOTAM and SNOWTAM are contained in Annex 15, Chapter 5 and Appendices 6 and 2, respectively.*

*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 Aeronautical Information Services Manual (Doc 8126, Chapter 2).*

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## CHAPTER 3. PHYSICAL CHARACTERISTICS

### 3.1 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 4. In 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.*

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

**3.1.2 Recommendation.—** *The 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 Airport Planning Manual (Doc 9184), Part 2, and in Guidance on the Balanced Approach to Aircraft Noise Management (Doc 9829).*

#### 3.1.3 Choice of maximum permissible crosswind components

**Recommendation.—** *In the application of 3.1.1 it should be assumed that landing or take-off of aeroplanes is, in normal circumstances, precluded when the crosswind 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 crosswind 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 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.*

## 3.1.4 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 Attachment A, Section 1.*

**Location of threshold**

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

*Note.*— *Guidance on the siting of the threshold is given in Attachment A, Section 10.*

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

*Note.*— *Guidance on factors which may be considered in the determination of the location of a displaced threshold is given in Attachment A, Section 10.*

**Actual length of runways**

## 3.1.7 Primary runway

**Recommendation.**— *Except as provided in 3.1.9, the actual runway length to be provided for a primary runway should be adequate to meet the operational requirements of the aeroplanes for which the runway is intended and should be not less than the longest length determined by applying the corrections for local conditions to the operations and performance characteristics of the relevant aeroplanes.*

*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 Aerodrome Design Manual (Doc 9157), Part 1.*

- 1.5 per cent where the code number is 3, except that for the first and last quarter of the length of a precision approach runway category II or III the longitudinal slope should not exceed 0.8 per cent; and
- 2 per cent where the code number is 1 or 2.

#### 3.1.15 Longitudinal slope changes

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

- 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 Attachment A, Section 4.

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

- 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.

#### 3.1.17 Sight distance

**Recommendation.**— Where slope changes cannot be avoided, they should 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 Aerodrome Design Manual (Doc 9157), Part 1.

#### 3.1.18 Distance between slope changes

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

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

- 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 Attachment A, Section 4.

### 3.1.19 Transverse slopes

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

- 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;

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 crosswind conditions the problem of aquaplaning from poor drainage is apt to be accentuated. Additional guidance is included in the Aerodrome Design Manual (Doc 9157), Parts 1 and 3.

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

*Note.*— Guidance on transverse slope is given in the Aerodrome Design Manual (Doc 9157), Part 3.

### Strength of runways

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

### Surface of runways

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

*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 Attachment A, Section 5. Additional guidance is included in the Aerodrome Design Manual (Doc 9157), Part 3.*

3.1.23 A paved runway shall be so constructed or resurfaced as to provide surface friction characteristics at or above the minimum friction level set by the State.

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

*Note.— Additional guidance is included in the Airport Services Manual (Doc 9137), Part 2.*

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

*Note.— Additional guidance is included in the Airport Services Manual (Doc 9137), Part 2.*

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

*Note 1.— Macrotexture and microtexture are taken into consideration in order to provide the required surface friction characteristics. Guidance on surface design is given in Attachment A, Section 7.*

*Note 2.— Guidance on methods used to measure surface texture is given in the Airport Services Manual (Doc 9137), Part 2.*

*Note 3.— Guidance on design and methods for improving surface texture is given in the Aerodrome Design Manual (Doc 9157), Part 3.*

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

*Note.— Guidance on methods for improving the runway surface texture is given in the Aerodrome Design Manual (Doc 9157), Part 3.*

## 3.2 Runway shoulders

### General

*Note.— Guidance on characteristics and treatment of runway shoulders is given in Attachment A, Section 8, and in the Aerodrome Design Manual (Doc 9157), Part 1.*

3.2.1 **Recommendation.**— *Runway shoulders should be provided for a runway where the code letter is D or E, and the runway width is less than 60 m.*

3.2.2 **Recommendation.**— *Runway shoulders should be provided for a runway where the code letter is F.*

### Width of runway shoulders

3.2.3 **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**

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

#### **Strength of runway shoulders**

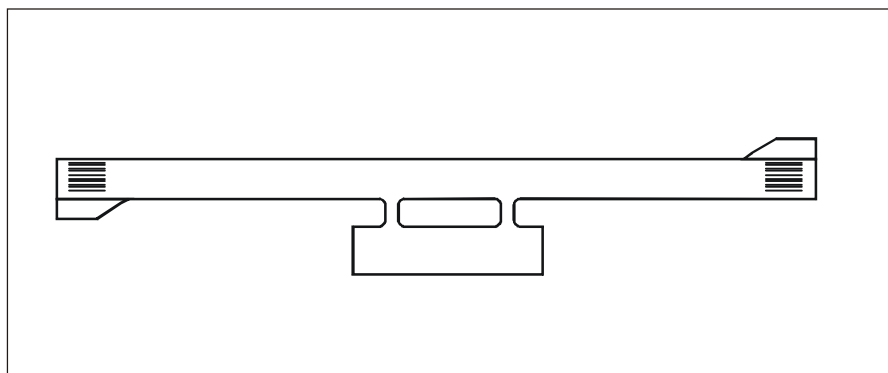
3.2.5 **Recommendation.**— *A runway shoulder should be prepared or constructed so as to be capable, in the event of an aeroplane running off the runway, of supporting the aeroplane without inducing structural damage to the aeroplane and of supporting ground vehicles which may operate on the shoulder.*

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

### **3.3 Runway turn pads**

#### **General**

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



**Figure 3-1. Typical turn pad layout**

**Width of runway strips**

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

- 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.

3.4.4 **Recommendation.**— *A strip including a non-precision approach runway should 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.*

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

- 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 9.9 for information regarding siting of equipment and installations on runway strips.

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

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

*Note 2.*— *Where open-air or covered storm water conveyances are installed, consideration will have to be given to ensure that their structure does not extend above the surrounding ground so as not to be considered an obstacle. See also Note 1 to 3.4.16.*

*Note 3.*— *Particular attention needs to be given to the design and maintenance of an open-air storm water conveyance in order to prevent wildlife attraction, notably birds. If needed, it can be covered by a net. Guidance on wildlife control and reduction can be found in the Airport Services Manual (Doc 9137), Part 3.*

3.4.7 No fixed object, other than visual aids required for air navigation or those required for aircraft safety purposes and which must be sited on the runway strip, and satisfying the relevant frangibility requirement in Chapter 5, shall be permitted on 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**

**3.4.8 Recommendation.**— *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 should provide a graded area for aeroplanes which the runway is intended to serve in the event of an aeroplane running off the runway.*

*Note.*— *Guidance on grading of a greater area of a strip including a precision approach runway where the code number is 3 or 4 is given in Attachment A, Section 8.*

**3.4.9 Recommendation.**— *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 should provide a graded area for aeroplanes which the runway is intended to serve in the event of an aeroplane running off the runway.*

**3.4.10** The surface of that portion of a strip that abuts a runway, shoulder or stopway shall be flush with the surface of the runway, shoulder or stopway.

**3.4.11 Recommendation.**— *That portion of a strip to at least 30 m before the start of a runway should be prepared against blast erosion in order to protect a landing aeroplane from the danger of an exposed edge.*

*Note 1.*— *The area provided to reduce the erosive effects of jet blast and propeller wash may be referred to as a blast pad.*

*Note 2.*— *Guidance on protection against aeroplane engine blast is available in the Aerodrome Design Manual (Doc 9157), Part 2.*

**3.4.12 Recommendation.**— *Where the areas in 3.4.11 have paved surfaces, they should be able to withstand the occasional passage of the critical aeroplane for runway pavement design.*

### *Slopes on runway strips*

#### 3.4.13 Longitudinal slopes

**Recommendation.**— *A longitudinal slope along that portion of a strip to be graded should 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.*

#### 3.4.14 Longitudinal slope changes

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

#### 3.4.15 Transverse slopes

**Recommendation.**— *Transverse slopes on that portion of a strip to be graded should be adequate to prevent the accumulation of water on the surface but should not exceed:*

- *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 should be negative as measured in the direction away from the runway and may be as great as 5 per cent.*

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

*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 rescue and firefighting (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*

**3.4.17 Recommendation.**— *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 should be so prepared or constructed as to minimize hazards arising from differences in load-bearing capacity to aeroplanes which the runway is intended to serve in the event of an aeroplane running off the runway.*

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

3.4.18 **Recommendation.**— *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 should be so prepared or constructed as to minimize hazards arising from differences in load-bearing capacity to aeroplanes which the runway is intended to serve in the event of an aeroplane running off the runway.*

### 3.5 Runway end safety areas

#### **General**

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

- 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 Attachment A, Section 9.*

3.5.2 **Recommendation.**— *A runway end safety area should be provided at each end of a runway strip where the code number is 1 or 2 and the runway is a non-instrument one.*

#### **Dimensions of runway end safety areas**

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

- 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 by the State.

*Note.*— *Guidance on arresting systems is given in Attachment A, Section 9.*

3.5.4 **Recommendation.**— *A runway end safety area should, as far as practicable, extend from the end of a runway strip to a distance of at least:*

- *240 m where the code number is 3 or 4; or a reduced length when an arresting system is installed;*
- *120 m where the code number is 1 or 2 and the runway is an instrument one; or a reduced length when an arresting system is installed; and*
- *30 m where the code number is 1 or 2 and the runway is a non-instrument one.*

### 3.7 Stopways

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

#### *Width of stopways*

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

#### *Slopes on stopways*

3.7.2 **Recommendation.**— Slopes and changes in slope on a stopway, and the transition from a runway to a stopway, should comply with the specifications of 3.1.13 to 3.1.19 for the runway with which the stopway is associated except that:

- a) the limitation in 3.1.14 of a 0.8 per cent slope for the first and last quarter of the length of a runway need not be applied to the stopway; and
- b) at the junction of the stopway and runway and along the stopway the maximum rate of slope change may be 0.3 per cent per 30 m (minimum radius of curvature of 10 000 m) for a runway where the code number is 3 or 4.

#### *Strength of stopways*

3.7.3 **Recommendation.**— A stopway should be prepared or constructed so as to be capable, in the event of an abandoned take-off, of supporting the aeroplane which the stopway is intended to serve without inducing structural damage to the aeroplane.

*Note.*— Attachment A, Section 2, presents guidance relative to the support capability of a stopway.

#### *Surface of stopways*

3.7.4 The surface of a paved stopway shall be so constructed or resurfaced as to provide surface friction characteristics at or above those of the associated runway.

### 3.8 Radio altimeter operating area

#### *General*

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

#### *Length of the area*

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

### **Width of the area**

3.8.3 **Recommendation.**— *A radio altimeter operating area should extend laterally, on each side of the extended centre line of the runway, to a distance of 60 m, except that, when special circumstances so warrant, the distance may be reduced to no less than 30 m if an aeronautical study indicates that such reduction would not affect the safety of operations of aircraft.*

### **Longitudinal slope changes**

3.8.4 **Recommendation.**— *On a radio altimeter operating area, slope changes should be avoided or kept to a minimum. Where slope changes cannot be avoided, the slope changes should be as gradual as practicable and abrupt changes or sudden reversals of slopes avoided. The rate of change between two consecutive slopes should not exceed 2 per cent per 30 m.*

*Note.*— *Guidance on radio altimeter operating area is given in Attachment A, Section 4.3, and in the 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 I.*

## **3.9 Taxiways**

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

*Note 2.*— *See Attachment A, Section 21, for specific taxiway design guidance which may assist in the prevention of runway incursions when developing a new taxiway or improving existing ones with known runway incursion safety risks.*

### **General**

3.9.1 **Recommendation.**— *Taxiways should be provided to permit the safe and expeditious surface movement of aircraft.*

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

3.9.2 **Recommendation.**— *Sufficient entrance and exit taxiways for a runway should be provided to expedite the movement of aeroplanes to and from the runway and provision of rapid exit taxiways considered when traffic volumes are high.*

3.9.3 The design of a taxiway shall be such that, when the cockpit of the aeroplane for which the taxiway is intended remains over the taxiway centre line markings, the clearance distance between the outer main wheel of the aeroplane and the edge of the taxiway shall be not less than that given by the following tabulation:

### 5.1.4 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. Attachment A, Section 16, provides guidance on the need to provide ground signals. Annex 2, Appendix 1, specifies the shape, colour and use of visual ground signals. The Aerodrome Design Manual (Doc 9157), Part 4, provides guidance on their design.*

#### **Location of signal area**

5.1.4.1 **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**

5.1.4.2 The signal area shall be an even horizontal surface at least 9 m square.

5.1.4.3 **Recommendation.**— *The colour of the signal area should be chosen to contrast with the colours of the signal panels used, and it should be surrounded by a white border not less than 0.3 m wide.*

## 5.2 Markings

### 5.2.1 General

#### **Interruption of runway markings**

5.2.1.1 At an intersection of two (or more) runways the markings of the more important runway, except for the runway side stripe marking, shall be displayed and the markings of the other runway(s) shall be interrupted. The runway side stripe marking of the more important runway may be either continued across the intersection or interrupted.

5.2.1.2 **Recommendation.**— *The order of importance of runways for the display of runway markings should be as follows:*

*1st — precision approach runway;*

*2nd — non-precision approach runway; and*

*3rd — non-instrument runway.*

5.2.1.3 At an intersection of a runway and taxiway the markings of the runway shall be displayed and the markings of the taxiway interrupted, except that runway side stripe markings may be interrupted.

*Note.— See 5.2.8.7 regarding the manner of connecting runway and taxiway centre line markings.*

#### **Colour and conspicuity**

5.2.1.4 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.*

5.2.1.5 Taxiway markings, runway turn pad markings and aircraft stand markings shall be yellow.

5.2.1.6 Apron safety lines shall be of a conspicuous colour which shall contrast with that used for aircraft stand markings.

5.2.1.7 **Recommendation.**— *At aerodromes where operations take place at night, pavement markings should be made with reflective materials designed to enhance the visibility of the markings.*

*Note.— Guidance on reflective materials is given in the Aerodrome Design Manual (Doc 9157), Part 4.*

#### **Unpaved taxiways**

5.2.1.8 **Recommendation.**— *An unpaved taxiway should be provided, so far as practicable, with the markings prescribed for paved taxiways.*

### **5.2.2 Runway designation marking**

#### **Application**

5.2.2.1 A runway designation marking shall be provided at the thresholds of a paved runway.

5.2.2.2 **Recommendation.**— *A runway designation marking should be provided, so far as practicable, at the thresholds of an unpaved runway.*

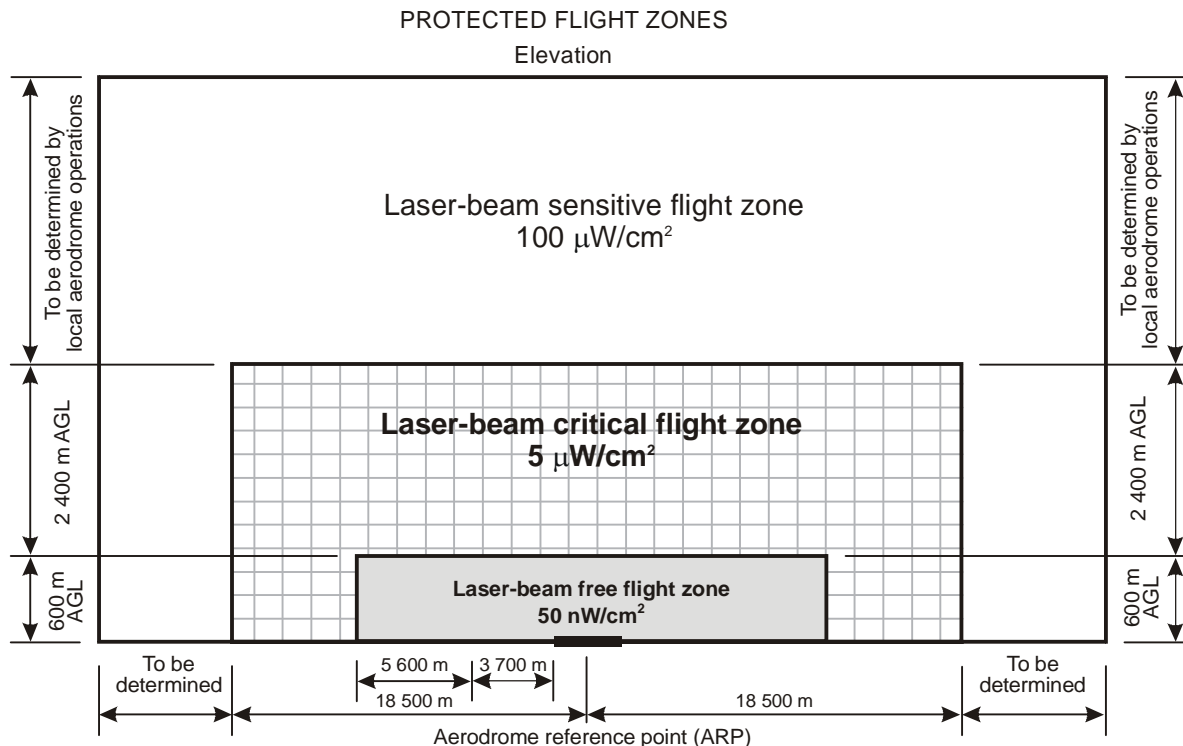
#### **Location**

5.2.2.3 A runway designation marking shall be located at a threshold as shown in Figure 5-2 as appropriate.

*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**

5.2.2.4 A runway designation marking shall consist of a two-digit number and on parallel runways shall be supplemented with a letter. On a single runway, dual parallel runways and triple parallel runways the two-digit number shall be the whole number nearest the one-tenth of the magnetic North when viewed from the direction of approach. On four or more parallel runways, one set of adjacent runways shall be numbered to the nearest one-tenth magnetic azimuth and the other set of adjacent runways numbered to the next nearest one-tenth of the magnetic azimuth. When the above rule would give a single digit number, it shall be preceded by a zero.



