Trinidad and Tobago
Civil Aviation Authority

TTCAA Advisory Circular

Subject: AERODROME STANDARDS
TTCAA Advisory Circular TAC-AD005
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PURPOSE

1. The purpose of this TTCAA Advisory Circular (TAC) is to give guidance and amplification of certain international standards prescribed in the Manual of Aerodrome Standards for aerodrome design and operations.

REGULATORY REQUIREMENTS AND STANDARDS

2. Annex 14 to the Chicago Convention prescribes the minimum standards for the operation of an aerodrome. The Trinidad and Tobago Civil Aviation Regulations [TTCAR] No.12 has referenced Annex 14 as the Manual of Aerodrome Standards and the standards contained therein applicable to the aerodrome, as the minimum standards for operation of aerodromes in Trinidad and Tobago.

AN INTRODUCTION TO THE MANUAL OF AERODROME STANDARDS

Scope and Relationship with Annex 14 and other Annexes

3. (1) Under Trinidad and Tobago Civil Aviation Regulations (TTCAR) No.12:4, a person shall not operate an aerodrome in Trinidad and Tobago unless such aerodrome is issued an Aerodrome Licence by the Authority. The Trinidad and Tobago Civil Aviation Authority is responsible for the certification process and the granting of an Arerodrome Licence, when it is determined that an applicant meets the requirements of TTCAR No.12. The aerodrome standards that must be complied with are the international standards for aerodromes prescribed in Annex 14 to the Chicago Convention. Where the Manual of Aerodrome Standards is referred to in TTCAR No.12, it means the International Standards and Recommended Practices for Aerodromes, contained in Annex 14 to the Chicago Convention as amended from time to time.

(2) Aerodrome safety is achieved by providing appropriate aerodrome services, facilities and equipment which meet the prescribed aerodrome standards, and maintaining them and the aerodrome environment to the level required for safe aircraft operations. By complying with the prescribed standards and procedures, and by taking a pro-active safety management approach in the operation of his aerodrome, an aerodrome operator can demonstrate that he has discharged his safety obligations to the traveling public.

(3) This Manual of Aerodrome Standards, as referred to under TTCAR No.12:3(3)contains aerodrome standards, recommended practices and guidance material applicable to the planning, operation and maintenance of aerodrome services, facilities and equipment to be complied with by aerodrome operators.

(4) The scope of this Manual is confined to the safety, regularity and efficiency aspects of aerodrome facilities, equipment and operational procedures. It does not cover such aspects as aviation security, aeronautical meteorology, air navigation services and accident/incident investigation which are subjects of separate regulations as shown in Table 1. The Manual of Aerodrome Standards also excludes the aspects of aerodrome operations relating to administration of aerodrome finances and the servicing of passengers and cargo.

Subject	**ICAO Annexes**	**TTCAR**
Air Navigation Services	1. Annex 3, 4, 10, 11,15	No.15
Aviation Security	2. Annex 17	No.8
Accident/Incident Investigation	3. Annex 13	No.14

Table 1

Requirement for an Aerodrome Licence

4. (1) Paragraph 1.3.1 of the Manual of Aerodrome Standards requires that aerodromes used for international operations shall be certified in accordance with the specifications contained in Annex 14 as well as other relevant ICAO specifications through an appropriate regulatory framework. Paragraph 1.3.3 stipulates, as a standard, that the regulatory framework shall include the establishment of criteria for the certification of aerodromes.

(2) In keeping with these ICAO standards, TTCAR No.12:4 states that a person shall not operate an aerodrome in Trinidad and Tobago unless such aerodrome is issued an Aerodrome Licence by the Authority.

(3) TTCAR No.12:6 describes the requirements for the application procedure and general conditions for the grant of an Aerodrome Licence which is conditional upon the Authority being satisfied that:

(a) The facilities and equipment of the aerodrome are in accordance with the standards specified in the Manual of Aerodrome Standards;

(b) The operating procedures of the aerodrome make satisfactory provision for the safety of aircraft and air navigation;

(c) The aerodrome is properly and adequately equipped for safe operations in commercial air transport;

(d) The aerodrome is properly and adequately equipped for its maintenance;

(e) The applicant has sufficient financial resources to conduct safe operations;

(f) An Aerodrome Manual, in accordance with Part III, of TTCAR No.12 has been prepared for the aerodrome;

(g) The applicant would, where the Aerodrome Licence is granted, be able to properly operate and maintain the aerodrome; and

(h) An acceptable safety management system that complies with the standards specified in the Manual of Aerodrome Standards is in place at the aerodrome.

(4) The Aerodrome Manual referred to in (f) above must contain accurate information and comply with the requirements specified in TTCAR No.12: Schedule 1.

Aerodrome Security

5. Aerodrome security requirements are prescribed in TTCAR No.8. The authority for setting polices on aerodrome operations lies with the Trinidad and Tobago Airports Authority and are outside the scope of the Manual of Aerodrome Standards except those areas for preventing unlawful interference in civil aviation at the aerodrome and for preventing unauthorized entry of persons, vehicles, equipment, animals and other things into the movement area.

Responsibilities of TTCAA

6. (1) The Trinidad and Tobago Civil Aviation Authority has the responsibility for the issue of Aerodrome licences which include:

(a) Ensuring that aerodromes in Trinidad and Tobago offer a safe operational environment in accordance with the Convention on International Civil Aviation;

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

(c) Notifying ICAO of differences between Trinidad and Tobago's aerodrome safety regulations and practices from the Standards and Recommended Practices (SARPs) contained in ICAO Annex 14 Vol. I;

(d) Carrying out aerodrome certification in accordance with TTCAR No.12;

(e) Developing and continual review of national safety standards and recommended practices relating to aerodromes;

(f) Monitoring and ensuring adherence to applicable standards and recommended practices through regular safety audits and providing measures for enforcing compliance;

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

(h) Providing expertise and support from authorized agencies to investigate aviation accidents/incidents;

(i) Reviewing aerodrome-related accident and incident investigation reports and performing investigations, where necessary, to determine if there is any violation of safety regulations and requirements by aerodrome operators;

(j) Coordinating with security inspectors and authorized agencies responsible for coordinating aerodrome security matters to promote the improvement and development of aerodrome security;

(k) Maintaining a technical library containing files for each certified aerodrome; records of the organization; documents issued by the ICAO relating to the design, operations and maintenance of aerodrome facilities and equipment; national aerodrome standards and recommended practices, relevant TTCAA Advisory circulars; relevant volumes of the IGMS; guidance material and where necessary, other relevant reference materials;

(l) Providing the DGCA with such information and advice as the DGCA may from time to time require; and

(m) Investigation of air accidents and incidents in Trinidad and Tobago

(2) Notwithstanding the responsibilities of the TTCAA in ensuring that aerodrome standards are set and maintained through the processes of certification of aerodrome operators and conduct of safety oversight audits, the responsibility for the safety of aerodrome operations rests with the certified aerodrome operators. A certified aerodrome operator with a Safety Management System in place is required to maintain its own safety audit and inspection programme with the TTCAA taking an interest in what the internal safety audit programme is achieving and how the aerodrome operator's organization is performing from a safety perspective.