**Figure 5-13. Protected flight zones with indication of maximum irradiance levels for visible laser beams**

#### **Lights which may cause confusion**

**5.3.1.3 Recommendation.**— *A non-aeronautical ground light which, by reason of its intensity, configuration or colour, might prevent, or cause confusion in, the clear interpretation of aeronautical ground lights should be extinguished, screened or otherwise modified so as to eliminate such a possibility. In particular, attention should be directed to a non-aeronautical ground light visible from the air within the areas described hereunder:*

- 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 9.9 for information regarding siting of equipment and installations on operational areas, and the Aerodrome Design Manual (Doc 9157), Part 6, for guidance on frangibility of light fixtures and supporting structures.

***Elevated approach lights***

5.3.1.4 Elevated approach lights and their supporting structures shall be frangible except that, in that portion of the approach lighting system beyond 300 m from the threshold:

- 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.

5.3.1.5 When an approach light fixture or supporting structure is not in itself sufficiently conspicuous, it shall be suitably marked.

***Elevated lights***

5.3.1.6 Elevated runway, stopway and taxiway lights shall be frangible. Their height shall be sufficiently low to preserve clearance for propellers and for the engine pods of jet aircraft.

***Surface lights***

5.3.1.7 Light fixtures inset in the surface of runways, stopways, taxiways and aprons shall be so designed and fitted as to withstand being run over by the wheels of an aircraft without damage either to the aircraft or to the lights themselves.

5.3.1.8 **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 Aerodrome Design Manual (Doc 9157), 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 Attachment A, Section 15, and the Aerodrome Design Manual (Doc 9157), Part 4).

*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**

5.3.3.8 An identification beacon shall be provided at an aerodrome which is intended for use at night and cannot be easily identified from the air by other means.

#### **Location**

5.3.3.9 The identification beacon shall be located on the aerodrome in an area of low ambient background lighting.

5.3.3.10 **Recommendation.**— *The location of the beacon should be such that the beacon is not shielded by objects in significant directions and does not dazzle a pilot approaching to land.*

#### **Characteristics**

5.3.3.11 An identification beacon at a land aerodrome shall show at all angles of azimuth. The vertical light distribution shall extend upwards from an elevation of not more than 1° to an elevation determined by the appropriate authority to be sufficient to provide guidance at the maximum elevation at which the beacon is intended to be used, and the effective intensity of the flash shall be not less than 2 000 cd.

*Note.— At locations where a high ambient background lighting level cannot be avoided, the effective intensity of the flash may be required to be increased by a factor up to a value of 10.*

5.3.3.12 An identification beacon shall show flashing-green at a land aerodrome and flashing-yellow at a water aerodrome.

5.3.3.13 The identification characters shall be transmitted in the International Morse Code.

5.3.3.14 **Recommendation.**— *The speed of transmission should be between six and eight words per minute, the corresponding range of duration of the Morse dots being from 0.15 to 0.2 seconds per dot.*

## **5.3.4 Approach lighting systems**

### **Application**

#### **5.3.4.1 Application**

##### **A.— Non-instrument runway**

**Recommendation.**— *Where physically practicable, a simple approach lighting system as specified in 5.3.4.2 to 5.3.4.9 should be provided to serve a non-instrument runway where the code number is 3 or 4 and intended for use at night, except when the runway is used only in conditions of good visibility and sufficient guidance is provided by other visual aids.*

*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 5.3.4.2 to 5.3.4.9 shall be provided to serve a non-precision approach runway, except when the runway is used only in conditions of good visibility or sufficient guidance is provided by other visual aids.

*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 5.3.4.10 to 5.3.4.21 shall be provided to serve a precision approach runway category I.

**D.— Precision approach runway categories II and III**

A precision approach category II and III lighting system as specified in 5.3.4.22 to 5.3.4.39 shall be provided to serve a precision approach runway category II or III.

***Simple approach lighting system******Location***

5.3.4.2 A simple approach lighting system shall consist of a row of lights on the extended centre line of the runway extending, whenever possible, over a distance of not less than 420 m from the threshold with a row of lights forming a crossbar 18 m or 30 m in length at a distance of 300 m from the threshold.

5.3.4.3 The lights forming the crossbar shall be as nearly as practicable in a horizontal straight line at right angles to, and bisected by, the line of the centre line lights. The lights of the crossbar shall be spaced so as to produce a linear effect, except that, when a crossbar of 30 m is used, gaps may be left on each side of the centre line. These gaps shall be kept to a minimum to meet local requirements and each shall not exceed 6 m.

*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 firefighting vehicles.*

*Note 2.— See Attachment A, Section 11, for guidance on installation tolerances.*

5.3.4.4 The lights forming the centre line shall be placed at longitudinal intervals of 60 m, except that, when it is desired to improve the guidance, an interval of 30 m may be used. The innermost light shall be located either 60 m or 30 m from the threshold, depending on the longitudinal interval selected for the centre line lights.

5.3.4.5 **Recommendation.**— *If it is not physically possible to provide a centre line extending for a distance of 420 m from the threshold, it should be extended to 300 m so as to include the crossbar. If this is not possible, the centre line lights should be extended as far as practicable, and each centre line light should then consist of a barrette at least 3 m in length. Subject to the approach system having a crossbar at 300 m from the threshold, an additional crossbar may be provided at 150 m from the threshold.*

5.3.4.6 The system shall lie as nearly as practicable in the horizontal plane passing through the threshold, provided that:

- a) no object other than an ILS or MLS azimuth antenna shall protrude through the plane of the approach lights within a distance of 60 m from the centre line of the system; and
- b) no light other than a light located within the central part of a crossbar or a centre line barrette (not their extremities) shall be screened from an approaching aircraft.

Any ILS or MLS azimuth antenna protruding through the plane of the lights shall be treated as an obstacle and marked and lighted accordingly.

### **Characteristics**

5.3.4.7 The lights of a simple approach lighting system shall be fixed lights and the colour of the lights shall be such as to ensure that the system is readily distinguishable from other aeronautical ground lights, and from extraneous lighting if present. Each centre line light shall consist of either:

- a) a single source; or
- b) a barrette at least 3 m in length.

*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.*

5.3.4.8 **Recommendation.**— *Where provided for a non-instrument runway, the lights should show at all angles in azimuth necessary to a pilot on base leg and final approach. The intensity of the lights should be adequate for all conditions of visibility and ambient light for which the system has been provided.*

5.3.4.9 **Recommendation.**— *Where provided for a non-precision approach runway, the lights should show at all angles in azimuth necessary to the pilot of an aircraft which on final approach does not deviate by an abnormal amount from the path defined by the non-visual aid. The lights should be designed to provide guidance during both day and night in the most adverse conditions of visibility and ambient light for which it is intended that the system should remain usable.*

### **Precision approach category I lighting system**

#### **Location**

5.3.4.10 A precision approach category I lighting system shall consist of a row of lights on the extended centre line of the runway extending, wherever possible, over a distance of 900 m from the runway threshold with a row of lights forming a crossbar 30 m in length at a distance of 300 m from the runway threshold.

*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 Attachment A, Section 11.*

5.3.4.11 The lights forming the crossbar shall be as nearly as practicable in a horizontal straight line at right angles to, and bisected by, the line of the centre line lights. The lights of the crossbar shall be spaced so as to produce a linear effect, except that gaps may be left on each side of the centre line. These gaps shall be kept to a minimum to meet local requirements and each shall not exceed 6 m.

*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 firefighting vehicles.*

*Note 2.— See Attachment A, Section 11, for guidance on installation tolerances.*

5.3.4.12 The lights forming the centre line shall be placed at longitudinal intervals of 30 m with the innermost light located 30 m from the threshold.

5.3.4.13 The system shall lie as nearly as practicable in the horizontal plane passing through the threshold, provided that:

- a) no object other than an ILS or MLS azimuth antenna shall protrude through the plane of the approach lights within a distance of 60 m from the centre line of the system; and
- b) no light other than a light located within the central part of a crossbar or a centre line barrette (not their extremities) shall be screened from an approaching aircraft.

Any ILS or MLS azimuth antenna protruding through the plane of the lights shall be treated as an obstacle and marked and lighted accordingly.

### **Characteristics**

5.3.4.14 The centre line and crossbar lights of a precision approach category I lighting system shall be fixed lights showing variable white. Each centre line light position shall consist of either:

- a) a single light source in the innermost 300 m of the centre line, two light sources in the central 300 m of the centre line and three light sources in the outer 300 m of the centre line to provide distance information; or
- b) a barrette.

5.3.4.15 Where the serviceability level of the approach lights specified as a maintenance objective in 10.5.10 can be demonstrated, each centre line light position may consist of either:

- a) a single light source; or
- b) a barrette.

5.3.4.16 The barrettes shall be at least 4 m in length. When barrettes are composed of lights approximating to point sources, the lights shall be uniformly spaced at intervals of not more than 1.5 m.

5.3.4.17 **Recommendation.**— *If the centre line consists of barrettes as described in 5.3.4.14 b) or 5.3.4.15 b), 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.*

5.3.4.18 Each flashing light as described in 5.3.4.17 shall be flashed twice a second in sequence, beginning with the outermost light and progressing toward the threshold to the innermost light of the system. The design of the electrical circuit shall be such that these lights can be operated independently of the other lights of the approach lighting system.

5.3.4.19 If the centre line consists of lights as described in 5.3.4.14 a) or 5.3.4.15 a), additional crossbars of lights to the crossbar provided at 300 m from the threshold shall be provided at 150 m, 450 m, 600 m and 750 m from the threshold. The lights forming each crossbar shall be as nearly as practicable in a horizontal straight line at right angles to, and bisected by, the line of the centre line lights. The lights shall be spaced so as to produce a linear effect, except that gaps may be left on each side of the centre line. These gaps shall be kept to a minimum to meet local requirements and each shall not exceed 6 m.

*Note.— See Attachment A, Section 11, for detailed configuration.*

5.3.4.20 Where the additional crossbars described in 5.3.4.19 are incorporated in the system, the outer ends of the crossbars shall lie on two straight lines that either are parallel to the line of the centre line lights or converge to meet the runway centre line 300 m from threshold.

5.3.4.21 The lights shall be in accordance with the specifications of Appendix 2, Figure A2-1.

*Note.— The flight path envelopes used in the design of these lights are given in Attachment A, Figure A-6.*

### **Precision approach category II and III lighting system**

#### **Location**

5.3.4.22 The approach lighting system shall consist of a row of lights on the extended centre line of the runway, extending, wherever possible, over a distance of 900 m from the runway threshold. In addition, the system shall have two side rows of lights, extending 270 m from the threshold, and two crossbars, one at 150 m and one at 300 m from the threshold, all as shown in Figure 5-14. Where the serviceability level of the approach lights specified as maintenance objectives in 10.5.7 can be demonstrated, the system may have two side rows of lights, extending 240 m from the threshold, and two crossbars, one at 150 m and one at 300 m from the threshold, all as shown in Figure 5-15.

*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 Attachment A, Section 11.*

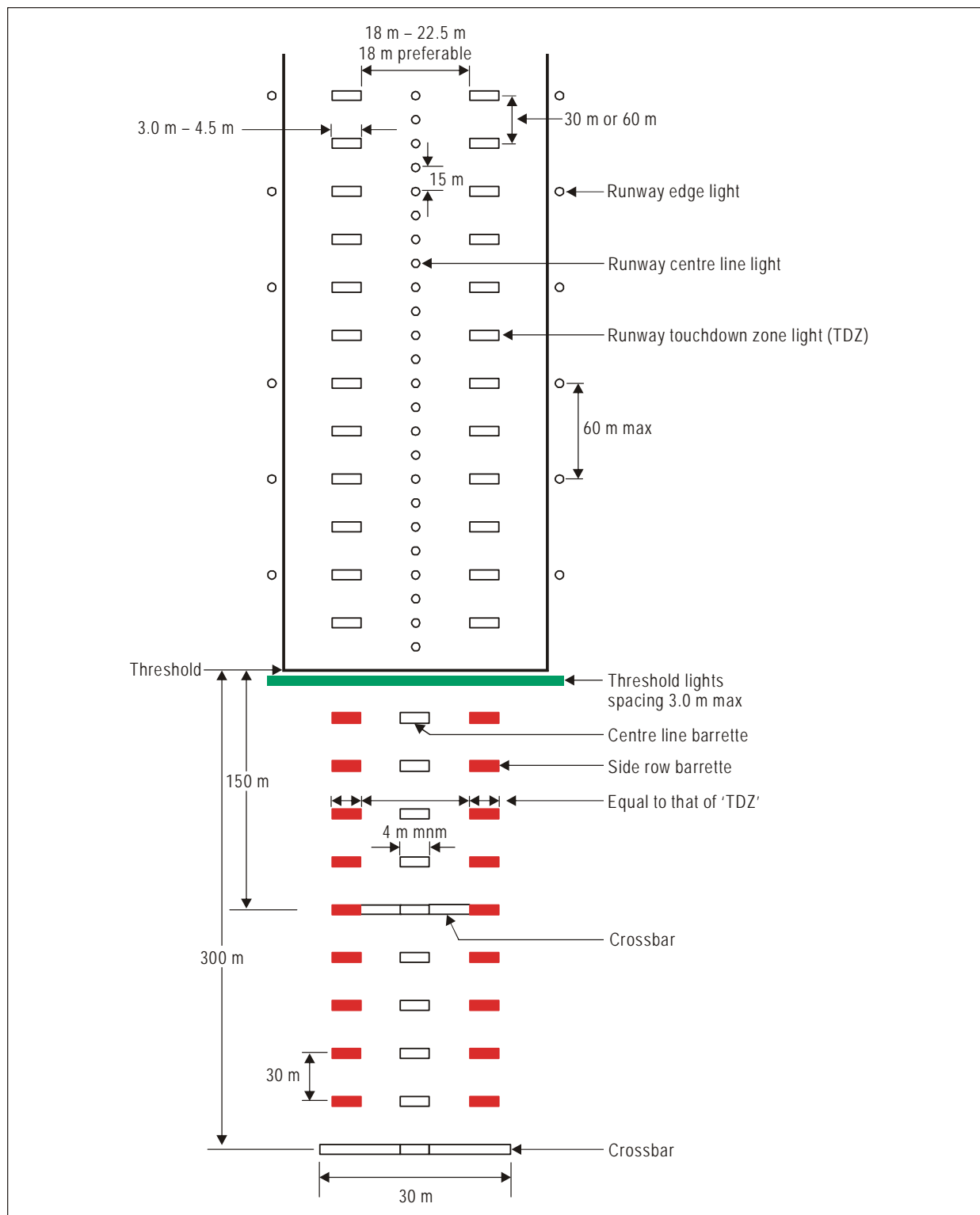
5.3.4.23 The lights forming the centre line shall be placed at longitudinal intervals of 30 m with the innermost lights located 30 m from the threshold.

5.3.4.24 The lights forming the side rows shall be placed on each side of the centre line, at a longitudinal spacing equal to that of the centre line lights and with the first light located 30 m from the threshold. Where the serviceability level of the approach lights specified as maintenance objectives in 10.5.7 can be demonstrated, lights forming the side rows may be placed on each side of the centre line, at a longitudinal spacing of 60 m with the first light located 60 m from the threshold. The lateral spacing (or gauge) between the innermost lights of the side rows shall be not less than 18 m nor more than 22.5 m, and preferably 18 m, but in any event shall be equal to that of the touchdown zone lights.

5.3.4.25 The crossbar provided at 150 m from the threshold shall fill in the gaps between the centre line and side row lights.

5.3.4.26 The crossbar provided at 300 m from the threshold shall extend on both sides of the centre line lights to a distance of 15 m from the centre line.

5.3.4.27 If the centre line beyond a distance of 300 m from the threshold consists of lights as described in 5.3.4.31 b) or 5.3.4.32 b), additional crossbars of lights shall be provided at 450 m, 600 m and 750 m from the threshold.



**Figure 5-14. Inner 300 m approach and runway lighting for precision approach runways, categories II and III**

5.3.4.33 The barrettes shall be at least 4 m in length. When barrettes are composed of lights approximating to point sources, the lights shall be uniformly spaced at intervals of not more than 1.5 m.

5.3.4.34 **Recommendation.**— *If the centre line beyond 300 m from the threshold consists of barrettes as described in 5.3.4.31 a) or 5.3.4.32 a), each barrette beyond 300 m should be supplemented by a flashing light, except where such lighting is considered unnecessary taking into account the characteristics of the system and the nature of the meteorological conditions.*

5.3.4.35 Each flashing light as described in 5.3.4.34 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.

5.3.4.36 The side row shall consist of barrettes showing red. The length of a side row barrette and the spacing of its lights shall be equal to those of the touchdown zone light barrettes.

5.3.4.37 The lights forming the crossbars shall be fixed lights showing variable white. The lights shall be uniformly spaced at intervals of not more than 2.7 m.

5.3.4.38 The intensity of the red lights shall be compatible with the intensity of the white lights.

5.3.4.39 The lights shall be in accordance with the specifications of Appendix 2, Figures A2-1 and A2-2.

*Note.*— *The flight path envelopes used in the design of these lights are given in Attachment A, Figure A-6.*

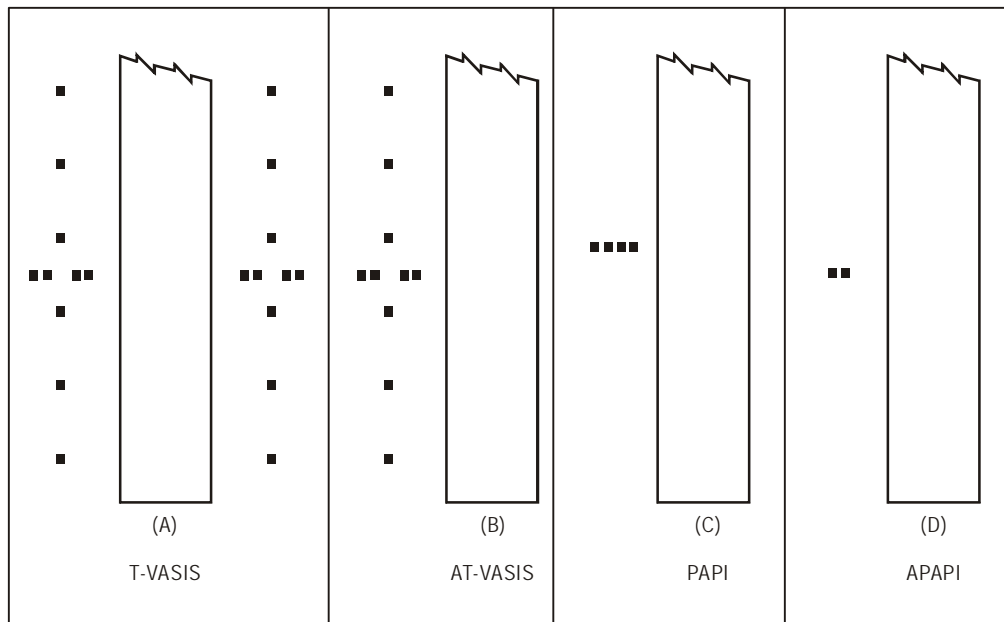
### 5.3.5 Visual approach slope indicator systems

#### **Application**

5.3.5.1 A visual approach slope indicator system shall be provided to serve the approach to a runway whether or not the runway is served by other visual approach aids or by non-visual aids, where one or more of the following conditions exist:

- a) the runway is used by turbojet or other aeroplanes with similar approach guidance requirements;
- b) the pilot of any type of aeroplane may have difficulty in judging the approach due to:
  - 1) inadequate visual guidance such as is experienced during an approach over water or featureless terrain by day or in the absence of sufficient extraneous lights in the approach area by night; or
  - 2) misleading information such as is produced by deceptive surrounding terrain or runway slopes;
- c) the presence of objects in the approach area may involve serious hazard if an aeroplane descends below the normal approach path, particularly if there are no non-visual or other visual aids to give warning of such objects;
- d) physical conditions at either end of the runway present a serious hazard in the event of an aeroplane undershooting or overrunning the runway; and
- e) terrain or prevalent meteorological conditions are such that the aeroplane may be subjected to unusual turbulence during approach.

*Note.*— *Guidance on the priority of installation of visual approach slope indicator systems is contained in Attachment A, Section 12.*



**Figure 5-16. Visual approach slope indicator systems**

5.3.5.2 The standard visual approach slope indicator systems shall consist of the following:

- a) T-VASIS and AT-VASIS conforming to the specifications contained in 5.3.5.7 to 5.3.5.23 inclusive;
- b) PAPI and APAPI systems conforming to the specifications contained in 5.3.5.24 to 5.3.5.41 inclusive;

as shown in Figure 5-16.

5.3.5.3 PAPI, 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 5.3.5.1 exist.

5.3.5.4 **Recommendation.**— *As of 1 January 2020, the use of T-VASIS and AT-VASIS as standard visual approach slope indicator systems should be discontinued.*

5.3.5.5 PAPI or APAPI shall be provided where the code number is 1 or 2 when one or more of the conditions specified in 5.3.5.1 exist.

5.3.5.6 **Recommendation.**— *Where a runway threshold is temporarily displaced from the normal position and one or more of the conditions specified in 5.3.5.1 exist, a PAPI should be provided except that where the code number is 1 or 2 an APAPI may be provided.*

#### ***T-VASIS and AT-VASIS***

##### ***Description***

5.3.5.7 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 Figure 5-17.

## 5.3.15 Rapid exit taxiway indicator lights

*Note.— The purpose of rapid exit taxiway indicator lights (RETILs) is to provide pilots with distance-to-go information to the nearest rapid exit taxiway on the runway, to enhance situational awareness in low visibility conditions and enable pilots to apply braking action for more efficient roll-out and runway exit speeds. It is essential that pilots operating at aerodromes with runway(s) displaying rapid exit taxiway indicator lights be familiar with the purpose of these lights.*

**Application**

5.3.15.1 **Recommendation.**— *Rapid exit taxiway indicator lights should be provided on a runway intended for use in runway visual range conditions less than a value of 350 m and/or where the traffic density is heavy.*

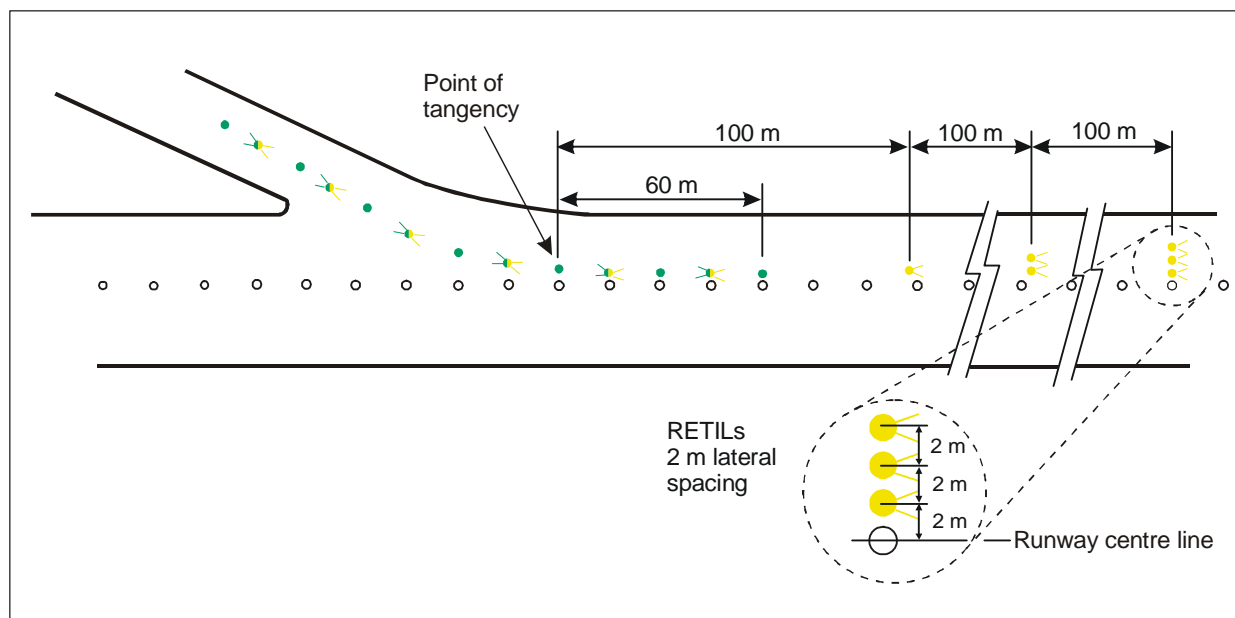
*Note.— See Attachment A, Section 14.*

5.3.15.2 Rapid exit taxiway indicator lights shall not be displayed in the event of any lamp failure or other failure that prevents the display of the light pattern depicted in Figure 5-25, in full.

**Location**

5.3.15.3 A set of rapid exit taxiway indicator lights shall be located on the runway on the same side of the runway centre line as the associated rapid exit taxiway, in the configuration shown in Figure 5-25. In each set, the lights shall be located 2 m apart and the light nearest to the runway centre line shall be displaced 2 m from the runway centre line.

5.3.15.4 Where more than one rapid exit taxiway exists on a runway, the set of rapid exit taxiway indicator lights for each exit shall not overlap when displayed.



**Figure 5-25. Rapid exit taxiway indicator lights (RETILs)**

### Characteristics

5.3.15.5 Rapid exit taxiway indicator lights shall be fixed unidirectional yellow lights, aligned so as to be visible to the pilot of a landing aeroplane in the direction of approach to the runway.

5.3.15.6 Rapid exit taxiway indicator lights shall be in accordance with the specifications in Appendix 2, Figure A2-6 or Figure A2-7, as appropriate.

5.3.15.7 **Recommendation.**— *Rapid exit taxiway indicator lights should be supplied with power on a separate circuit to other runway lighting so that they may be used when other lighting is switched off.*

### 5.3.16 Stopway lights

#### Application

5.3.16.1 Stopway lights shall be provided for a stopway intended for use at night.

#### Location

5.3.16.2 Stopway lights shall be placed along the full length of the stopway and shall be in two parallel rows that are equidistant from the centre line and coincident with the rows of the runway edge lights. Stopway lights shall also be provided across the end of a stopway on a line at right angles to the stopway axis as near to the end of the stopway as possible and, in any case, not more than 3 m outside the end.

### Characteristics

5.3.16.3 Stopway lights shall be fixed unidirectional lights showing red in the direction of the runway.

### 5.3.17 Taxiway centre line lights

#### Application

5.3.17.1 Taxiway centre line lights shall be provided on an exit taxiway, taxiway, de-icing/anti-icing facility 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.

5.3.17.2 **Recommendation.**— *Taxiway centre line lights should be provided on a taxiway intended for use at night in runway visual range conditions of 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, narrow taxiway or in snow conditions, this may be done with taxiway edge lights or markers.*

### Characteristics

**7.2.3 Recommendation.**— *A taxi side stripe marking should consist of a pair of solid lines, each 15 cm wide and spaced 15 cm apart and the same colour as the taxiway centre line marking.*

*Note.— Guidance on providing additional transverse stripes at an intersection or a small area on the apron is given in the Aerodrome Design Manual (Doc 9157), Part 4.*

### 7.3 Pre-threshold area

### Application

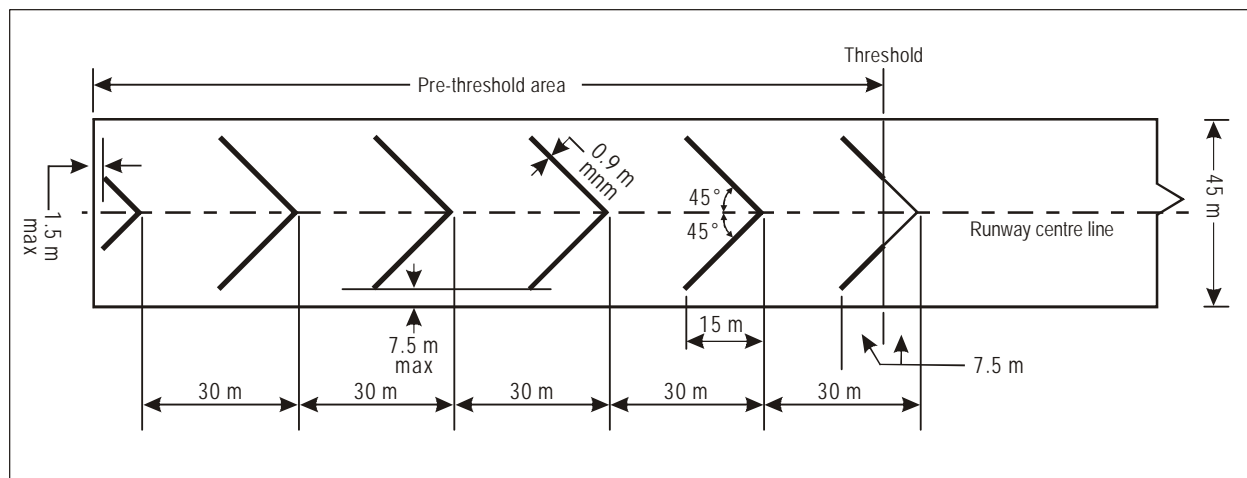
**7.3.1 Recommendation.**— *When the surface before a threshold is paved and exceeds 60 m in length and is not suitable for normal use by aircraft, the entire length before the threshold should be marked with a chevron marking.*

*Location*

**7.3.2 Recommendation.**— *A chevron marking should point in the direction of the runway and be placed as shown in Figure 7-2.*

### Characteristics

**7.3.3 Recommendation.**— *A chevron marking should be of conspicuous colour and contrast with the colour used for the runway markings; it should preferably be yellow. It should have an overall width of at least 0.9 m.*



**Figure 7-2. Pre-threshold marking**

## 7.4 Unserviceable areas

### *Application*

7.4.1 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. On a movement area used at night, unserviceability lights shall be used.

*Note.— Unserviceability markers and lights are used for such purposes as warning pilots of a hole in a taxiway or apron pavement or outlining a portion of pavement, such as on an apron, that is under repair. They are not suitable for use when a portion of a runway becomes unserviceable, nor on a taxiway when a major portion of the width becomes unserviceable. In such instances, the runway or taxiway is normally closed.*

### *Location*

7.4.2 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 Attachment A, Section 13.*

### *Characteristics of unserviceability markers*

7.4.3 Unserviceability markers shall consist of conspicuous upstanding devices such as flags, cones or marker boards.

### *Characteristics of unserviceability lights*

7.4.4 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*

7.4.5 **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*

7.4.6 **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*

7.4.7 **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.*

- a) a full-scale aerodrome emergency exercise at intervals not exceeding two years and partial emergency exercises in the intervening year to ensure that any deficiencies found during the full-scale aerodrome emergency exercise have been corrected; or
- b) a series of modular tests commencing in the first year and concluding in a full-scale aerodrome emergency exercise at intervals not exceeding three years;

and reviewed thereafter, or after an actual emergency, so as to correct any deficiency found during such exercises or actual emergency.

*Note 1.— The purpose of a full-scale exercise is to ensure the adequacy of the plan to cope with different types of emergencies. The purpose of a partial exercise is to ensure the adequacy of the response to individual participating agencies and components of the plan, such as the communications system. The purpose of modular tests is to enable concentrated effort on specific components of established emergency plans.*

*Note 2.— Guidance material on airport emergency planning is available in the Airport Services Manual (Doc 9137), Part 7.*

### **Emergencies in difficult environments**

9.1.14 The plan shall include the ready availability of, and coordination with, appropriate specialist rescue services to be able to respond to emergencies where an aerodrome is located close to water and/or swampy areas and where a significant portion of approach or departure operations takes place over these areas.

9.1.15 **Recommendation.**— *At those aerodromes located close to water and/or swampy areas, or difficult terrain, the aerodrome emergency plan should include the establishment, testing and assessment at regular intervals of a predetermined response for the specialist rescue services.*

9.1.16 **Recommendation.**— *An assessment of the approach and departure areas within 1 000 m of the runway threshold should be carried out to determine the options available for intervention.*

*Note.— Guidance material on assessing approach and departure areas within 1 000 m of runway thresholds can be found in Chapter 13 of the Airport Services Manual (Doc 9137), Part 1.*

## **9.2 Rescue and firefighting**

### **General**

*Introductory Note.— The principal objective of a rescue and firefighting service is to save lives in the event of an aircraft accident or incident occurring at, or in the immediate vicinity of, an aerodrome. The rescue and firefighting service is provided to create and maintain survivable conditions, to provide egress routes for occupants and to initiate the rescue of those occupants unable to make their escape without direct aid. The rescue may require the use of equipment and personnel other than those assessed primarily for rescue and firefighting purposes.*

*The most important factors bearing on effective rescue in a survivable aircraft accident are: the training received, the effectiveness of the equipment and the speed with which personnel and equipment designated for rescue and firefighting purposes can be put into use.*

*Requirements to combat building and fuel farm fires, or to deal with foaming of runways, are not taken into account.*

## Application

9.2.1 Rescue and firefighting 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 firefighting 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.*

9.2.2 Where an aerodrome is located close to water/swampy areas, or difficult terrain, and where a significant portion of approach or departure operations takes place over these areas, specialist rescue services and firefighting equipment appropriate to the hazard and risk shall be available.

*Note 1.— Special firefighting equipment need not be provided for water areas; this does not prevent the provision of such equipment if it would be of practical use, such as when the areas concerned include reefs or islands.*

*Note 2.— The objective is to plan and deploy the necessary life-saving flotation equipment as expeditiously as possible in a number commensurate with the largest aeroplane normally using the aerodrome.*

*Note 3.— Additional guidance is available in Chapter 13 of the Airport Services Manual (Doc 9137), Part 1.*

## Level of protection to be provided

9.2.3 The level of protection provided at an aerodrome for rescue and firefighting shall be appropriate to the aerodrome category determined using the principles in 9.2.5 and 9.2.6, except that, where the number of movements of the aeroplanes in the highest category normally using the aerodrome is less than 700 in the busiest consecutive three months, the level of protection provided shall be not less than one category below the determined category.

*Note.— Either a take-off or a landing constitutes a movement.*

9.2.4 **Recommendation.**— *The level of protection provided at an aerodrome for rescue and firefighting should be equal to the aerodrome category determined using the principles in 9.2.5 and 9.2.6.*

9.2.5 The aerodrome category shall be determined from Table 9-1 and shall be based on the longest aeroplanes normally using the aerodrome and their fuselage width.

*Note.— To categorize the aeroplanes using the aerodrome, first evaluate their overall length and second, their fuselage width.*

9.2.6 If, after selecting the category appropriate to the longest aeroplane's overall length, that aeroplane's fuselage width is greater than the maximum width in Table 9-1, column 3, for that category, then the category for that aeroplane shall actually be one category higher.

*Note 1.— See guidance in the Airport Services Manual (Doc 9137), Part 1, for categorizing aerodromes, including those for all-cargo aircraft operations, for rescue and firefighting purposes.*

*Note 2.— Guidance on training of personnel, rescue equipment for difficult environments and other facilities and services for rescue and firefighting is given in Attachment A, Section 17, and in the Airport Services Manual (Doc 9137), Part 1.*

9.2.7 During anticipated periods of reduced activity, the level of protection available shall be no less than that needed for the highest category of aeroplane planned to use the aerodrome during that time irrespective of the number of movements.