(3) The TTCAA monitors the safety performance through the conduct of regular safety audits, reviewing the findings, identifying preventive and corrective actions needed, examining safety occurrences at the aerodromes and evaluating concerns expressed by the public or other industry participants.

(4) The Manual of Aerodrome Standards contains requirements based on the Standards and Recommended Practices contained in ICAO Annex 14 Vol. I and other related ICAO guidance material. Aerodrome operators must document their internal actions in their Aerodrome Manuals to demonstrate their continued compliance with these requirements.

(5) From time to time the TTCAA will publish Advisory Circulars like this TAC, and directives which are intended to supplement the standards and recommended practices contained in the Manual of Aerodrome Standards, or to provide recommended practices and additional material for guidance. These documents illustrate a means, but not necessarily the only means, of complying with the Regulations. They may amplify certain regulatory requirements by providing interpretive and explanatory materials. It is expected that aerodrome operators will provide adequate practices and document internal actions in their own Aerodrome Manuals to address the subject matter contained in these TTCAA publications.

Differences to be Published in AIP

7. Aerodrome operators shall publish any differences between the provisions at their aerodromes and the Standards prescribed in the Manual of Aerodrome Standards under the Aerodrome (AD) section of the AIP.

Limited Index of Significant subjects in the Manual of Aerodrome Standards

8. Appendix A is a limited index of significant subjects included in the Manual of Aerodrome Standards, Volume 1 pertinent to aerodrome design and operations.

PHYSICAL CHARACTERISTICS

Aerodrome Reference Code

9. (1) The intent of the reference code is to provide a system that interrelates the numerous specifications concerning the characteristics of aerodromes so as to provide a guidance on the aerodrome facilities that that are suitable for the aeroplanes that are intended to operate at the aerodrome. The code is depicted at Table 2. The reference code comprises:

(a) A number determined by selecting the higher value of declared TODA or ASDA.

(b) A letter which corresponds to the wingspan or main gear outer-wheel span, whichever is the more demanding, of the largest aircraft likely to be operating at the aerodrome.

(2) The determination of a runway's reference code is for the identification of the horizontal and vertical parameters of the surfaces associated with that runway, and is not intended to influence the pavement strength. The TTCAA will determine the runway reference code in consultation with the aerodrome operator.

Code Element 1		**Code Element 2**		
Code number (1)	**Aeroplane reference field length (2)**	**Code Letter (3)**	**Wing span (4)**	**Outer main gear wheel span (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 1200 m	B	15 m up to but not including 24 m	4.5 m up to but not including 6 m
3	1200 m up to but not including 1800 m	C	24 m up to but not including 36 m	6 m up to but not including 9 m

Table 2

Code Element 1			Code Element 2	
Code number (1)	**Aeroplane reference field length (2)**	**Code Letter (3)**	**Wing span (4)**	**Outer main gear wheel span (5)**
4	1800 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	F 65 m up to but not including 80m	14 m up to but not including 16 m

Table 2 (*cont'd*)

NUMBER SITING AND ORIENTATION OF RUNWAYS

General Factors

10. Many factors should be taken into account in the determination of the siting and orientation of runways. The factors which most frequently require study may be classified under four headings:

(a) **Type of operation.** Attention should be paid in particular to whether the aerodrome is to be used in all meteorological conditions or only in visual meteorological conditions, and whether it is intended for use by day and night, or only by day.

(b) **Climatological conditions.** A study of the wind distribution should be made to determine the usability factor. In this regard, the following comments should be taken into account:

(i) Wind statistics used for the calculation of the usability factor are normally available in ranges of speed and direction, and the accuracy of the results obtained depends, to a large extent, on the assumed distribution of observations within these ranges. In the absence of any sure information as to the true distribution, it is usual to assume a uniform distribution since, in relation to the most favourable runway orientations, this generally results in a slightly conservative for the usability factor.

(ii) The maximum mean cross-wind components given in the Manual of Aerodrome Standards, Chapter 3, 3.1.3 refer to normal circumstances. There are some factors which may require that a reduction of those maximum values be taken into account at a particular aerodrome. These include:

(A) The wide variations which may exist, in handling characteristics and maximum permissible cross-wind components, among diverse types of aeroplanes (including future types) within each of the three groups given in the Manual of Aerodrome Standards, Chapter 3, 3.1.3;

(B) Prevalence and nature of gusts;

(C) Prevalence and nature of turbulence;

(D) The availability of a secondary runway;

(E) The width of runways;

(F) The runway surface conditions – water, snow and ice on the runway materially reduce the allowable cross-wind component; and

(G) The strength of the wind associated with the limiting cross-wind component.

__Note:__ A study should also be made of the occurrence of poor visibility and/or low cloud base. Account should be taken of their frequency as well as the accompanying wind direction and speed.

(c) **Topography of the aerodrome site, its approaches, and surroundings.** This applies particularly to:

(i) Compliance with the obstacle limitation surfaces;

(ii) Current and future land use. The orientation and layout should be selected so as to protect as far as possible the particularly sensitive areas such as residential, school and hospital zones from the discomfort caused by aircraft noise.

__Note:__ Detailed information on this topic is provided in the Airport Planning Manual, Part 2, and in Guidance on the Balanced Approach to Aircraft Noise Management (ICAO, Doc 9829.

(iii) Current and future runway lengths to be provided;

(iv) Construction costs; and

(v) Possibility of installing suitable non-visual and visual aids for approach-to-land.

(d) **Air traffic in the vicinity of the aerodrome.** This applies particularly to -

(i) Proximity of other aerodromes or ATS routes;

(ii) Traffic density; and

(iii) Air traffic control and missed approach procedures.

Number of Runways in each Direction

11. The number of runways to be provided in each direction depends on the number of aircraft movements to be catered to.

CLEARWAYS AND STOPWAYS

12. (1) The decision to provide a stopway and/or a clearway as an alternative to an increased length of runway will depend on the physical characteristics of the area beyond the runway end, and on the operating performance requirements of the prospective aeroplanes. The runway, stopway and clearway lengths to be provided are determined by the aeroplane takeoff performance, but a check should also be made of the landing distance required by the aeroplanes using the runway to ensure that adequate runway length is provided for landing. The length of a clearway, however, cannot exceed half the length of take-off run available.

(2) The aeroplane performance operating limitations require a length which is enough to ensure that the aeroplane can, after starting a take-off, either be brought safely to a stop or complete the take-off safely. For the purpose of discussion it is supposed that the runway, stopway and clearway lengths provided at the aerodrome are only just adequate for the aeroplane requiring the longest take-off and accelerate-stop distances, taking into account its take-off mass, runway characteristics and ambient atmospheric conditions. Under these circumstances there is, for each take-off, a speed, called the decision speed; below this speed, the take-off must be abandoned if an engine fails, while above it the take-off must be completed. A very long take-off run and take-off distance would be required to complete a take-off when an engine fails before the decision speed is reached, because of the insufficient speed and the reduced power available. There would be no difficulty in stopping in the remaining accelerate stop distance available provided action is taken immediately. In these circumstances the correct course of action would be to abandon the take-off.