9.2.35 **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.*

9.2.36 **Recommendation.**— *When the surface of the road is indistinguishable from the surrounding area, or in areas where snow may obscure the location of the roads, edge markers should be placed at intervals of about 10 m.*

### **Fire stations**

9.2.37 **Recommendation.**— *All rescue and firefighting vehicles should normally be housed in a fire station. Satellite fire stations should be provided whenever the response time cannot be achieved from a single fire station.*

9.2.38 **Recommendation.**— *The fire station should be located so that the access for rescue and firefighting vehicles into the runway area is direct and clear, requiring a minimum number of turns.*

### **Communication and alerting systems**

9.2.39 **Recommendation.**— *A discrete communication system should be provided linking a fire station with the control tower, any other fire station on the aerodrome and the rescue and firefighting vehicles.*

9.2.40 **Recommendation.**— *An alerting system for rescue and firefighting personnel, capable of being operated from that station, should be provided at a fire station, any other fire station on the aerodrome and the aerodrome control tower.*

### **Number of rescue and firefighting vehicles**

9.2.41 **Recommendation.**— *The minimum number of rescue and firefighting vehicles provided at an aerodrome should be in accordance with the following tabulation:*

Aerodrome category	Rescue and firefighting 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 firefighting vehicles is given in the Airport Services Manual (Doc 9137), Part 1.*

## Personnel

9.2.42 All rescue and firefighting 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 firefighting equipment in use at the aerodrome, including pressure-fed fuel fires.

*Note 1.— Guidance to assist the appropriate authority in providing proper training is given in Attachment A, Section 17, and the Airport Services Manual (Doc 9137), 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”.*

9.2.43 The rescue and firefighting personnel training programme shall include training in human performance, including team coordination.

*Note.— Guidance material to design training programmes on human performance and team coordination can be found in the Human Factors Training Manual (Doc 9683).*

9.2.44 **Recommendation.**— *During flight operations, sufficient trained and competent personnel should be designated to be readily available to ride the rescue and firefighting vehicles and to operate the equipment at maximum capacity. These personnel should be deployed in a way that ensures that minimum response times can be achieved and that continuous agent application at the appropriate rate can be fully maintained. Consideration should also be given for personnel to use hand lines, ladders and other rescue and firefighting equipment normally associated with aircraft rescue and firefighting operations.*

9.2.45 **Recommendation.**— *In determining the minimum number of rescue and firefighting personnel required, a task resource analysis should be completed and the level of staffing documented in the Aerodrome Manual.*

*Note.— Guidance on the use of a task resource analysis can be found in the Airport Services Manual (Doc 9137), Part 1.*

9.2.46 All responding rescue and firefighting personnel shall be provided with protective clothing and respiratory equipment to enable them to perform their duties in an effective manner.

## 9.3 Disabled aircraft removal

*Note.— Guidance on removal of a disabled aircraft, including recovery equipment, is given in the Airport Services Manual (Doc 9137), Part 5. See also Annex 13 — Aircraft Accident and Incident Investigation concerning protection of evidence, custody and removal of aircraft.*

9.3.1 **Recommendation.**— *A plan for the removal of an aircraft disabled on, or adjacent to, the movement area should be established for an aerodrome, and a coordinator designated to implement the plan, when necessary.*

9.3.2 **Recommendation.**— *The disabled aircraft removal plan should be based on the characteristics of the aircraft that may normally be expected to operate at the aerodrome, and include among other things:*

- a) a list of equipment and personnel on, or in the vicinity of, the aerodrome which would be available for such purpose; and*
- b) arrangements for the rapid receipt of aircraft recovery equipment kits available from other aerodromes.*

## 9.4 Wildlife strike hazard reduction

*Note.—The presence of wildlife (birds and animals) on and in the aerodrome vicinity poses a serious threat to aircraft operational safety.*

9.4.1 The wildlife strike hazard on, or in the vicinity of, an aerodrome shall be assessed through:

- a) the establishment of a national procedure for recording and reporting wildlife strikes to aircraft;
- b) the collection of information from aircraft operators, aerodrome personnel and other sources on the presence of wildlife on or around the aerodrome constituting a potential hazard to aircraft operations; and
- c) an ongoing evaluation of the wildlife hazard by competent personnel.

*Note.— See Annex 15, Chapter 8.*

9.4.2 Wildlife strike reports shall be collected and forwarded to ICAO for inclusion in the ICAO Bird Strike Information System (IBIS) database.

*Note.— The IBIS is designed to collect and disseminate information on wildlife strikes to aircraft. Information on the system is included in the Manual on the ICAO Bird Strike Information System (IBIS) (Doc 9332).*

9.4.3 Action shall be taken to decrease the risk to aircraft operations by adopting measures to minimize the likelihood of collisions between wildlife and aircraft.

*Note.— 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 Airport Services Manual (Doc 9137), Part 3.*

9.4.4 The appropriate authority shall take action to eliminate or to prevent the establishment of garbage disposal dumps or any other source which may attract wildlife to the aerodrome, or its vicinity, unless an appropriate wildlife assessment indicates that they are unlikely to create conditions conducive to a wildlife hazard problem. Where the elimination of existing sites is not possible, the appropriate authority shall ensure that any risk to aircraft posed by these sites is assessed and reduced to as low as reasonably practicable.

9.4.5 **Recommendation.**— *States should give due consideration to aviation safety concerns related to land developments in the vicinity of the aerodrome that may attract wildlife.*

## 9.5 Apron management service

9.5.1 **Recommendation.**— *When warranted by the volume of traffic and operating conditions, an appropriate apron management service should be provided on an apron by an aerodrome ATS unit, by another aerodrome operating authority, 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.

**9.5.2 Recommendation.**— *When the aerodrome control tower does not participate in the apron management service, procedures should be established to facilitate the orderly transition of aircraft between the apron management unit and the aerodrome control tower.*

*Note.*— *Guidance on an apron management service is given in the Airport Services Manual (Doc 9137), Part 8, and in the Manual of Surface Movement Guidance and Control Systems (SMGCS) (Doc 9476).*

9.5.3 An apron management service shall be provided with radiotelephony communications facilities.

9.5.4 Where low visibility procedures are in effect, persons and vehicles operating on an apron shall be restricted to the essential minimum.

*Note.*— *Guidance on related special procedures is given in the Manual of Surface Movement Guidance and Control Systems (SMGCS) (Doc 9476).*

9.5.5 An emergency vehicle responding to an emergency shall be given priority over all other surface movement traffic.

9.5.6 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.

9.5.7 An aircraft stand shall be visually monitored to ensure that the recommended clearance distances are provided to an aircraft using the stand.

## 9.6 Ground servicing of aircraft

9.6.1 Fire extinguishing equipment suitable for at least initial intervention in the event of a fuel fire and personnel trained in its use shall be readily available during the ground servicing of an aircraft, and there shall be a means of quickly summoning the rescue and firefighting service in the event of a fire or major fuel spill.

9.6.2 When aircraft refuelling operations take place while passengers are embarking, on board or disembarking, ground equipment shall be positioned so as to allow:

- a) the use of a sufficient number of exits for expeditious evacuation; and
- b) a ready escape route from each of the exits to be used in an emergency.

## 9.7 Aerodrome vehicle operations

*Note 1.*— *Guidance on aerodrome vehicle operations is contained in Attachment A, Section 18, and on traffic rules and regulations for vehicles in the 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.*

- b) on a clearway if it would endanger an aircraft in the air.

9.9.2 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 3-1; or
- c) on a clearway and which would endanger an aircraft in the air;

shall be frangible and mounted as low as possible.

9.9.3 **Recommendation.**— *Any equipment or installation required for air navigation or for aircraft safety purposes which must be located on the non-graded portion of a runway strip should be regarded as an obstacle and should be frangible and mounted as low as possible.*

*Note.*— *Guidance on the siting of navigation aids is contained in the Aerodrome Design Manual (Doc 9157), Part 6.*

9.9.4 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.

9.9.5 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.

9.9.6 **Recommendation.**— *Any equipment or installation required for air navigation or for aircraft safety purposes which is an obstacle of operational significance in accordance with 4.2.4, 4.2.11, 4.2.20 or 4.2.27 should be frangible and mounted as low as possible.*

## 9.10 Fencing

### *Application*

9.10.1 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.

9.10.2 A fence or other suitable barrier shall be provided on an aerodrome to deter the inadvertent or premeditated access of an unauthorized person onto a non-public area of the aerodrome.

*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.*

9.10.3 Suitable means of protection shall be provided to deter the inadvertent or premeditated access of unauthorized persons into ground installations and facilities essential for the safety of civil aviation located off the aerodrome.

### *Location*

9.10.4 The fence or barrier shall be located so as to separate the movement area and other facilities or zones on the aerodrome vital to the safe operation of aircraft from areas open to public access.

9.10.5 **Recommendation.**— *When greater security is thought necessary, a cleared area should be provided on both sides of the fence or barrier to facilitate the work of patrols and to make trespassing more difficult. Consideration should be given to the provision of a perimeter road inside the aerodrome fencing for the use of both maintenance personnel and security patrols.*

## 9.11 Security lighting

**Recommendation.**— *At an aerodrome where it is deemed desirable for security reasons, a fence or other barrier provided for the protection of international civil aviation and its facilities should be illuminated at a minimum essential level. Consideration should be given to locating lights so that the ground area on both sides of the fence or barrier, particularly at access points, is illuminated.*

## 9.12 Autonomous runway incursion warning system

*Note 1.— The inclusion of detailed specifications for an autonomous runway incursion warning system (ARIWS) in this section is not intended to imply that an ARIWS has to be provided at an aerodrome.*

*Note 2.— The implementation of an ARIWS is a complex issue deserving careful consideration by aerodrome operators, air traffic services and States, and in coordination with the aircraft operators.*

*Note 3.— Attachment A, Section 20, provides a description of an ARIWS and information on its use.*

## CHAPTER 10. AERODROME MAINTENANCE

### 10.1 General

10.1.1 A maintenance programme, including preventive maintenance where appropriate, shall be established at an aerodrome to maintain facilities in a condition which does not impair the safety, regularity or efficiency of air navigation.

*Note 1.— Preventive maintenance is programmed maintenance work done in order to prevent a failure or degradation of facilities.*

*Note 2.— “Facilities” are intended to include such items as pavements, visual aids, fencing, drainage systems, electrical systems and buildings.*

10.1.2 **Recommendation.**— *The design and application of the maintenance programme should observe Human Factors principles.*

*Note.— Guidance material on Human Factors principles can be found in the Human Factors Training Manual (Doc 9683) and in the Airport Services Manual (Doc 9137), Part 8.*

### 10.2 Pavements

10.2.1 The surfaces of all movement areas including pavements (runways, taxiways and aprons) and adjacent areas shall be inspected and their conditions monitored regularly as part of an aerodrome preventive and corrective maintenance programme with the objective of avoiding and eliminating any foreign object debris (FOD) that might cause damage to aircraft or impair the operation of aircraft systems.

*Note 1.— See 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 PANS-Aerodromes (Doc 9981), the Manual of Surface Movement Guidance and Control Systems (SMGCS) (Doc 9476) and the Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual (Doc 9830).*

*Note 3.— Additional guidance on sweeping/cleaning of surfaces is contained in the Airport Services Manual (Doc 9137), Part 9.*

*Note 4.— Guidance on precautions to be taken in regard to the surface of shoulders is given in Attachment A, Section 8, and the Aerodrome Design Manual (Doc 9157), Part 2.*

*Note 5.— Where the pavement is used by large aircraft or aircraft with tire pressures in the upper categories referred to in 2.6.6 c), particular attention should be given to the integrity of light fittings in the pavement and pavement joints.*

10.2.2 The surface of a runway shall be maintained in a condition such as to prevent formation of harmful irregularities.

*Note.— See Attachment A, Section 5.*

10.2.3 A paved runway shall be maintained in a condition so as to provide surface friction characteristics at or above the minimum friction level specified by the State.

*Note.— Assessment, Measurement and Reporting of Runway Surface Conditions (Cir 329) contains further information on this subject.*

10.2.4 Runway surface friction characteristics for maintenance purposes shall be periodically measured with a continuous friction measuring device using self-wetting features and documented. The frequency of these measurements shall be sufficient to determine the trend of the surface friction characteristics of the runway.

*Note 1.— Guidance on evaluating the runway surface friction characteristics is provided in Assessment, Measurement and Reporting of Runway Surface Conditions (Cir 329).*

*Note 2.— The objective of 10.2.3 to 10.2.8 is to ensure that the surface friction characteristics for the entire runway remain at or above a minimum friction level specified by the State.*

10.2.5 When runway surface friction measurements are made for maintenance purposes using a self-wetting continuous friction measuring device, the performance of the device shall meet the standard set or agreed by the State.

10.2.6 Personnel measuring runway surface friction required in 10.2.5 shall be trained to fulfil their duties.

10.2.7 Corrective maintenance action shall be taken to prevent the runway surface friction characteristics for either the entire runway or a portion thereof from falling below a minimum friction level specified by the State.

*Note.— A portion of runway in the order of 100 m long may be considered significant for maintenance or reporting action.*

10.2.8 **Recommendation.**— *The runway surface should be visually assessed, as necessary, under natural or simulated rain conditions for ponding or poor drainage and where required, corrective maintenance action taken.*

10.2.9 **Recommendation.**— *When a taxiway is used by turbine-engined aeroplanes, the surface of the taxiway shoulders should be maintained so as to be free of any loose stones or other objects that could be ingested by the aeroplane engines.*

*Note.— Guidance on this subject is given in the Aerodrome Design Manual (Doc 9157), Part 2.*

### 10.3 Removal of contaminants

10.3.1 Snow, slush, ice, 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.— The above requirement does not imply that winter operations on compacted snow and ice are prohibited. Information on snow removal and ice control and removal of other contaminants is given in the PANS-Aerodromes (Doc 9981).*

10.3.2 **Recommendation.**— *Taxiways should be kept clear of snow, slush, ice, etc., to the extent necessary to enable aircraft to be taxied to and from an operational runway.*

10.3.3 **Recommendation.**— *Aprons should be kept clear of snow, slush, ice, etc., to the extent necessary to enable aircraft to manoeuvre safely or, where appropriate, to be towed or pushed.*

**10.3.4 Recommendation.**— *Whenever the clearance of snow, slush, ice, etc., from the various parts of the movement area cannot be carried out simultaneously, the order of priority after the runway(s) in use should be set in consultation with the affected parties such as rescue and firefighting service and documented in a snow plan.*

*Note.* — *See Annex 15, Appendix 1, Part 3, AD 1.2.2 for information to be promulgated in an AIP concerning a snow plan. The Aeronautical Information Services Manual (Doc 8126), Chapter 5 contains guidance on the description of a snow plan including general policy concerning operational priorities established for the clearance of movement areas.*

**10.3.5 Recommendation.**— *Chemicals to remove or to prevent the formation of ice and frost on aerodrome pavements should be used when conditions indicate their use could be effective. Caution should be exercised in the application of the chemicals so as not to create a more slippery condition.*

*Note.*— *Information on the use of chemicals for aerodrome pavements is given in the PANS-Aerodromes (Doc 9981).*

**10.3.6** Chemicals which may have harmful effects on aircraft or pavements, or chemicals which may have toxic effects on the aerodrome environment, shall not be used.

#### 10.4 Runway pavement overlays

*Note.*— *The following specifications are intended for runway pavement overlay projects when the runway is to be returned temporarily to an operational status before resurfacing is complete. This may necessitate a temporary ramp between the new and old runway surfaces. Guidance on overlaying pavements and assessing their operational status is given in the Aerodrome Design Manual (Doc 9157), Part 3.*

**10.4.1** The longitudinal slope of the temporary ramp, measured with reference to the existing runway surface or previous overlay course, shall be:

- a) 0.5 to 1.0 per cent for overlays up to and including 5 cm in thickness; and
- b) not more than 0.5 per cent for overlays more than 5 cm in thickness.

**10.4.2 Recommendation.**— *Overlaying should proceed from one end of the runway toward the other end so that based on runway utilization most aircraft operations will experience a down ramp.*

**10.4.3 Recommendation.**— *The entire width of the runway should be overlaid during each work session.*

**10.4.4** Before a runway being overlaid is returned to a temporary operational status, a runway centre line marking conforming to the specifications in Section 5.2.3 shall be provided. Additionally, the location of any temporary threshold shall be identified by a 3.6 m wide transverse stripe.

**10.4.5 Recommendation.**— *The overlay should be constructed and maintained above the minimum friction level specified in 10.2.3.*

#### 10.5 Visual aids

*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.*

## 10.5 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. Aerodrome operators who have come to expect the melting of ice and snow by this heat signature may wish to evaluate whether or not a modified maintenance schedule is required during such conditions, or evaluate the possible operational value of installing LED fixtures with heating elements.*

*Note 3.— Enhanced vision systems (EVS) technology relies on the infra-red heat signature provided by incandescent lighting. Annex 15 protocols provide an appropriate means of notifying aerodrome users of EVS when lighting systems are converted to LED.*

10.5.1 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 Appendix 2. For light units where the designed main beam average intensity is above the value shown in Appendix 2, the 50 per cent value shall be related to that design value.