(3) On the other hand, if an engine fails after the decision speed is reached, the aeroplane will have sufficient speed and power available to complete the take-off safely in the remaining take-off distance available. However, because of the high speed, there would be difficulty in stopping the aeroplane in the remaining accelerate-stop distance available.

(4) The decision speed is not a fixed speed for any aeroplane, but can be selected by the pilot within limits to suit the accelerate-stop and take-off distance available, aeroplane take-off mass, runway characteristics, and ambient atmospheric conditions at the aerodrome. Normally, a higher decision speed is selected as the accelerate-stop distance available increases.

(5) A variety of combinations of accelerate-stop distances required and take-off distances required can be obtained to accommodate a particular aeroplane, taking into account the aeroplane take-off mass, runway characteristics, and ambient atmospheric conditions. Each combination requires its particular length of take-off run.

(6) The most familiar case is where the decision speed is such that the take-off distance required is equal to the accelerate-stop distance required; this value is known as the balanced field length. Where stopway and clearway are not provided, these distances are both equal to the runway length. However, if landing distance is for the moment ignored, runway is not essential for the whole of the balanced field length, as the take-off run required is, of course, less than the balanced field length. The balanced field length can, therefore, be provided by a runway supplemented by an equal length of clearway and stopway, instead of wholly as a runway. If the runway is used for take-off in both directions, an equal length of clearway and stopway has to be provided at each runway end. The saving in runway length is, therefore, bought at the cost of a greater overall length.

(7) In case economic considerations preclude the provision of stopway and, as a result, only runway and clearway are to be provided, the runway length (neglecting landing requirements) should be equal to the accelerate-stop distance required or the take-off run required, whichever is the greater. The take-off distance available will be the length of the runway plus the length of clearway.

(8) The minimum runway length and the maximum stopway or clearway length to be provided may be determined from the data in the aeroplane flight manual for the aeroplane considered to be critical from the viewpoint of runway length requirements as follows:

(a) If a stopway is economically possible, the lengths to be provided are those for the balanced field length. The runway length is the take-off run required or the landing distance required, whichever is the greater. If the accelerate-stop distance required is greater than the runway length so determined, the excess may be provided as stopway, usually at each end of the runway. In addition, a clearway of the same length as the stopway must also be provided;

(b) If a stopway is not to be provided, the runway length is the landing distance required, or if it is greater, the accelerate-stop distance required, which corresponds to the lowest practical value of the decision speed. The excess of the take-off distance required over the runway length may be provided as clearway, usually at each end of the runway.

(9) In addition to the above consideration, the concept of clearways in certain circumstances can be applied to a situation where the take-off distance required for all engines operating exceeds that required for the engine failure case.

(10) The economy of a stopway can be entirely lost if, after each usage, it must be regraded and compacted. Therefore, it should be designed to withstand at least a certain number of loadings of the aeroplane which the stopway is intended to serve without inducing structural damage to the aeroplane.

CALCULATION OF DECLARED DISTANCES

13. (1) The declared distances to be calculated for each runway direction comprise: the take-off run available (TORA), take-off distance available (TODA), accelerate-stop distance available (ASDA), and landing distance available (LDA).

(2) Where a runway is not provided with a stopway or clearway and the threshold is located at the extremity of the runway, the four declared distances should normally be equal to the length of the runway, as shown in Figure 1.

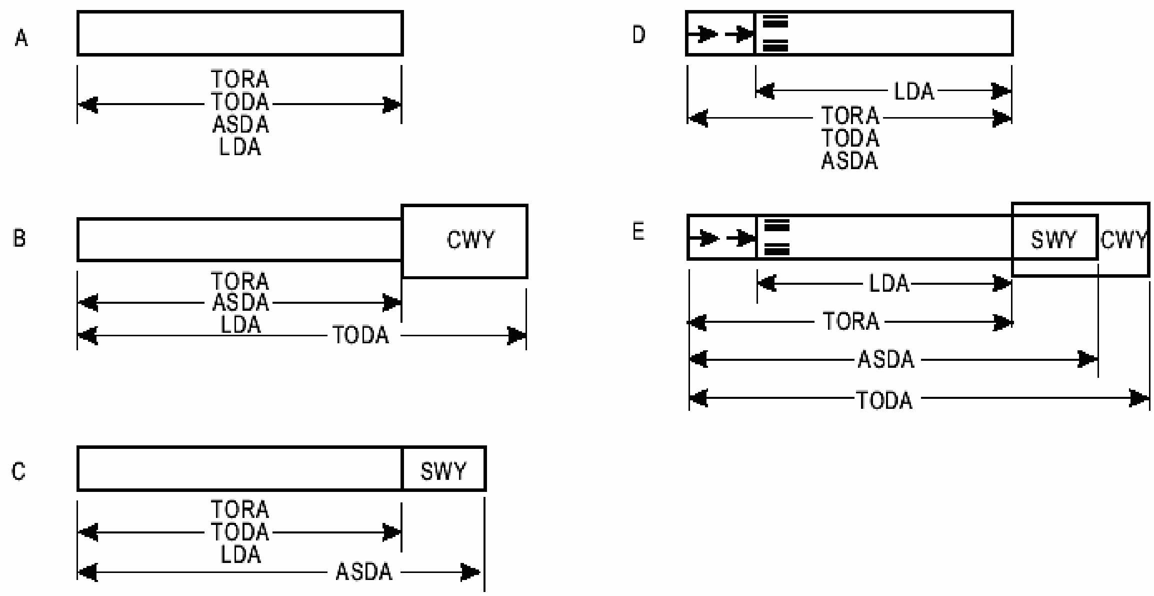
(3) Where a runway is provided with a clearway (CWY), then the TODA will include the length of clearway, as shown in Figure 2.

(4) Where a runway is provided with a stopway (SWY), then the ASDA will include the length of stopway, as shown in Figure 3.

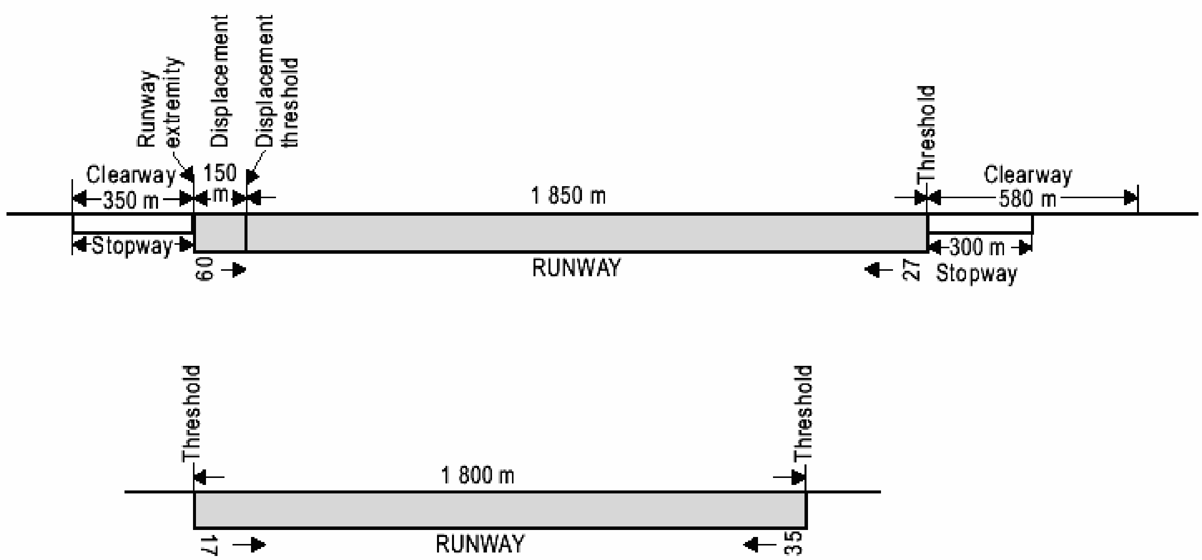
(5) Where a runway has a displaced threshold, then the LDA will be reduced by the distance the threshold is displaced, as shown in Figure 4. A displaced threshold affects only the LDA for approaches made to that threshold; all declared distances for operations in the reciprocal direction are unaffected.

(6) Figures 2 through 4 illustrate a runway provided with a clearway or a stopway or having a displaced threshold. Where more than one of these features exist, then more than one of the declared distances will be modified - but the modification will follow the same principle illustrated. An example showing a situation where all these features exist is shown in Figure 5.

(7) A suggested format for providing information on declared distances is given in Figure 6. If a runway direction cannot be used for take-off or landing, or both, because it is operationally forbidden, then this should be declared and the words "not usable" or the abbreviation "NU" entered.



Note.— All declared distances are illustrated for operations from left to right.



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RUNWAY	TORA	ASDA	TODA	LDA
	m	m	m	m
09	2 000	2 300	2 580	1 850
27	2 000	2 350	2 350	2 000
17	NU	NU	NU	1 800
35	1 800	1 800	1 800	NU

Figure 1 Illustration of declared distances

SLOPES ON A RUNWAY

Distance between Slope Changes

14. Figure 2 should be used in the following example which illustrates how the distance between slope changes is to be determined:

(a) D for a runway where the code number is 3 should be at least:

15,000 (Ix - yI + ly - zI) m
Ix - yI being the absolute numerical value of x - y
ly - zI being the absolute numerical value of y - z

Assuming x = + 0.01
y = -0.005
z = +0.005
then Ix - yl = 0.015
ly-zI=0.01

(b) To comply with the specifications, D should be not less than:

15,000 (0.015 + 0.01) m,

that is, 15,000 x 0.025 = 375 m

Consideration of Longitudinal and Transverse Slopes

15. When a runway is planned that will combine the extreme values for the slopes and changes in slope permitted under the Manual of Aerodrome Standards, Chapter 3, 3.1.13 to 3.1.19, a study should be made to ensure that the resulting surface profile will not hamper the operation of aeroplanes.

Radio Altimeter Operating Area

16. In order to accommodate aeroplanes making auto-coupled approaches and automatic landings (irrespective of weather conditions) it is desirable that slope changes be avoided or kept to a minimum, on a rectangular area at least 300 m long before the threshold of a precision approach runway. The area should be symmetrical about the extended centre line, 120 m wide. When special circumstances so warrant, the width may be reduced to no less than 60 m if an aeronautical study indicates that such reduction would not affect the safety of operations of aircraft. This is desirable because these aeroplanes are equipped with a radio altimeter for final height and flare guidance, and when the aeroplane is above the terrain immediately prior to the threshold, the radio altimeter will begin to provide information to the automatic pilot for auto-flare. Where slope changes cannot be avoided, the rate of change between two consecutive slopes should not exceed 2 per cent per 30 m.

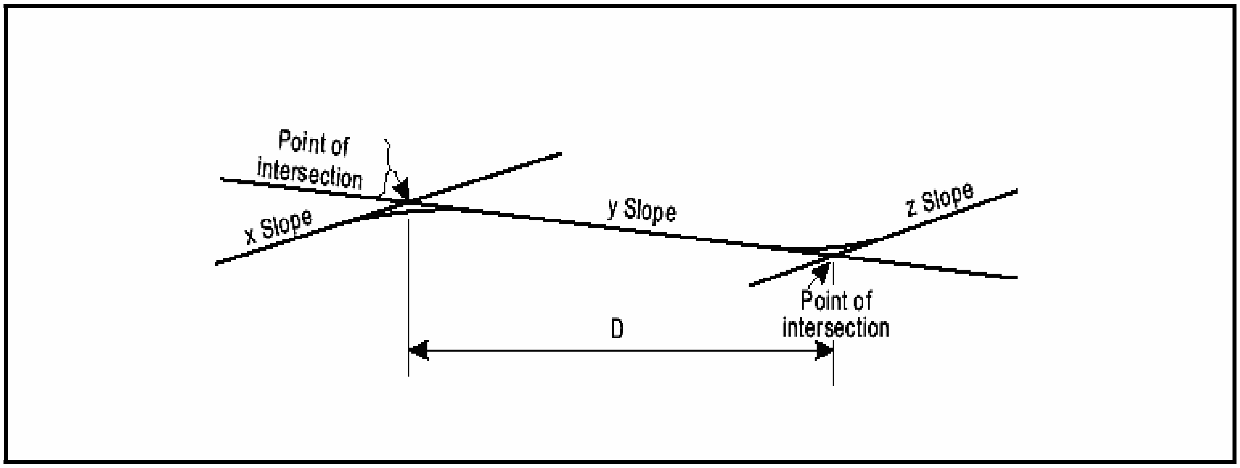

Figure 2 Profile on centre line of runway

RUNWAY SURFACE EVENNESS

17. (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. In adopting tolerances for runway surface irregularities, a standard of construction which is achievable for short distances of 3 m and which conforms to good engineering practice is:

"Except across the crown of a camber or across drainage channels, the finished surface of the wearing course is to be of such regularity that, when tested with a 3 m straightedge placed anywhere in any direction on the surface, there is no deviation greater than 3 mm between the bottom of the straight-edge and the surface of the pavement anywhere along the straight edge."

(2) Caution should also be exercised when inserting runway lights or drainage grilles in runway surfaces to ensure that adequate smoothness of the surface is maintained.