10.5.2 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 Airport Services Manual (Doc 9137), Part 9.*

10.5.3 **Recommendation.**— *The system of preventive maintenance employed for a precision approach runway category II or III should include at least the following checks:*

- a) visual inspection and in-field measurement of the intensity, beam spread and orientation of lights included in the approach and runway lighting systems;*
- b) control and measurement of the electrical characteristics of each circuitry included in the approach and runway lighting systems; and*
- c) control of the correct functioning of light intensity settings used by air traffic control.*

10.5.4 **Recommendation.**— *In-field measurement of intensity, beam spread and orientation of lights included in approach and runway lighting systems for a precision approach runway category II or III should be undertaken by measuring all lights, as far as practicable, to ensure conformance with the applicable specification of Appendix 2.*

10.5.5 **Recommendation.**— *Measurement of intensity, beam spread and orientation of lights included in approach and runway lighting systems for a precision approach runway category II or III should be undertaken using a mobile measuring unit of sufficient accuracy to analyse the characteristics of the individual lights.*

10.5.6 **Recommendation.**— *The frequency of measurement of lights for a precision approach runway category II or III should be based on traffic density, the local pollution level, the reliability of the installed lighting equipment and the continuous assessment of the results of the in-field measurements but, in any event, should not be less than twice a year for in-pavement lights and not less than once a year for other lights.*

10.5.7 The system of preventive maintenance employed for a precision approach runway category II or III shall have as its objective that, during any period of category II or III operations, all approach and runway lights are serviceable and that, in any event, at least:

- b) if the surface irregularities exceed the heights defined by the tolerable limit curve, but are less than the heights defined by the excessive limit curve, at the specified minimum acceptable length, herein noted by the excessive region, then maintenance corrective action is mandatory to restore the condition to the acceptable region. The runway may remain in service but be repaired within a reasonable period. This region could lead to the risk of possible aircraft structural damage due to a single event or fatigue failure over time; and
- c) if the surface irregularities exceed the heights defined by the excessive limit curve, at the specified minimum acceptable length, herein noted by the unacceptable region, then the area of the runway where the roughness has been identified warrants closure. Repairs must be made to restore the condition to within the acceptable limit region and the aircraft operators may be advised accordingly. This region runs the extreme risk of a structural failure and must be addressed immediately.

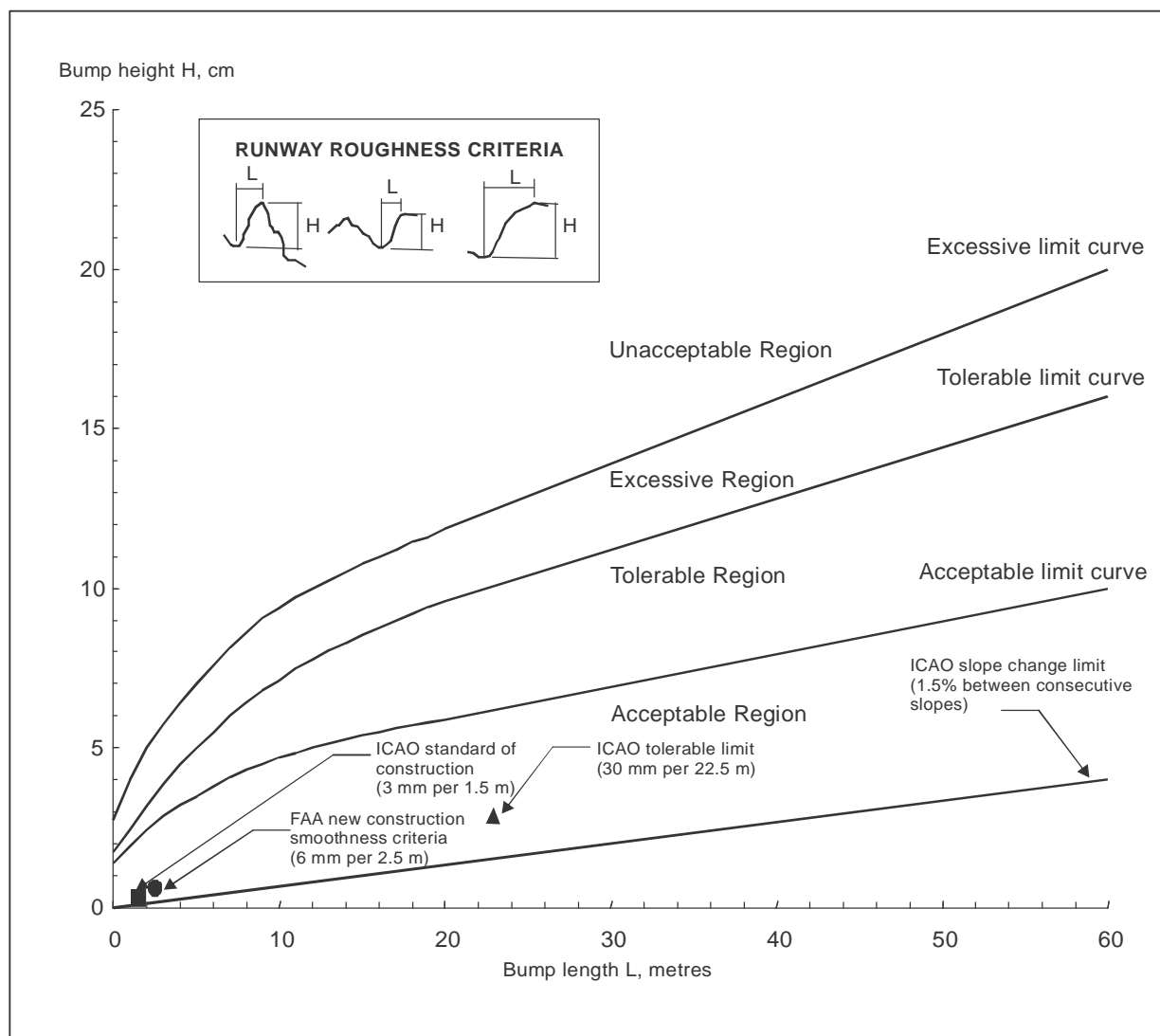
Surface irregularity	Length of irregularity (m)								
	3	6	9	12	15	20	30	45	60
Acceptable surface irregularity height (cm)	2.9	3.8	4.5	5	5.4	5.9	6.5	8.5	10
Tolerable surface irregularity height (cm)	3.9	5.5	6.8	7.8	8.6	9.6	11	13.6	16
Excessive surface irregularity height (cm)	5.8	7.6	9.1	10	10.8	11.9	13.9	17	20

Note that “surface irregularity” is defined herein to mean isolated surface elevation deviations that do not lie along a uniform slope through any given section of a runway. For the purposes of this concern, a “section of a runway” is defined herein to mean a segment of a runway throughout which a continuing general uphill, downhill or flat slope is prevalent. The length of this section is generally between 30 and 60 metres, and can be greater, depending on the longitudinal profile and the condition of the pavement.

The maximum tolerable step type bump, such as that which could exist between adjacent slabs, is simply the bump height corresponding to zero bump length at the upper end of the tolerable region of the roughness criteria of Figure A-3. The bump height at this location is 1.75 cm.

5.4 Figure A-3 illustrates a comparison of the surface roughness criteria with those developed by the United States Federal Aviation Administration. Further guidance regarding temporary slopes for overlay works on operational runways can be found in the *Aerodrome Design Manual*, Part 3 — *Pavements* (Doc 9157).

5.5 Deformation of the runway with time may also increase the possibility of the formation of water pools. Pools as shallow as approximately 3 mm in depth, particularly if they are located where they are likely to be encountered at high speed by landing aeroplanes, can induce aquaplaning, which can then be sustained on a wet runway by a much shallower depth of water. Improved guidance regarding the significant length and depth of pools relative to aquaplaning is the subject of further research. It is, of course, especially necessary to prevent pools from forming whenever there is a possibility that they might become frozen.



**Figure A-3. Comparison of roughness criteria**

*Note.— These criteria address single event roughness, not long wavelength harmonic effects nor the effect of repetitive surface undulations.*

## 6. Runway condition report for reporting runway surface condition

6.1 On a global level, movement areas are exposed to a multitude of climatic conditions and consequently a significant difference in the condition to be reported. The runway condition report (RCR) describes a basic methodology applicable for all these climatic variations and is structured in such a way that States can adjust them to the climatic conditions applicable for that State or region.

6.2 The concept of the RCR is premised on:

- a) an agreed set of criteria used in a consistent manner for runway surface condition assessment, aeroplane (performance) certification and operational performance calculation;
- b) a unique runway condition code (RWYCC) linking the agreed set of criteria with the aircraft landing and take-off performance table, and related to the braking action experienced and eventually reported by flight crews;
- c) reporting of contaminant type and depth that is relevant to take-off performance;
- d) a standardized common terminology and phraseology for the description of runway surface conditions that can be used by aerodrome operator inspection personnel, air traffic controllers, aircraft operators and flight crew; and
- e) globally-harmonized procedures for the establishment of the RWYCC with a built-in flexibility to allow for local variations to match the specific weather, infrastructure and other particular conditions.

6.3 These harmonized procedures are reflected in a runway condition assessment matrix (RCAM) which correlates the RWYCC, the agreed set of criteria and the aircraft braking action which the flight crew should expect for each value of the RWYCC.

6.4 Procedures which relate to the use of the RCAM are provided in the PANS-Aerodromes (Doc 9981).

6.5 It is recognized that information provided by the aerodrome's personnel assessing and reporting runway surface condition is crucial to the effectiveness of the runway condition report. A misreported runway condition alone should not lead to an accident or incident. Operational margins should cover for a reasonable error in the assessment, including unreported changes in the runway condition. But a misreported runway condition can mean that the margins are no longer available to cover for other operational variance (such as unexpected tailwind, high and fast approach above threshold or long flare).

6.6 This is further amplified by the need for providing the assessed information in the proper format for dissemination, which requires insight into the limitations set by the syntax for dissemination. This in turn restricts the wording of plain text remarks that can be provided.

6.7 It is important to follow standard procedures when providing assessed information on the runway surface conditions to ensure that safety is not compromised when aeroplanes use wet or contaminated runways. Personnel should be trained in the relevant fields of competence and their competence verified in a manner required by the State to ensure confidence in their assessments.

6.8 The training syllabus may include initial and periodic recurrent training in the following areas:

- a) aerodrome familiarization, including aerodrome markings, signs and lighting;
- b) aerodrome procedures as described in the aerodrome manual;
- c) aerodrome emergency plan;

- d) Notice to Airmen (NOTAM) initiation procedures;
- e) completion of initiation procedures for RCR;
- f) aerodrome driving rules;
- g) air traffic control procedures on the movement area;
- h) radiotelephone operating procedures;
- i) phraseology used in aerodrome control, including the ICAO spelling alphabet;
- j) aerodrome inspection procedures and techniques;
- k) type of runway contaminants and reporting;
- l) assessment and reporting of runway surface friction characteristics;
- m) use of runway friction measurement device;
- n) calibration and maintenance of runway friction measurement device;
- o) awareness of uncertainties related to l) and m); and
- p) low visibility procedures.

## **7. Drainage characteristics of the movement area and adjacent areas**

### **7.1 General**

7.1.1 Rapid drainage of surface water is a primary safety consideration in the design, construction and maintenance of the movement area and adjacent areas. The objective is to minimize water depth on the surface by draining water off the runway in the shortest path possible and particularly out of the area of the wheel path. There are two distinct drainage processes taking place:

- a) natural drainage of the surface water from the top of the pavement surface until it reaches the final recipient such as rivers or other water bodies; and
- b) dynamic drainage of the surface water trapped under a moving tire until it reaches outside the tire-to-ground contact area.

7.1.2 Both processes can be controlled through:

- a) design;
- b) construction; and
- c) maintenance.

of the pavements in order to prevent accumulation of water on the pavement surface.

## 7.2 Design of pavement

7.2.1 Surface drainage is a basic requirement and serves to minimize water depth on the surface. The objective is to drain water off the runway in the shortest path. Adequate surface drainage is provided primarily by an appropriately sloped surface (in both the longitudinal and transverse directions). The resulting combined longitudinal and transverse slope is the path for the drainage run-off. This path can be shortened by adding transverse grooves.

7.2.2 Dynamic drainage is achieved through built-in texture in the pavement surface. The rolling tire builds up water pressure and squeezes the water out the escape channels provided by the texture. The dynamic drainage of the tire-to-ground contact area may be improved by adding transverse grooves provided that they are subject to rigorous maintenance.

## 7.3 Construction of pavement

7.3.1 Through construction, the drainage characteristics of the surface are built into the pavement. These surface characteristics are:

- a) slopes;
- b) texture:
  - 1) microtexture;
  - 2) macrotexture;

7.3.2 Slopes for the various parts of the movement area and adjacent parts are described in Chapter 3 and figures are given as per cent. Further guidance is given in the *Aerodrome Design Manual* (Doc 9157), Part 1, Chapter 5.

7.3.3 Texture in the literature is described as microtexture or macrotexture. These terms are understood differently in various parts of the aviation industry.

7.3.4 Microtexture is the texture of the individual stones and is hardly detectable by the eye. Microtexture is considered a primary component in skid resistance at slow speeds. On a wet surface at higher speeds a water film may prevent direct contact between the surface asperities and the tire due to insufficient drainage from the tire-to-ground contact area.

7.3.5 Microtexture is a built-in quality of the pavement surface. By specifying crushed material that will withstand polishing microtexture, drainage of thin waterfilms are ensured for a longer period of time. Resistance against polishing is expressed in terms of the Polished Stone Values (PSV) which is in principle a value obtained from a friction measurement in accordance with international standards. These standards define the PSV minima that will enable a material with a good microtexture to be selected.

7.3.6 A major problem with microtexture is that it can change within short time periods without being easily detected. A typical example of this is the accumulation of rubber deposits in the touchdown area which will largely mask microtexture without necessarily reducing macrotexture.

7.3.7 Macrotexture is the texture among the individual stones. This scale of texture may be judged approximately by the eye. Macrotexture is primarily created by the size of aggregate used or by surface treatment of the pavement and is the major factor influencing drainage capacity at high speeds. Materials shall be selected so as to achieve good macrotexture.

7.3.8 The primary purpose of grooving a runway surface is to enhance surface drainage. Natural drainage can be slowed down by surface texture, but grooving can speed up the drainage by providing a shorter drainage path and increasing the drainage rate.

7.3.9 For measurement of macrotexture, simple methods such as the “sand and grease patch” methods described in the *Airport Services Manual* (Doc 9137), Part 2 were developed. These methods were used for the early research on which current airworthiness requirements are based, which refer to a classification categorizing macrotexture from A to E. This classification was developed, using sand or grease patch measuring techniques, and issued in 1971 by the Engineering Sciences Data Unit (ESDU).

*Runway classification based on texture information from ESDU 71026:*

<i>Classification</i>	<i>Texture depths (mm)</i>
A	0.10 – 0.14
B	0.15 – 0.24
C	0.25 – 0.50
D	0.51 – 1.00
E	1.01 – 2.54

7.3.10 Using this classification, the threshold value between microtexture and macrotexture is 0.1 mm mean texture depth (MTD). Related to this scale, the normal wet runway aircraft performance is based upon texture giving drainage and friction qualities midway between classification B and C (0.25 mm). Improved drainage through better texture might qualify for a better aircraft performance class. However such credit must be in accordance with aeroplane manufacturers’ documentation and agreed by the State. Presently credit is given to grooved or porous friction course runways following design, construction and maintenance criteria acceptable to the State. The harmonized certification standards of some States refer to texture giving drainage and friction qualities midway between classification D and E (1.0 mm).

7.3.11 For construction, design and maintenance, States use various international standards. Currently *ISO 13473-1: Characterization of pavement texture by use of surface profiles — Part 1: Determination of Mean Profile Depth* links the volumetric measuring technique with non-contact profile measuring techniques giving comparable texture values. These standards describe the threshold value between microtexture and macrotexture as 0.5 mm. The volumetric method has a validity range from 0.25 to 5 mm MTD. The profilometry method has a validity range from 0 to 5 mm mean profile depth (MPD). The values of MPD and MTD differ due to the finite size of the glass spheres used in the volumetric technique and because the MPD is derived from a two-dimensional profile rather than a three-dimensional surface. Therefore a transformation equation must be established for the measuring equipment used to relate MPD to MTD.

7.3.12 The ESDU scale groups runway surfaces based on macrotexture from A through E, where E represents the surface with best dynamic drainage capacity. The ESDU scale thus reflects the dynamic drainage characteristics of the pavement. Grooving any of these surfaces enhances the dynamic drainage capacity. The resulting drainage capacity of the surface is thus a function of the texture (A through E) and grooving. The contribution from grooving is a function of the size of the grooves and the spacing between the grooves. Aerodromes exposed to heavy or torrential rainfall must ensure that the pavement and adjacent areas have drainage capability to withstand these rainfalls or put limitations on the use of the pavements under such extreme situations. These airports should seek to have the maximum allowable slopes and the use of aggregates providing good drainage characteristics. They should also consider grooved pavements in the E classification to ensure that safety is not impaired.

#### 7.4 Maintenance of drainage characteristics of pavement

7.4.1 Macrotexture does not change within a short timespan but accumulation of rubber can fill up the texture and as such reduce the drainage capacity, which can result in impaired safety. Furthermore the runway structure may change over time and give unevenness which results in ponding after rainfall. Guidance on rubber removal and unevenness can be found in the *Airport Services Manual* (Doc 9137), Part 2. Guidance on methods for improving surface texture can be found in the *Aerodrome Design Manual* (Doc 9157), Part 3.

7.4.2 When groovings are used, the condition of the grooves should be regularly inspected to ensure that no deterioration has occurred and that the grooves are in good condition. Guidance on maintenance of pavements is available in the *Airport Services Manual* (Doc 9137), Part 2 — *Pavement Surface Conditions* and Part 9 — *Airport Maintenance Practices* and the *Aerodrome Design Manual* (Doc 9157), Part 2.