(3) The operation of aircraft and differential settlement of surface foundations will eventually lead to increases in surface irregularities. Small deviations in the above tolerances will not seriously hamper aircraft operations. In general, isolated irregularities of the order of 2.5 cm to 3 cm over a 45 m distance are tolerable. Exact information of the maximum acceptable deviation cannot be given, as it varies with the type and speed of an aircraft.

(4) 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.

DETERMINATION OF FRICTION CHARACTERISTICS OF WET PAVED RUNWAYS

18. (1) The friction of a wet paved runway should be measured to:

(a) Verify the friction characteristics of new or resurfaced paved runways when wet (The Manual of Aerodrome Standards, Chapter 3, 3.1.24);

(b) Assess periodically the slipperiness of paved runways when wet (The Manual of Aerodrome Standards, Chapter 10, 10.2.3);

(c) Determine the effect on friction when drainage characteristics are poor (The Manual of Aerodrome Standards, Chapter 10, 10.2.6); and

(d) Determine the friction of paved runways that become slippery under unusual conditions (The Manual of Aerodrome Standards, Chapter 2, 2.9.8).

(2) Runways should be evaluated when first constructed or after resurfacing to determine the wet runway surface friction characteristics. Although it is recognized that friction reduces with use, this value will represent the friction of the relatively long central portion of the runway that is uncontaminated by rubber deposits from aircraft operations and is therefore of operational value. Evaluation tests should be made on clean surfaces. If it is not possible to clean a surface before testing, then for purposes of preparing an initial report a test could be made on a portion of clean surface in the central part of the runway.

(3) Friction tests of existing surface conditions should be taken periodically in order to identify runways with low friction when wet. The Authority will define what minimum friction level it considers acceptable before a runway is classified as slippery when wet and publish this value in the aeronautical information publication (AIP). When the friction of a runway is found to be below this reported value, then such information should be promulgated by NOTAM. A maintenance planning level should also be established, below which, appropriate corrective maintenance action should be initiated to improve the friction. However, when the friction characteristics for either the entire runway or a portion thereof are below the minimum friction level, corrective maintenance action must be taken without delay. Friction measurements should be taken at intervals that will ensure identification of runways in need of maintenance or special surface treatment before the condition becomes serious. The time interval between measurements will depend on factors such as: aircraft type and frequency of usage, climatic conditions, pavement type, and pavement service and maintenance requirements.

(4) For uniformity and to permit comparison with other runways, friction tests of existing, new or resurfaced runways should be made with a continuous friction measuring device provided with a smooth tread tire. The device should have a capability of using self-wetting features to enable measurements of the friction characteristics of the surface to be made at a water depth of at least 1 mm.

(5) When it is suspected that the friction characteristics of a runway may be reduced because of poor drainage, owing to inadequate slopes or depressions, then an additional test should be made, but this time under natural conditions representative of a local rain. This test differs from the previous one in that water depths in the poorly cleared areas are normally greater in a local rain condition. The test results are thus more apt to identify problem areas having low friction values that could induce aquaplaning than the previous test. If circumstances do not permit tests to be conducted during natural conditions representative of a rain, then this condition may be simulated.

(6) Even when the friction has been found to be above the level set by the Authority to define a slippery runway, it may be known that under unusual conditions, such as after a long dry period, the runway may have become slippery. When such a condition is known to exist, then a friction measurement should be made as soon as it is suspected that the runway may have become slippery.

(7) When the results of any of the measurements identified in subparagraphs (3) through (6) above indicate that only a particular portion of a runway surface is slippery, then action to promulgate this information and, if appropriate, take corrective action is equally important.

(8) When conducting friction tests on wet runways, it is important to note that, unlike compacted snow and ice conditions, in which there is very limited variation of the friction coefficient with speed, a wet runway produces a drop in friction with an increase in speed. However, as the speed increases, the rate at which the friction is reduced becomes less. Among the factors affecting the friction coefficient between the tire and the runway surface, texture is particularly important. If the runway has a good macro-texture allowing the water to escape beneath the tire, then the friction value will be less affected by speed. Conversely, a low macro-texture surface will produce a larger drop in friction with increase in speed. Accordingly, when testing runways to determine their friction characteristics and whether maintenance action is necessary to improve it, a speed high enough to reveal these friction/speed variations should be used.

(9) Volume I of the Manual of Aerodrome Standards requires that two friction levels be specified as follows:

(a) A maintenance friction level below which corrective maintenance action should be initiated; and

(b) A minimum friction level below which information that a runway may be slippery when wet should be made available.

Furthermore, the Authority would establish criteria for the friction characteristics of new or resurfaced runway surfaces. Table 3, shown below, provides guidance on establishing the design objective for new runway surfaces and maintenance planning and minimum friction levels for runway surfaces in use.

Test equipment	Test Tire		Test speed (km/h)	Test water depth (mm)	Design objective for new surface	Maintenance planning level	Minimum friction level
	Type	Pressure (kPa)					
(1)	(2)		(3)	(4)	(5)	(6)	(7)
Mu-meter Trailer	A	70	65	1.0	0.72	0.52	0.42
	A	70	95	1.0	0.66	0.38	0.26
Skiddometer Trailer	B	210	65	1.0	0.82	0.60	0.50
	B	210	95	1.0	0.74	0.47	0.34
Surface Friction Tester Vehicle	B	210	65	1.0	0.82	0.60	0.50
	B	210	95	1.0	0.74	0.47	0.34
Runway Friction Tester Vehicle	B	210	65	1.0	0.82	0.60	0.50
	B	210	95	1.0	0.74	0.54	0.41
TATRA Friction Tester Vehicle	B	210	65	1.0	0.76	0.57	0.48
	B	210	95	1.0	0.67	0.52	0.42
GRIPTESTER Trailer	C	140	65	1.0	0.74	0.53	0.43
	C	140	95	1.0	0.64	0.36	0.24

Table 3

(10) The friction values given above are absolute values and are intended to be applied without any tolerance. These values were developed from a research study conducted in a State. The two friction measuring tires mounted on the Mumeter were smooth tread and had a special rubber formulation, i.e. Type A. The tires were tested at a 15 degree included angle of alignment along the longitudinal axis of the trailer. The single friction measuring tires mounted on the Skiddometer, Surface Friction Tester, Runway Friction Tester and TATRA were smooth tread and used the same rubber formulation, i.e. Type B. The GRIPTESTER was tested with a single smooth tread tire having the same rubber formulation as Type B but the size was smaller, i.e. Type C. The specifications of these tires (i.e. Types A, B and C) are contained in the Airport Services Manual, Part 2. Friction measuring devices using rubber formulation, tire tread/groove patterns, water depth, tire pressures, or test speeds different from those used in the programme described above, cannot be directly equated with the friction values given in the table. The values in columns (5), (6) and (7) are averaged values representative of the runway or significant portion thereof. It is considered desirable to test the friction characteristics of a paved runway at more than one speed.

(11) Other friction measuring devices can be used, provided they have been correlated with at least one test equipment mentioned above. The *Airport Services Manual,* Part 2 provides guidance on the methodology for determining the friction values corresponding to the design objective, maintenance planning level and minimum friction level for a friction tester not identified in the above table.

STRIPS

Shoulders

19. (1) A runway strip is 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.

(2) 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.

(3) 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).

(4) 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, 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.

(5) 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.

Objects on Strips

20. 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.

Grading of a Strip for Precision Approach Runways

21. The Manual of Aerodrome Standards, 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-3 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.

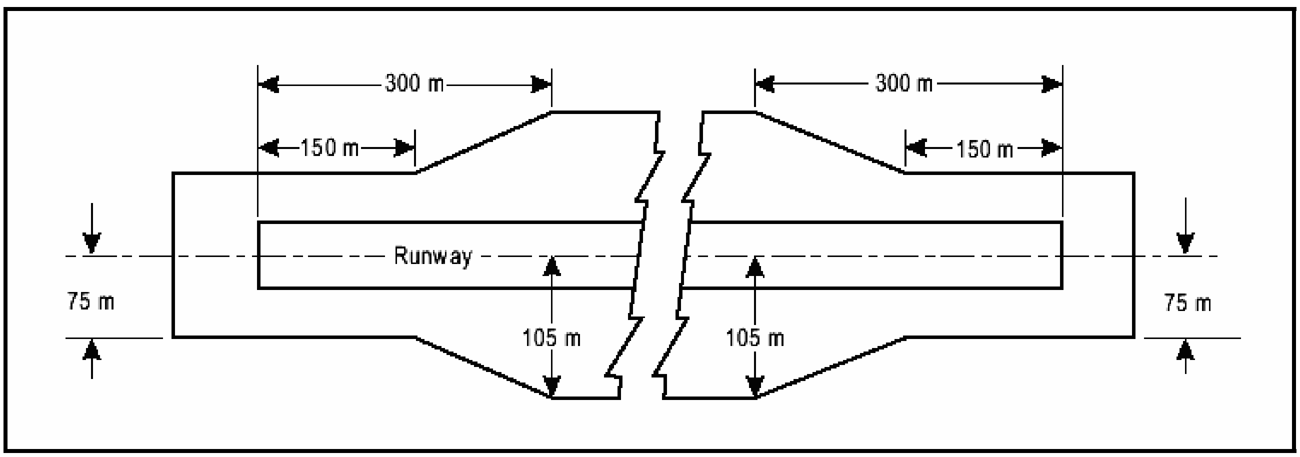

Figure 3 Graded portion of a strip including a precision approach runway where the code number is 3 or 4

RUNWAY END SAFETY AREAS

22. (1) A runway end safety area (RESA) is an area symmetrical about the extended runway centerline and adjacent to the end of the strip which is primarily intended to minimize the risk of damage to an aeroplane undershooting of overrunning the runway. Where a runway end safety area is provided in accordance with the Manual of Aerodrome Standards, 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 and on a non-precision approach or non-instrument runway, the first upstanding obstacle may be a road, a railroad or other constructed or natural feature. In such circumstances, the runway end safety area should extend as far as the obstacle.

(2) Where provision of a runway end safety area may involve encroachment in areas where it would be particularly prohibitive to implement, and the appropriate authority considers a runway end safety area essential, consideration may have to be given to reducing some of the declared distances.

LOCATION OF THRESHOLD

General

23. (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.)

(2) In determining that no obstacle 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 150m.

Displaced Threshold

24. (1) 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 or 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 and the safety area as appropriate. If an object extends above the approach surface and the object cannot be removed, consideration should be given to displacing the threshold permanently.

(2) To meet the obstacle limitation objectives of the Manual of Aerodrome Standards, 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.

(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.

(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.

(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 the Manual of Aerodrome Standards, Chapter 6 should continue to be met in relation to the displaced threshold.

APPROACH LIGHTING SYSTEMS

Types and Characteristics

25. (1) The specifications in the Manual of Aerodrome Standards, Volume 1 provide for the basic characteristics for simple and precision approach lighting system. It is intended that existing lighting systems not conforming to the specifications in Sections 5.3.4.21, 5.3.4.39, 5.3.9.10, 5.3.10.10, 5.3.10.11, 5.3.11.5, 5.3.12.8, 5.3.13.6 and 5.3.16.8 of the Manual of Aerodrome Standards, should have been replaced by 1 January 2005. For certain aspects of approach lighting 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-5 and A-6. A diagram of the inner 300 m of the precision approach category II and III lighting system is shown in Figure 5-13.

(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 the Manual of Aerodrome Standards, Chapter 5, 5.3.1.9, and the photometric requirements specified in Appendix 2, Figure A2-1 or A2-2.

(3) Flight path envelopes to be used in designing the lighting are shown in Figure 4.