7.4.3 The pavement may be shot blasted in order to enhance the pavement macrotexture.

## 8. Strips

### 8.1 Shoulders

8.1.1 The shoulder of a runway or stopway should be prepared or constructed so as to minimize any hazard to an aeroplane running off the runway or stopway. Some guidance is given in the following paragraphs on certain special problems which may arise, and on the further question of measures to avoid the ingestion of loose stones or other objects by turbine engines.

8.1.2 In some cases, the bearing strength of the natural ground in the strip may be sufficient, without special preparation, to meet the requirements for shoulders. Where special preparation is necessary, the method used will depend on local soil conditions and the mass of the aeroplanes the runway is intended to serve. Soil tests will help in determining the best method of improvement (e.g. drainage, stabilization, surfacing, light paving).

8.1.3 Attention should also be paid when designing shoulders to prevent the ingestion of stones or other objects by turbine engines. Similar considerations apply here to those which are discussed for the margins of taxiways in the *Aerodrome Design Manual* (Doc 9157), Part 2, both as to the special measures which may be necessary and as to the distance over which such special measures, if required, should be taken.

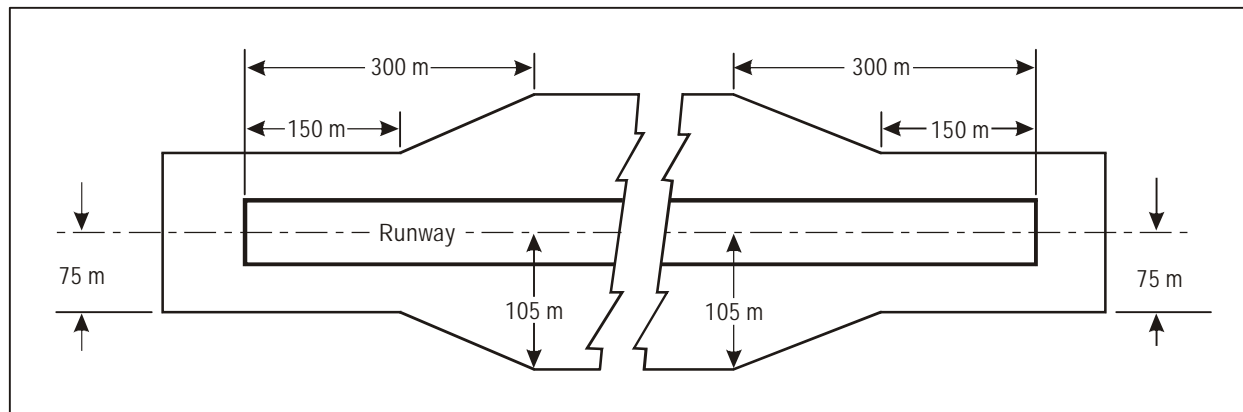
8.1.4 Where shoulders have been treated specially, either to provide the required bearing strength or to prevent the presence of stones or debris, difficulties may arise because of a lack of visual contrast between the runway surface and that of the adjacent strip. This difficulty can be overcome either by providing a good visual contrast in the surfacing of the runway or strip, or by providing a runway side stripe marking.

### 8.2 Objects on strips

Within the general area of the strip adjacent to the runway, measures should be taken to prevent an aeroplane's wheel, when sinking into the ground, from striking a hard vertical face. Special problems may arise for runway light fittings or other objects mounted in the strip or at the intersection with a taxiway or another runway. In the case of construction, such as runways or taxiways, where the surface must also be flush with the strip surface, a vertical face can be eliminated by chamfering from the top of the construction to not less than 30 cm below the strip surface level. Other objects, the functions of which do not require them to be at surface level, should be buried to a depth of not less than 30 cm.

### 8.3 Grading of a strip for precision approach runways

Chapter 3, 3.4.8, recommends that the portion of a strip of an instrument runway within at least 75 m from the centre line should be graded where the code number is 3 or 4. For a precision approach runway, it may be desirable to adopt a greater width where the code number is 3 or 4. Figure A-4 shows the shape and dimensions of a wider strip that may be considered for such a runway. This strip has been designed using information on aircraft running off runways. The portion to be graded extends to a distance of 105 m from the centre line, except that the distance is gradually reduced to 75 m from the centre line at both ends of the strip, for a length of 150 m from the runway end.



**Figure A-4. Graded portion of a strip including a precision approach runway where the code number is 3 or 4**

## 9. Runway end safety areas

9.1 Where a runway end safety area is provided in accordance with Chapter 3, consideration should be given to providing an area long enough to contain overruns and undershoots resulting from a reasonably probable combination of adverse operational factors. On a precision approach runway, the ILS localizer is normally the first upstanding obstacle, and the runway end safety area should extend up to this facility. In other circumstances, the first upstanding obstacle may be a road, a railroad or other constructed or natural feature. The provision of a runway end safety area should take such obstacles into consideration.

9.2 Where provision of a runway end safety area would be particularly prohibitive to implement, consideration would have to be given to reducing some of the declared distances of the runway for the provision of a runway end safety area and installation of an arresting system.

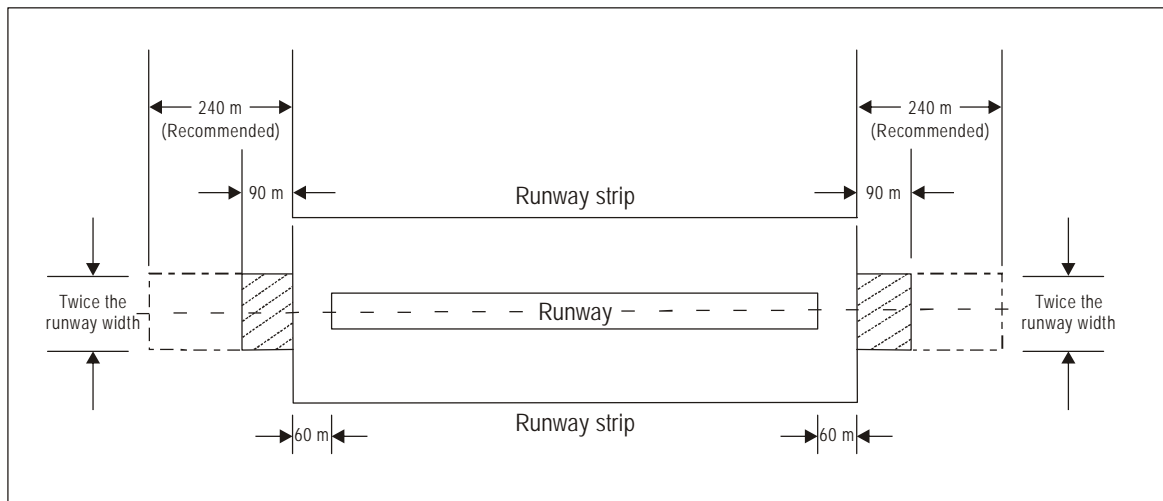
9.3 Research programmes, as well as evaluation of actual aircraft overruns into arresting systems, have demonstrated that the performance of some arresting systems can be predictable and effective in arresting aircraft overruns.

9.4 Demonstrated performance of an arresting system can be achieved by a validated design method, which can predict the performance of the system. The design and performance should be based on the type of aircraft anticipated to use the associated runway that imposes the greatest demand upon the arresting system.

9.5 The design of an arresting system must consider multiple aircraft parameters, including but not limited to, allowable aircraft gear loads, gear configuration, tire contact pressure, aircraft centre of gravity and aircraft speed. Accommodating undershoots must also be addressed. Additionally, the design must allow the safe operation of fully loaded rescue and firefighting vehicles, including their ingress and egress.

9.6 The information relating to the provision of a runway end safety area and the presence of an arresting system should be published in the AIP.

9.7 Additional information is contained in the *Aerodrome Design Manual* (Doc 9157), Part 1.



**Figure A-5. Runway end safety area for a runway where the code number is 3 or 4**

## 10. Location of threshold

### 10.1 General

10.1.1 The threshold is normally located at the extremity of a runway, if there are no obstacles penetrating above the approach surface. In some cases, however, due to local conditions it may be desirable to displace the threshold permanently (see below). When studying the location of a threshold, consideration should also be given to the height of the ILS reference datum and/or MLS approach reference datum and the determination of the obstacle clearance limits. (Specifications concerning the height of the ILS reference datum and MLS approach reference datum are given in Annex 10, Volume I.)

10.1.2 In determining that no obstacles penetrate above the approach surface, account should be taken of mobile objects (vehicles on roads, trains, etc.) at least within that portion of the approach area within 1 200 m longitudinally from the threshold and of an overall width of not less than 150 m.

### 10.2 Displaced threshold

10.2.1 If an object extends above the approach surface and the object cannot be removed, consideration should be given to displacing the threshold permanently.

10.2.2 To meet the obstacle limitation objectives of Chapter 4, the threshold should ideally be displaced down the runway for the distance necessary to provide that the approach surface is cleared of obstacles.

10.2.3 However, displacement of the threshold from the runway extremity will inevitably cause reduction of the landing distance available, and this may be of greater operational significance than penetration of the approach surface by marked and lighted obstacles. A decision to displace the threshold, and the extent of such displacement, should therefore have regard to an optimum balance between the considerations of clear approach surfaces and adequate landing distance. In deciding this question, account will need to be taken of the types of aeroplanes which the runway is intended to serve, the limiting visibility and cloud base conditions under which the runway will be used, the position of the obstacles in relation to the threshold and extended centre line and, in the case of a precision approach runway, the significance of the obstacles to the determination of the obstacle clearance limit.

10.2.4 Notwithstanding the consideration of landing distance available, the selected position for the threshold should not be such that the obstacle free surface to the threshold is steeper than 3.3 per cent where the code number is 4 or steeper than 5 per cent where the code number is 3.

10.2.5 In the event of a threshold being located according to the criteria for obstacle free surfaces in the preceding paragraph, the obstacle marking requirements of Chapter 6 should continue to be met in relation to the displaced threshold.

10.2.6 Depending on the length of the displacement, the RVR at the threshold could differ from that at the beginning of the runway for take-offs. The use of red runway edge lights with photometric intensities lower than the nominal value of 10 000 cd for white lights increases that phenomenon. The impact of a displaced threshold on take-off minima should be assessed by the appropriate authority.

10.2.7 Provisions in Annex 14, Volume I, regarding marking and lighting of displaced thresholds and some operational recommendations can be found in 5.2.4.9, 5.2.4.10, 5.3.5.5, 5.3.8.1, 5.3.9.7, 5.3.10.3, 5.3.10.7 and 5.3.12.6.

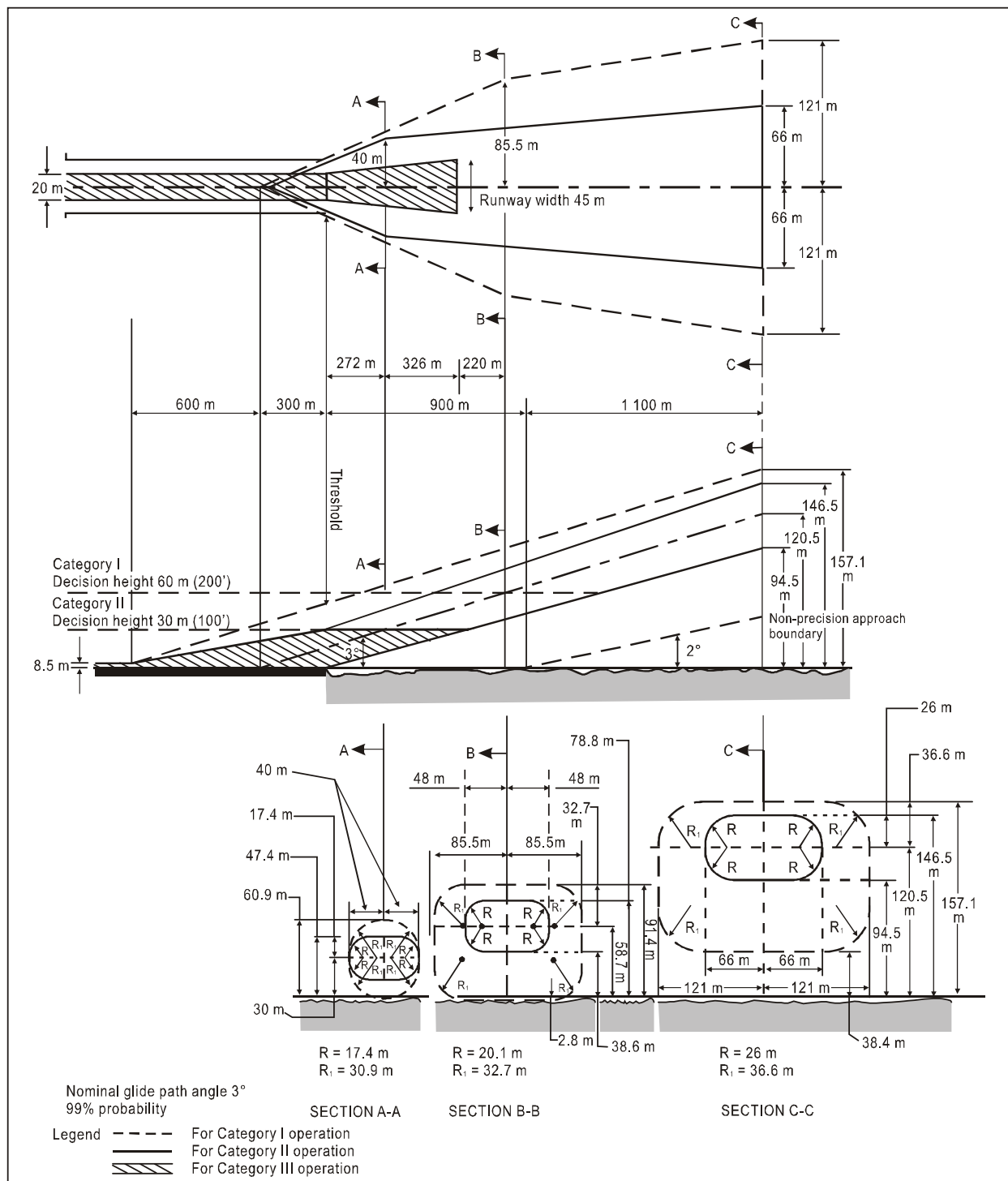
## **11. Approach lighting systems**

### **11.1 Types and characteristics**

11.1.1 The specifications in this volume provide for the basic characteristics for simple and precision approach lighting systems. For certain aspects of these systems, some latitude is permitted, for example, in the spacing between centre line lights and crossbars. The approach lighting patterns that have been generally adopted are shown in Figures A-7 and A-8. A diagram of the inner 300 m of the precision approach category II and III lighting system is shown in Figure 5-14.

11.1.2 The approach lighting configuration is to be provided irrespective of the location of the threshold, i.e. whether the threshold is at the extremity of the runway or displaced from the runway extremity. In both cases, the approach lighting system should extend up to the threshold. However, in the case of a displaced threshold, inset lights are used from the runway extremity up to the threshold to obtain the specified configuration. These inset lights are designed to satisfy the structural requirements specified in Chapter 5, 5.3.1.9, and the photometric requirements specified in Appendix 2, Figure A2-1 or A2-2.

11.1.3 Flight path envelopes to be used in designing the lighting are shown in Figure A-6.



**Figure A-6. Flight path envelopes to be used for lighting design for category I, II and III operations**

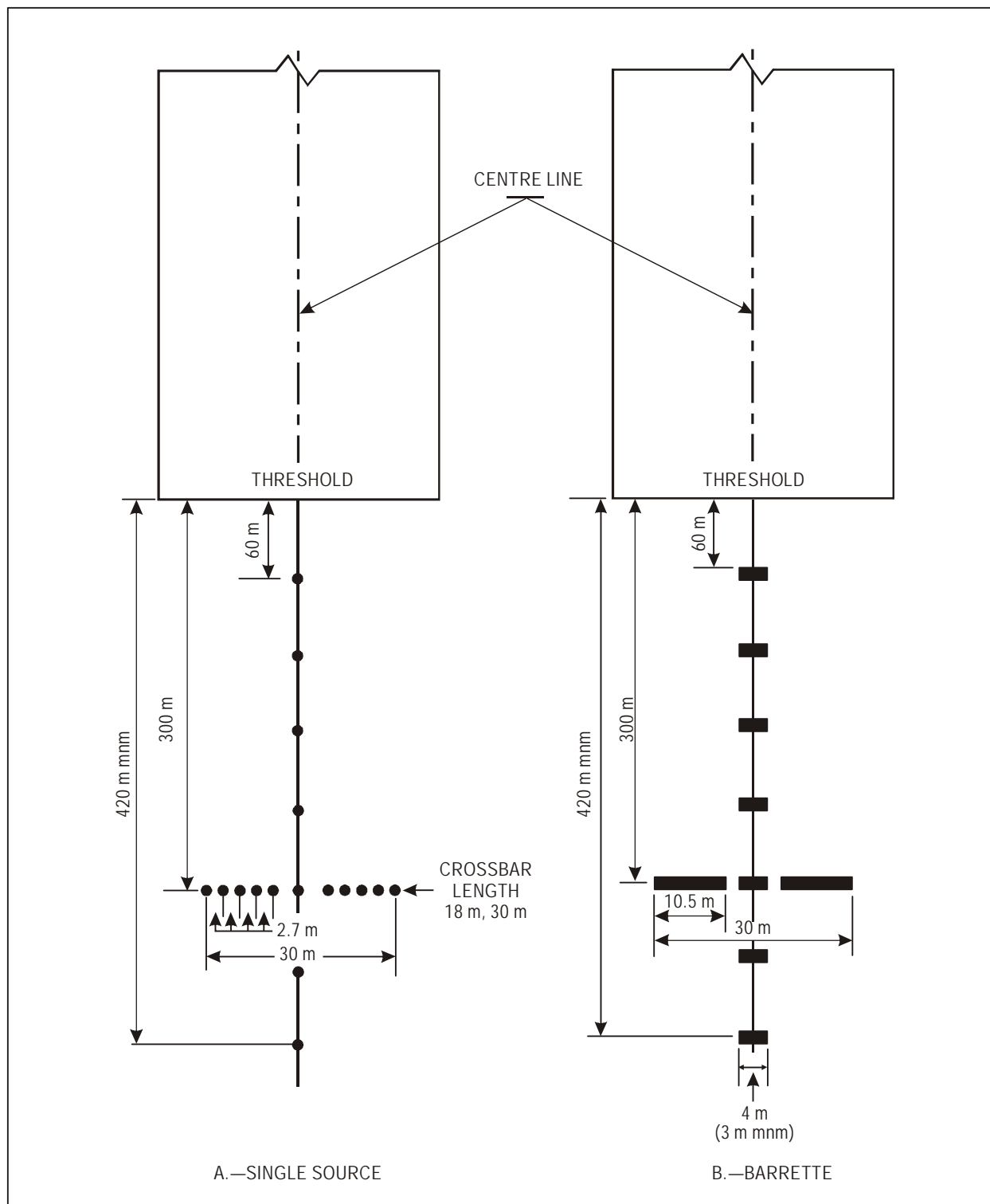


Figure A-7. Simple approach lighting systems

## 11.2 Installation tolerances

### *Horizontal*

11.2.1 The dimensional tolerances are shown in Figure A-8.

11.2.2 The centre line of an approach lighting system should be as coincident as possible with the extended centre line of the runway with a maximum tolerance of  $\pm 15'$ .