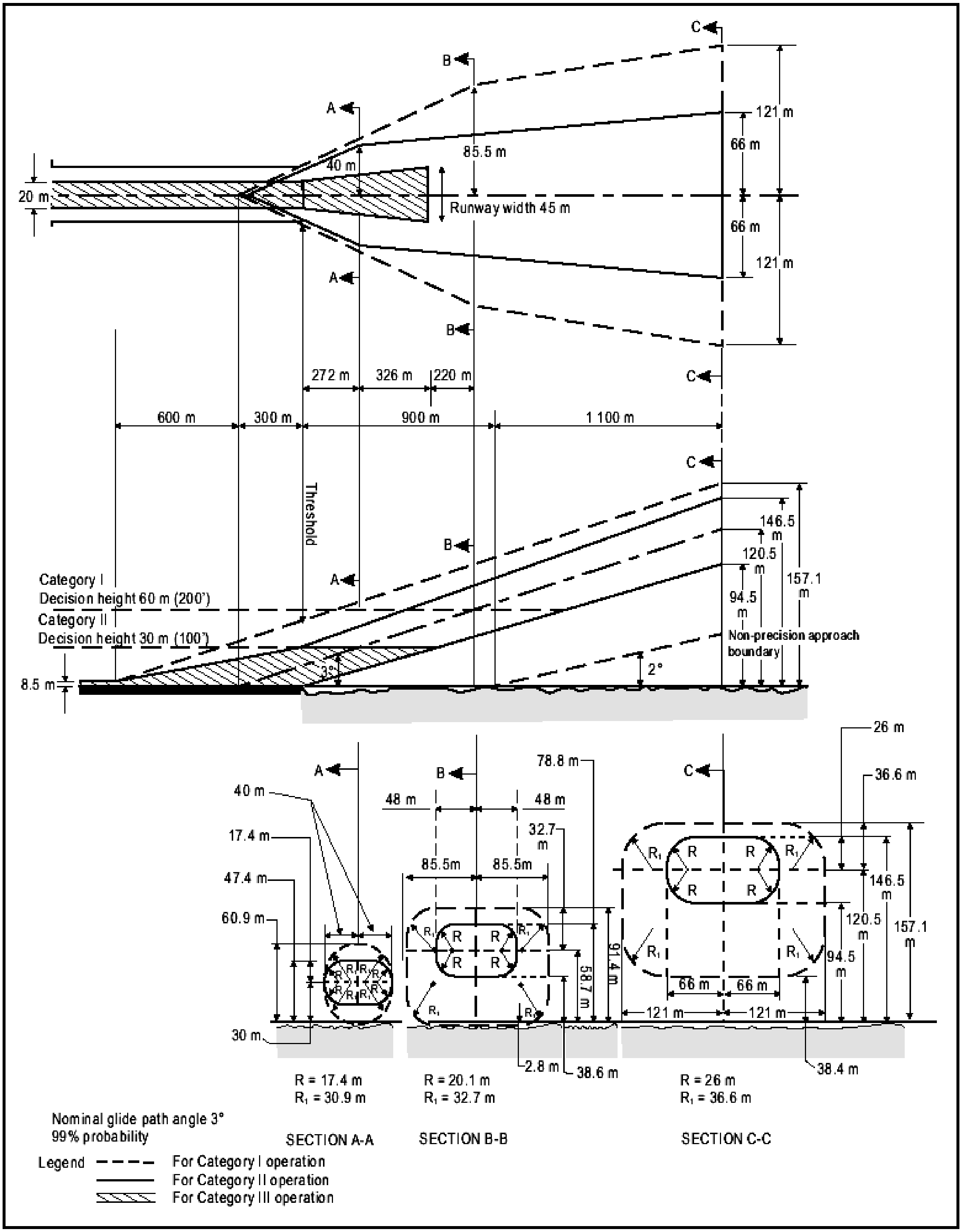

Figure 4 Flight path envelopes to be used for lighting design for category I, II and III operations