11.2.3 The longitudinal spacing of the centre line lights should be such that one light (or group of lights) is located in the centre of each crossbar, and the intervening centre line lights are spaced as evenly as practicable between two crossbars or a crossbar and a threshold.

11.2.4 The crossbars and barrettes should be at right angles to the centre line of the approach lighting system with a tolerance of  $\pm 30'$ , if the pattern in Figure A-8 (A) is adopted or  $\pm 2^\circ$ , if Figure A-8 (B) is adopted.

11.2.5 When a crossbar has to be displaced from its standard position, any adjacent crossbar should, where possible, be displaced by appropriate amounts in order to reduce the differences in the crossbar spacing.

11.2.6 When a crossbar in the system shown in Figure A-8 (A) is displaced from its standard position, its overall length should be adjusted so that it remains one-twentieth of the actual distance of the crossbar from the point of origin. It is not necessary, however, to adjust the standard 2.7 m spacing between the crossbar lights, but the crossbars should be kept symmetrical about the centre line of the approach lighting.

### *Vertical*

11.2.7 The ideal arrangement is to mount all the approach lights in the horizontal plane passing through the threshold (see Figure A-9), and this should be the general aim as far as local conditions permit. However, buildings, trees, etc., should not obscure the lights from the view of a pilot who is assumed to be  $1^\circ$  below the electronic glide path in the vicinity of the outer marker.

11.2.8 Within a stopway or clearway, and within 150 m of the end of a runway, the lights should be mounted as near to the ground as local conditions permit in order to minimize risk of damage to aeroplanes in the event of an overrun or undershoot. Beyond the stopway and clearway, it is not so necessary for the lights to be mounted close to the ground, and therefore undulations in the ground contours can be compensated for by mounting the lights on poles of appropriate height.

11.2.9 It is desirable that the lights be mounted so that, as far as possible, no object within a distance of 60 m on each side of the centre line protrudes through the plane of the approach lighting system. Where a tall object exists within 60 m of the centre line and within 1 350 m from the threshold for a precision approach lighting system, or 900 m for a simple approach lighting system, it may be advisable to install the lights so that the plane of the outer half of the pattern clears the top of the object.

11.2.10 In order to avoid giving a misleading impression of the plane of the ground, the lights should not be mounted below a gradient of 1 in 66 downwards from the threshold to a point 300 m out, and below a gradient of 1 in 40 beyond the 300 m point. For a precision approach category II and III lighting system, more stringent criteria may be necessary, e.g. negative slopes not permitted within 450 m of the threshold.

11.2.11 *Centre line.* The gradients of the centre line in any section (including a stopway or clearway) should be as small as practicable, and the changes in gradients should be as few and small as can be arranged and should not exceed 1 in 60. Experience has shown that as one proceeds outwards from the runway, rising gradients in any section of up to 1 in 66, and falling gradients of down to 1 in 40, are acceptable.

11.2.12 *Crossbars.* The crossbar lights should be so arranged as to lie on a straight line passing through the associated centre line lights, and wherever possible this line should be horizontal. It is permissible, however, to mount the lights on a transverse gradient not more than 1 in 80, if this enables crossbar lights within a stopway or clearway to be mounted nearer to the ground on sites where there is a cross-fall.

### 11.3 Clearance of obstacles

11.3.1 An area, hereinafter referred to as the light plane, has been established for obstacle clearance purposes, and all lights of the system are in this plane. This plane is rectangular in shape and symmetrically located about the approach lighting system's centre line. It starts at the threshold and extends 60 m beyond the approach end of the system, and is 120 m wide.

11.3.2 No objects are permitted to exist within the boundaries of the light plane which are higher than the light plane except as designated herein. All roads and highways are considered as obstacles extending 4.8 m above the crown of the road, except aerodrome service roads where all vehicular traffic is under control of the aerodrome authorities and coordinated with the aerodrome traffic control tower. Railroads, regardless of the amount of traffic, are considered as obstacles extending 5.4 m above the top of the rails.

11.3.3 It is recognized that some components of electronic landing aids systems, such as reflectors, antennas, monitors, etc., must be installed above the light plane. Every effort should be made to relocate such components outside the boundaries of the light plane. In the case of reflectors and monitors, this can be done in many instances.

11.3.4 Where an ILS localizer is installed within the light plane boundaries, it is recognized that the localizer, or screen if used, must extend above the light plane. In such cases the height of these structures should be held to a minimum and they should be located as far from the threshold as possible. In general the rule regarding permissible heights is 15 cm for each 30 m the structure is located from the threshold. As an example, if the localizer is located 300 m from the threshold, the screen will be permitted to extend above the plane of the approach lighting system by  $10 \times 15 = 150$  cm maximum, but preferably should be kept as low as possible consistent with proper operation of the ILS.

11.3.5 In locating an MLS azimuth antenna the guidance contained in Annex 10, Volume I, Attachment G, should be followed. This material, which also provides guidance on collocating an MLS azimuth antenna with an ILS localizer antenna, suggests that the MLS azimuth antenna may be sited within the light plane boundaries where it is not possible or practical to locate it beyond the outer end of the approach lighting for the opposite direction of approach. If the MLS azimuth antenna is located on the extended centre line of the runway, it should be as far as possible from the closest light position to the MLS azimuth antenna in the direction of the runway end. Furthermore, the MLS azimuth antenna phase centre should be at least 0.3 m above the light centre of the light position closest to the MLS azimuth antenna in the direction of the runway end. (This could be relaxed to 0.15 m if the site is otherwise free of significant multipath problems.) Compliance with this requirement, which is intended to ensure that the MLS signal quality is not affected by the approach lighting system, could result in the partial obstruction of the lighting system by the MLS azimuth antenna. To ensure that the resulting obstruction does not degrade visual guidance beyond an acceptable level, the MLS azimuth antenna should not be located closer to the runway end than 300 m and the preferred location is 25 m beyond the 300 m crossbar (this would place the antenna 5 m behind the light position 330 m from the runway end). Where an MLS azimuth antenna is so located, a central part of the 300 m crossbar of the approach lighting system would alone be partially obstructed. Nevertheless, it is important to ensure that the unobstructed lights of the crossbar remain serviceable all the time.

11.3.6 Objects existing within the boundaries of the light plane, requiring the light plane to be raised in order to meet the criteria contained herein, should be removed, lowered or relocated where this can be accomplished more economically than raising the light plane.

11.3.7 In some instances objects may exist which cannot be removed, lowered or relocated economically. These objects may be located so close to the threshold that they cannot be cleared by the 2 per cent slope. Where such conditions exist and no alternative is possible, the 2 per cent slope may be exceeded or a “stair step” resorted to in order to keep the approach lights above the objects. Such “step” or increased gradients should be resorted to only when it is impracticable to follow standard slope criteria, and they should be held to the absolute minimum. Under this criterion no negative slope is permitted in the outermost portion of the system.

#### 11.4 Consideration of the effects of reduced lengths

11.4.1 The need for an adequate approach lighting system to support precision approaches where the pilot is required to acquire visual references prior to landing cannot be stressed too strongly. The safety and regularity of such operations is dependent on this visual acquisition. The height above runway threshold at which the pilot decides there are sufficient visual cues to continue the precision approach and land will vary, depending on the type of approach being conducted and other factors such as meteorological conditions, ground and airborne equipment, etc. The required length of approach lighting system which will support all the variations of such approaches is 900 m, and this shall always be provided whenever possible.

11.4.2 However, there are some runway locations where it is impossible to provide the 900 m length of approach lighting system to support precision approaches.

11.4.3 In such cases, every effort should be made to provide as much approach lighting system as possible. The appropriate authority may impose restrictions on operations to runways equipped with reduced lengths of lighting. There are many factors which determine at what height the pilot must have decided to continue the approach to land or execute a missed approach. It must be understood that the pilot does not make an instantaneous judgement upon reaching a specified height. The actual decision to continue the approach and landing sequence is an accumulative process which is only concluded at the specified height. Unless lights are available prior to reaching the decision point, the visual assessment process is impaired and the likelihood of missed approaches will increase substantially. There are many operational considerations which must be taken into account by the appropriate authorities in deciding if any restrictions are necessary to any precision approach and these are detailed in Annex 6.

### 12. Priority of installation of visual approach slope indicator systems

12.1 It has been found impracticable to develop guidance material that will permit a completely objective analysis to be made of which runway on an aerodrome should receive first priority for the installation of a visual approach slope indicator system. However, factors that must be considered when making such a decision are:

- a) frequency of use;
- b) seriousness of the hazard;
- c) presence of other visual and non-visual aids;
- d) type of aeroplanes using the runway; and
- e) frequency and type of adverse weather conditions under which the runway will be used.

12.2 With respect to the seriousness of the hazard, the order given in the application specifications for a visual approach slope indicator system, 5.3.5.1 b) to e) of Chapter 5, may be used as a general guide. These may be summarized as:

- a) inadequate visual guidance because of:
  - 1) approaches over water or featureless terrain, or absence of sufficient extraneous light in the approach area by night;
  - 2) deceptive surrounding terrain;
- b) serious hazard in approach;
- c) serious hazard if aeroplanes undershoot or overrun; and
- d) unusual turbulence.

12.3 The presence of other visual or non-visual aids is a very important factor. Runways equipped with ILS or MLS would generally receive the lowest priority for a visual approach slope indicator system installation. It must be remembered, though, that visual approach slope indicator systems are visual approach aids in their own right and can supplement electronic aids. When serious hazards exist and/or a substantial number of aeroplanes not equipped for ILS or MLS use a runway, priority might be given to installing a visual approach slope indicator on this runway.

12.4 Priority should be given to runways used by turbojet aeroplanes.

### **13. Lighting of unserviceable areas**

Where a temporarily unserviceable area exists, it may be marked with fixed-red lights. These lights should mark the most potentially dangerous extremities of the area. A minimum of four such lights should be used, except where the area is triangular in shape where a minimum of three lights may be employed. The number of lights should be increased when the area is large or of unusual configuration. At least one light should be installed for each 7.5 m of peripheral distance of the area. If the lights are directional, they should be orientated so that as far as possible their beams are aligned in the direction from which aircraft or vehicles will approach. Where aircraft or vehicles will normally approach from several directions, consideration should be given to adding extra lights or using omnidirectional lights to show the area from these directions. Unserviceable area lights should be frangible. Their height should be sufficiently low to preserve clearance for propellers and for engine pods of jet aircraft.

### **14. Rapid exit taxiway indicator lights**

14.1 Rapid exit taxiway indicator lights (RETILs) comprise a set of yellow unidirectional lights installed in the runway adjacent to the centre line. The lights are positioned in a 3-2-1 sequence at 100 m intervals prior to the point of tangency of the rapid exit taxiway centre line. They are intended to give an indication to pilots of the location of the next available rapid exit taxiway.

14.2 In low visibility conditions, RETILs provide useful situational awareness cues while allowing the pilot to concentrate on keeping the aircraft on the runway centre line.

14.3 Following a landing, runway occupancy time has a significant effect on achievable runway capacity. RETILs allow pilots to maintain a good roll-out speed until it is necessary to decelerate to an appropriate speed for the turn into a rapid exit turn-off. A roll-out speed of 60 knots until the first RETIL (three-light barrette) is reached is seen as the optimum.

## 15. Intensity control of approach and runway lights

15.1 The conspicuity of a light depends on the impression received of contrast between the light and its background. If a light is to be useful to a pilot by day when on approach, it must have an intensity of at least 2 000 or 3 000 cd, and in the case of approach lights an intensity of the order of 20 000 cd is desirable. In conditions of very bright daylight fog it may not be possible to provide lights of sufficient intensity to be effective. On the other hand, in clear weather on a dark night, an intensity of the order of 100 cd for approach lights and 50 cd for the runway edge lights may be found suitable. Even then, owing to the closer range at which they are viewed, pilots have sometimes complained that the runway edge lights seemed unduly bright.

15.2 In fog the amount of light scattered is high. At night this scattered light increases the brightness of the fog over the approach area and runway to the extent that little increase in the visual range of the lights can be obtained by increasing their intensity beyond 2 000 or 3 000 cd. In an endeavour to increase the range at which lights would first be sighted at night, their intensity must not be raised to an extent that a pilot might find excessively dazzling at diminished range.

15.3 From the foregoing will be evident the importance of adjusting the intensity of the lights of an aerodrome lighting system according to the prevailing conditions, so as to obtain the best results without excessive dazzle that would disconcert the pilot. The appropriate intensity setting on any particular occasion will depend both on the conditions of background brightness and the visibility. Detailed guidance material on selecting intensity setting for different conditions is given in the *Aerodrome Design Manual* (Doc 9157), Part 4.

## 16. Signal area

A signal area need be provided only when it is intended to use visual ground signals to communicate with aircraft in flight. Such signals may be needed when the aerodrome does not have an aerodrome control tower or an aerodrome flight information service unit, or when the aerodrome is used by aeroplanes not equipped with radio. Visual ground signals may also be useful in the case of failure of two-way radio communication with aircraft. It should be recognized, however, that the type of information which may be conveyed by visual ground signals should normally be available in AIPs or NOTAM. The potential need for visual ground signals should therefore be evaluated before deciding to provide a signal area.

## 17. Rescue and firefighting services

### 17.1 Administration

17.1.1 The rescue and firefighting service at an aerodrome should be under the administrative control of the aerodrome management, which should also be responsible for ensuring that the service provided is organized, equipped, staffed, trained and operated in such a manner as to fulfil its proper functions.

17.1.2 In drawing up the detailed plan for the conduct of search and rescue operations in accordance with 4.2.1 of Annex 12 — *Search and Rescue*, the aerodrome management should coordinate its plans with the relevant rescue coordination centres to ensure that the respective limits of their responsibilities for an aircraft accident within the vicinity of an aerodrome are clearly delineated.

17.1.3 Coordination between the rescue and firefighting service at an aerodrome and public protective agencies, such as local fire brigade, police force, coast guard and hospitals, should be achieved by prior agreement for assistance in dealing with an aircraft accident.

17.1.4 A grid map of the aerodrome and its immediate vicinity should be provided for the use of the aerodrome services concerned. Information concerning topography, access roads and location of water supplies should be indicated. This map should be conspicuously posted in the control tower and fire station, and available on the rescue and firefighting vehicles and such other supporting vehicles required to respond to an aircraft accident or incident. Copies should also be distributed to public protective agencies as desirable.

17.1.5 Coordinated instructions should be drawn up detailing the responsibilities of all concerned and the action to be taken in dealing with emergencies. The appropriate authority should ensure that such instructions are promulgated and observed.

## 17.2 Training

The training curriculum should include initial and recurrent instruction in at least the following areas:

- a) airport familiarization;
- b) aircraft familiarization;
- c) rescue and firefighting personnel safety;
- d) emergency communications systems on the aerodrome, including aircraft fire-related alarms;
- e) use of the fire hoses, nozzles, turrets and other appliances required for compliance with Chapter 9, 9.2;
- f) application of the types of extinguishing agents required for compliance with Chapter 9, 9.2;
- g) emergency aircraft evacuation assistance;
- h) firefighting operations;
- i) adaptation and use of structural rescue and firefighting equipment for aircraft rescue and firefighting;
- j) dangerous goods;
- k) familiarization with firefighters' duties under the aerodrome emergency plan; and
- l) protective clothing and respiratory protection.

## 17.3 Level of protection to be provided

17.3.1 In accordance with Chapter 9, 9.2, aerodromes should be categorized for rescue and firefighting purposes and the level of protection provided should be appropriate to the aerodrome category.

17.3.2 However, Chapter 9, 9.2.3, permits a lower level of protection to be provided for a limited period where the number of movements of the aeroplanes in the highest category normally using the aerodrome is less than 700 in the busiest consecutive three months. It is important to note that the concession included in 9.2.3 is applicable only where there is a wide range of difference between the dimensions of the aeroplanes included in reaching 700 movements.

## 17.4 Rescue equipment for difficult environments

17.4.1 Suitable rescue equipment and services should be available at an aerodrome where the area to be covered by the service includes water, swampy areas or other difficult environment that cannot be fully served by conventional wheeled vehicles. This is particularly important where a significant portion of approach/departure operations takes place over these areas.

17.4.2 The rescue equipment should be carried on boats or other vehicles such as helicopters and amphibious or air cushion vehicles, capable of operating in the area concerned. The vehicles should be so located that they can be brought into action quickly to respond to the areas covered by the service.

17.4.3 At an aerodrome bordering the water, the boats or other vehicles should preferably be located on the aerodrome, and convenient launching or docking sites provided. If these vehicles are located off the aerodrome, they should preferably be under the control of the aerodrome rescue and firefighting service or, if this is not practicable, under the control of another competent public or private organization working in close coordination with the aerodrome rescue and firefighting service (such as police, military services, harbour patrol or coast guard).

17.4.4 Boats or other vehicles should have as high a speed as practicable so as to reach an accident site in minimum time. To reduce the possibility of injury during rescue operations, water jet-driven boats are preferred to water propeller-driven boats unless the propellers of the latter boats are ducted. Should the water areas to be covered by the service be frozen for a significant period of the year, the equipment should be selected accordingly. Vehicles used in this service should be equipped with life rafts and life preservers related to the requirements of the larger aircraft normally using the aerodrome, with two-way radio communication, and with floodlights for night operations. If aircraft operations during periods of low visibility are expected, it may be necessary to provide guidance for the responding emergency vehicles.

17.4.5 The personnel designated to operate the equipment should be adequately trained and drilled for rescue services in the appropriate environment.

## 17.5 Facilities

17.5.1 The provision of special telephone, two-way radio communication and general alarm systems for the rescue and firefighting service is desirable to ensure the dependable transmission of essential emergency and routine information. Consistent with the individual requirements of each aerodrome, these facilities serve the following purposes:

- a) direct communication between the activating authority and the aerodrome fire station in order to ensure the prompt alerting and dispatch of rescue and firefighting vehicles and personnel in the event of an aircraft accident or incident;
- b) direct communication between the rescue and firefighting service and the flight crew of an aircraft in emergency;
- c) emergency signals to ensure the immediate summoning of designated personnel not on standby duty;
- d) as necessary, summoning essential related services on or off the aerodrome; and
- e) maintaining communication by means of two-way radio with the rescue and firefighting vehicles in attendance at an aircraft accident or incident.

17.5.2 The availability of ambulance and medical facilities for the removal and after-care of casualties arising from an aircraft accident should receive the careful consideration of the appropriate authority and should form part of the overall emergency plan established to deal with such emergencies.

## 18. Operators of vehicles

18.1 The authorities responsible for the operation of vehicles on the movement area should ensure that the operators are properly qualified. This may include, as appropriate to the driver's function, knowledge of:

- a) the geography of the aerodrome;
- b) aerodrome signs, markings and lights;
- c) radiotelephone operating procedures;
- d) terms and phrases used in aerodrome control including the ICAO spelling alphabet;
- e) rules of air traffic services as they relate to ground operations;
- f) airport rules and procedures; and
- g) specialist functions as required, for example, in rescue and firefighting.

18.2 The operator should be able to demonstrate competency, as appropriate, in:

- a) the operation or use of vehicle transmit/receive equipment;
- b) understanding and complying with air traffic control and local procedures;
- c) vehicle navigation on the aerodrome; and
- d) special skills required for the particular function.

In addition, as required for any specialist function, the operator should be the holder of a State driver's licence, a State radio operator's licence or other licences.

18.3 The above should be applied as is appropriate to the function to be performed by the operator, and it is not necessary that all operators be trained to the same level, for example, operators whose functions are restricted to the apron.

18.4 If special procedures apply for operations in low visibility conditions, it is desirable to verify an operator's knowledge of the procedures through periodic checks.

## 19. The ACN-PCN method of reporting pavement strength

### 19.1 Overload operations

19.1.1 Overloading of pavements can result either from loads too large, or from a substantially increased application rate, or both. Loads larger than the defined (design or evaluation) load shorten the design life, whilst smaller loads extend it. With the exception of massive overloading, pavements in their structural behaviour are not subject to a particular limiting load above which they suddenly or catastrophically fail. Behaviour is such that a pavement can sustain a definable load for an expected number of repetitions during its design life. As a result, occasional minor overloading is acceptable, when expedient, with only limited loss in pavement life expectancy and relatively small acceleration of pavement deterioration. For those operations in which magnitude of overload and/or the frequency of use do not justify a detailed analysis, the following criteria are suggested:

- a) for flexible pavements, occasional movements by aircraft with ACN not exceeding 10 per cent 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.

19.1.2 Such overload movements should not normally be permitted on pavements exhibiting signs of distress or failure. Furthermore, overloading should be avoided during any periods of thaw following frost penetration, or when the strength of the pavement or its subgrade could be weakened by water. Where overload operations are conducted, the appropriate authority should review the relevant pavement condition regularly, and should also review the criteria for overload operations periodically since excessive repetition of overloads can cause severe shortening of pavement life or require major rehabilitation of pavement.

## 19.2 ACNs for several aircraft types

For convenience, several aircraft types currently in use have been evaluated on rigid and flexible pavements founded on the four subgrade strength categories in Chapter 2, 2.6.6 b), and the results tabulated in the *Aerodrome Design Manual* (Doc 9157), Part 3.

## 20. Autonomous runway incursion warning system (ARIWS)

*Note 1.— These autonomous systems are generally quite complex in design and operation and, as such, deserve careful consideration by all levels of the industry, from the regulating authority to the end user. This guidance is offered to provide a more clear description of the system(s) and offer some suggested actions required in order to properly implement these system(s) at an aerodrome in any State.*

*Note 2.— The Manual on the Prevention of Runway Incursion (Doc 9870) presents different approaches for the prevention of runway incursion.*

### 20.1 General description

20.1.1 The operation of an ARIWS is based upon a surveillance system which monitors the actual situation on a runway and automatically returns this information to warning lights at the runway (take-off) thresholds and entrances. When an aircraft is departing from a runway (rolling) or arriving at a runway (short final), red warning lights at the entrances will illuminate, indicating that it is unsafe to enter or cross the runway. When an aircraft is aligned on the runway for take-off and another aircraft or vehicle enters or crosses the runway, red warning lights will illuminate at the threshold area, indicating that it is unsafe to start the take-off roll.

20.1.2 In general, an ARIWS consists of an independent surveillance system (primary radar, multilateration, specialized cameras, dedicated radar, etc.) and a warning system in the form of extra airfield lighting systems connected through a processor which generates alerts independent from ATC directly to the flight crews and vehicle operators.

20.1.3 An ARIWS does not require circuit interleaving, secondary power supply or operational connection to other visual aid systems.

20.1.4 In practice, not every entrance or threshold needs to be equipped with warning lights. Each aerodrome will have to assess its needs individually depending on the characteristics of the aerodrome. There are several systems developed offering the same or similar functionality.

## 20.2 Flight crew actions

20.2.1 It is of critical importance that flight crews understand the warning being transmitted by the ARIWS system. Warnings are provided in near real-time, directly to the flight crew because there is no time for “relay” types of communications. In other words, a conflict warning generated to ATS which must then interpret the warning, evaluate the situation and communicate to the aircraft in question, would result in several seconds being taken up where each second is critical in the ability to stop the aircraft safely and prevent a potential collision. Pilots are presented with a globally consistent signal which means “STOP IMMEDIATELY” and must be taught to react accordingly. Likewise, pilots receiving an ATS clearance to take-off or cross a runway, and seeing the red light array, must STOP and advise ATS that they aborted/stopped because of the red lights. Again, the criticality of the timeline involved is so tight that there is no room for misinterpretation of the signal. It is of utmost importance that the visual signal be consistent around the world.

20.2.2 It must also be stressed that the extinguishing of the red lights does not, in itself, indicate a clearance to proceed. That clearance is still required from air traffic control. The absence of red warning lights only means that potential conflicts have not been detected.

20.2.3 In the event that a system becomes unserviceable, one of two things will occur. If the system fails in the extinguished condition, then no procedural changes need to be accomplished. The only thing that will happen is the loss of the automatic, independent warning system. Both ATS operations and flight crew procedures (in response to ATS clearances) will remain unchanged.

20.2.4 Procedures should be developed to address the circumstance where the system fails in the illuminated condition. It will be up to the ATS and/or aerodrome operator to establish those procedures depending on their own circumstances. It must be remembered that flight crews are instructed to “STOP” at all red lights. If the affected portion of the system, or the entire system, is shut off the situation is reverted to the extinguished scenario described in 20.2.3.

## 20.3 Aerodromes

20.3.1 An ARIWS does not have to be provided at all aerodromes. An aerodrome considering the installation of such a system may wish to assess its needs individually, depending on traffic levels, aerodrome geometry, ground taxi patterns, etc. Local user groups such as the Local Runway Safety Team (LRST) can be of assistance in this process. Also, not every runway or taxiway needs to be equipped with the lighting array(s), and not every installation requires a comprehensive ground surveillance system to feed information to the conflict detection computer.

20.3.2 Although there may be local specific requirements, some basic system requirements are applicable to all ARIWS:

- a) the control system and energy power supply of the system must be independent from any other system in use at the aerodrome, especially the other parts of the lighting system;
- b) the system must operate independently from ATS communications;
- c) the system must provide a globally accepted visual signal that is consistent and instantly understood by crews; and
- d) local procedures should be developed in the case of malfunction or failure of a portion of, or the entire system.

## 20.4 Air traffic services

20.4.1 The ARIWS is designed to be complementary to normal ATS functions, providing warnings to flight crews and vehicle operators when some conflict has been unintentionally created or missed during normal aerodrome operations. The ARIWS will provide a direct warning when, for example, ground control or tower (local) control has provided a clearance to hold short of a runway but the flight crew or vehicle operator has “missed” the hold short portion of their clearance and tower has issued a take-off or landing clearance to that same runway, and the non-read back by the flight crew or vehicle operator was missed by air traffic control.

20.4.2 In the case where a clearance has been issued and a crew reports a non-compliance due to “red lights”, or aborting because of “red lights”, then it is imperative that the controller assess the situation and provide additional instructions as necessary. It may well be that the system has generated a false warning or that the potential incursion no longer exists; however, it may also be a valid warning. In any case, additional instructions and/or a new clearance need to be provided. In a case where the system has failed, then procedures will need to be put into place as described in 20.2.3 and 20.2.4. In no case should the illumination of the ARIWS be dismissed without confirmation that, in fact, there is no conflict. It is worth noting that there have been numerous incidents avoided at aerodromes with such systems installed. It is also worth noting that there have been false warnings as well, usually as a result of the calibration of the warning software, but in any case, the potential conflict existence or non-existence must be confirmed.

20.4.3 While many installations may have a visual or audio warning available to ATS personnel, it is in no way intended that ATS personnel be required to actively monitor the system. Such warnings may assist ATS personnel in quickly assessing the conflict in the event of a warning and help them to provide appropriate further instructions, but the ARIWS should not play an active part in the normal functioning of any ATS facility.

20.4.4 Each aerodrome where the system is installed will develop procedures depending upon its unique situation. Again, it must be stressed that under no circumstances should pilots or operators be instructed to “cross the red lights”. As indicated previously, the use of local runway safety teams can greatly assist in this development process.

## 20.5 Promulgation of information

20.5.1 Information on the characteristics and status of an ARIWS at an aerodrome are promulgated in the AIP section AD 2.9, and its status updated as necessary through NOTAM or ATIS in compliance with 2.9.1 of this Annex.

20.5.2 Aircraft operators are to ensure that flight crews’ documentation include procedures regarding ARIWS and appropriate guidance information, in compliance with Annex 6, Part I.

20.5.3 Aerodromes may provide additional sources of guidance on operations and procedures for their personnel, aircraft operators, ATS and third-party personnel who may have to deal with an ARIWS.

## **21. Taxiway design guidance for minimizing the potential for runway incursions**

21.1 Good aerodrome design practices can reduce the potential for runway incursions while maintaining operating efficiency and capacity. The following taxiway design guidance may be considered to be part of a runway incursion prevention programme as a means to ensure that runway incursion aspects are addressed during the design phase for new runways and taxiways. Within this focused guidance, the prime considerations are to limit the number of aircraft or vehicles entering or crossing a runway, provide pilots with enhanced unobstructed views of the entire runway, and correct taxiways identified as hot spots as much as possible.

21.2 The centre line of an entrance taxiway should be perpendicular to the runway centre line, where possible. This design principle provides pilots with an unobstructed view of the entire runway, in both directions, to confirm that the runway and approach are clear of conflicting traffic before proceeding towards the runway. Where the taxiway angle is such that a clear unobstructed view, in both directions, is not possible, consideration should be given to providing a perpendicular portion of the taxiway immediately adjacent to the runway to allow for a full visual scan by the pilots prior to entering or crossing a runway.

21.3 For taxiways intersecting with runways, avoid designing taxiways wider than recommended in this Annex. This design principle offers improved recognition of the location of the runway holding position and the accompanying sign, marking and lighting visual cues.

21.4 Existing taxiways wider than recommended in this Annex, can be rectified by painting taxi side stripe markings to the recommended width. As far as practicable, it is preferable to redesign such locations properly rather than to repaint such locations.

21.5 Multi-taxiway entrances to a runway should be parallel to each other and should be distinctly separated by an unpaved area. This design principle allows each runway holding location an earthen area for the proper placement of accompanying sign, marking and lighting visual cues at each runway holding position. Moreover, the design principle eliminates the needless costs of building unusable pavement and as well as the costs for painting taxiway edge markings to indicate such unusable pavement. In general, excess paved areas at runway holding positions reduce the effectiveness of sign, marking and lighting visual cues.

21.6 Build taxiways that cross a runway as a single straight taxiway. Avoid dividing the taxiway into two after crossing the runway. This design principle avoids constructing “Y-shaped” taxiways known to present risk of runway incursions.

21.7 If possible, avoid building taxiways that enter at the mid-runway location. This design principle helps to reduce the collision risks at the most hazardous locations (high energy location) because normally departing aircraft have too much energy to stop, but not enough speed to take-off, before colliding with another errant aircraft or vehicle.

21.8 Provide clear separation of pavement between a rapid exit taxiway and other non-rapid taxiways entering or crossing a runway. This design principle avoids two taxiways from overlapping each other to create an excessive paved area that would confuse pilots entering a runway.

21.9 Avoid the placement of different pavement materials (asphalt and cement concrete) at or near the vicinity of the runway holding position, as far as practicable. This design principle avoids creating visual confusion as to the actual location of the runway holding position.

21.10 Many aerodromes have more than one runway, notably paired parallel runways (two runways on one side of the terminal), which creates a difficult problem in that either on arrival or departure an aircraft is required to cross a runway. Under such a configuration, the safety objective here is to avoid or at least keep to a minimum the number of runway crossings. This safety objective may be achieved by constructing a “perimeter taxiway”. A perimeter taxiway is a taxi route that goes around the end of a runway, enabling arrival aircraft (when landings are on outer runway of a pair) to get to the terminal, or departure aircraft (when departures are on outer runway of a pair) to get to the runway, without either crossing a runway or conflicting with a departing or approaching aircraft.

21.11 A perimeter taxiway would be designed according to the following criteria:

- a) Sufficient space is required between the landing threshold and the taxiway centre line where it crosses under the approach path to enable the critical taxiing aircraft to pass under the approach without penetrating any approach surface.
- b) The jet blast impact of aircraft taking off should be considered in consultation with aircraft manufacturers; the extent of take-off thrust should be evaluated when determining the location of a perimeter taxiway.

- c) The requirement for a runway end safety area, as well as possible interference with landing systems and other navigation aids should also be taken into account. For example, in the case of an ILS, the perimeter taxiway should be located behind the localiser antenna, not between the localiser antenna and the runway, due to the potential for severe ILS disturbance, noting that this is harder to achieve as the distance between the localizer and the runway increases.
- d) Human factors issues should also be taken into account. Appropriate measures should be put in place to assist pilots to distinguish between aircraft that are crossing the runway and those that are safely on a perimeter taxiway.

## 22. Aerodrome mapping data

### 22.1 Introduction

Chapter 2, 2.1.2 and 2.1.3, relate to the provision of aerodrome mapping data. The aerodrome mapping data features are collected and made available to the aeronautical information services for aerodromes designated by States with consideration of the intended applications. These applications are closely tied to an identified need and operational use where the application of the data would provide a safety benefit or could be used as mitigation of a safety concern.

### 22.2 Applications

22.2.1 Aerodrome mapping data include aerodrome geographic information that supports applications which improve the user's situational awareness or supplement surface navigation, thereby increasing safety margins and operational efficiency. With appropriate data element accuracy, these data sets support collaborative decision-making, common situational awareness and aerodrome guidance applications. The data sets are intended to be used in the following air navigation applications:

- a) on-board positioning and route awareness including moving maps with own aircraft position, surface guidance and navigation;
- b) traffic awareness including surveillance and runway incursion detection and alerting (such as, respectively, in A-SMGCS levels 1 and 2);
- c) ground positioning and route awareness including situational displays with aircraft and vehicles position and taxi route, surface guidance and navigation (such as A-SMGCS levels 3 and 4);
- d) facilitation of aerodrome-related aeronautical information, including NOTAMs;
- e) resource and aerodrome facility management; and
- f) aeronautical chart production.

22.2.2 The data may also be used in other applications such as training/flight simulators and on-board or ground enhanced vision systems (EVS), synthetic vision systems (SVS) and combined vision systems (CVS).

### 22.3 Determination of aerodromes to be considered for collection of aerodrome mapping data features

In order to determine which aerodromes may make use of applications requiring the collection of aerodrome mapping data features, the following aerodrome characteristics may be considered:

- safety risks at the aerodrome;
- visibility conditions;
- aerodrome layout; and
- traffic density.

*Note.— Further guidance on aerodrome mapping data can be found in the Airport Services Manual, Part 8 — Airport Operational Service (Doc 9137).*

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