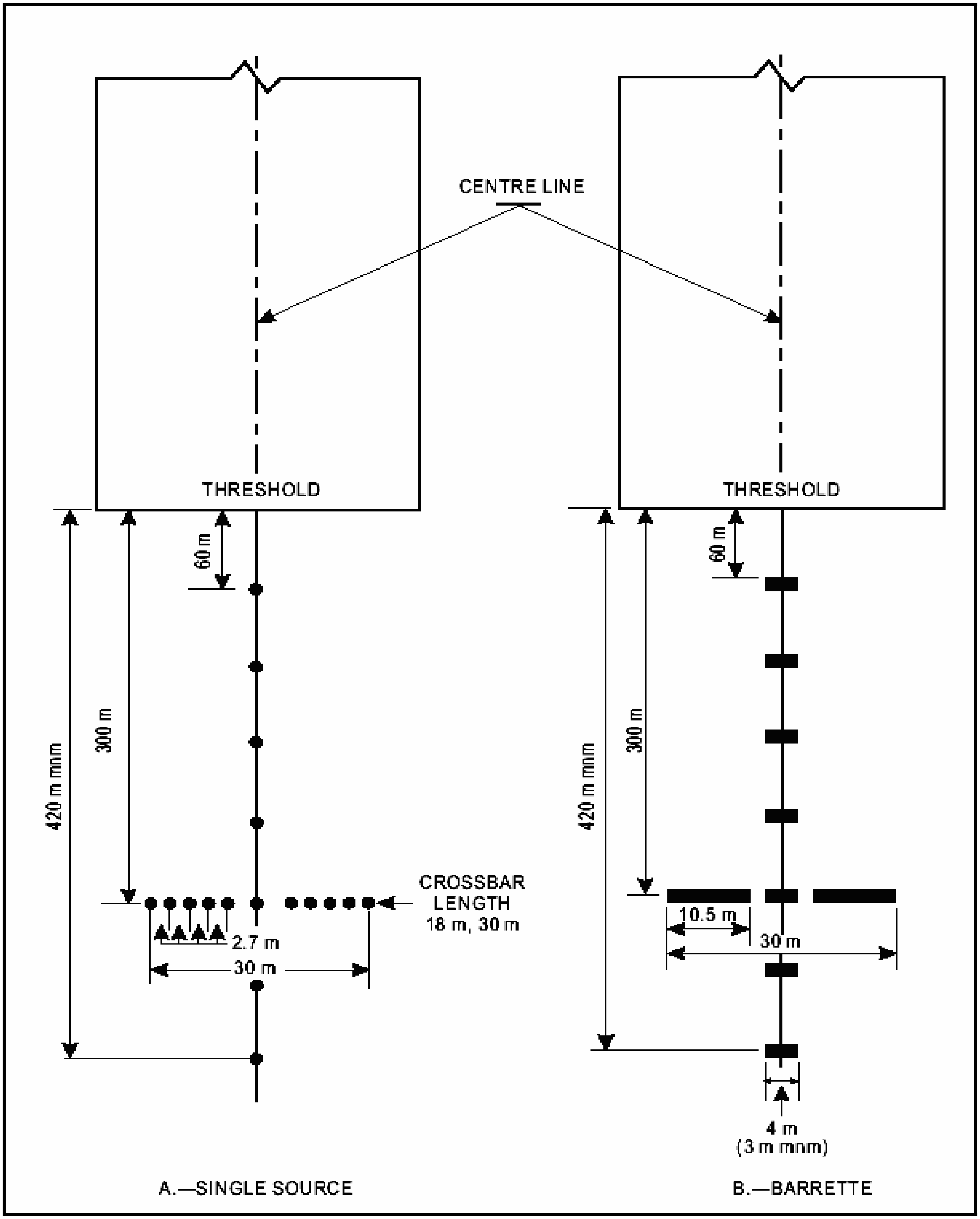

Figure 5 Simple approach lighting systems

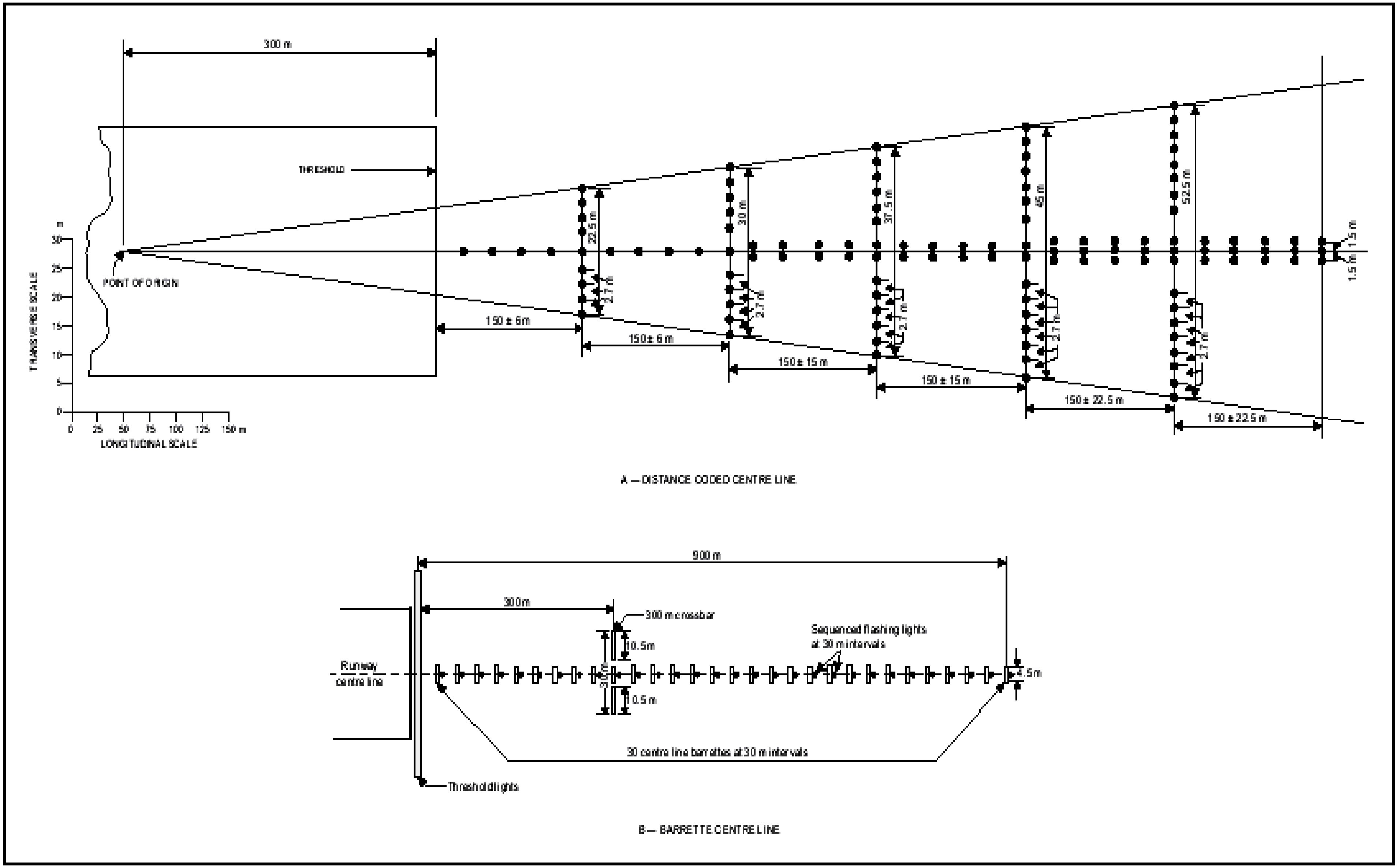

Figure 6 Precision approach category I lighting systems

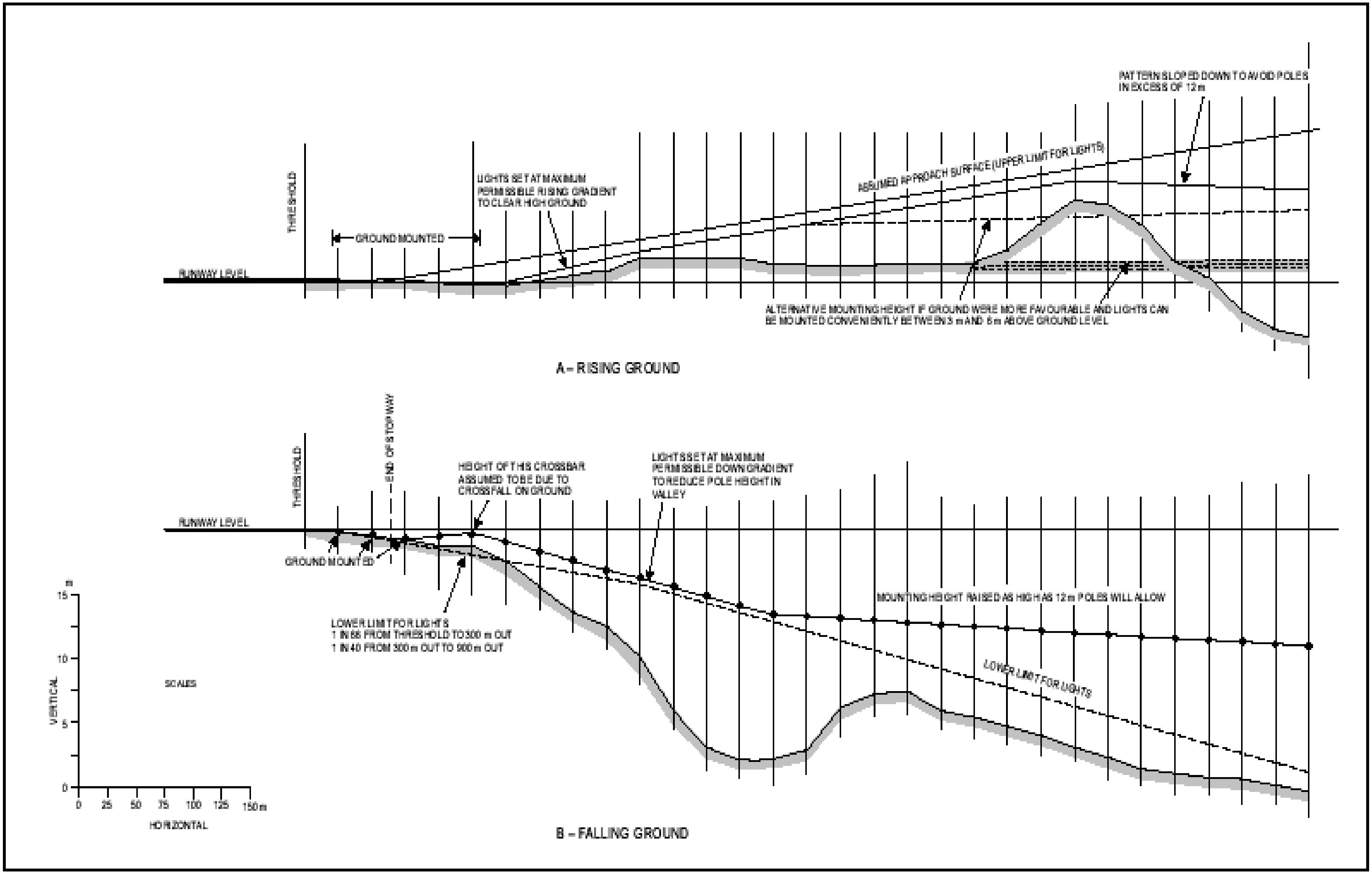

Figure 7 Vertical installation tolerances

Horizontal Installation Tolerances

26. (1) The dimensional tolerances are shown in Figure 6.

(2) The centre line of an approach lighting system should be as coincident as possible with the extended centre line of the runway with a maximum tolerance of ± 15'.

(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.

(4) The crossbars and barrettes should be at right angles to the centre line of the approach lighting system with a tolerance of ± 30', if the pattern in Figure 6 (A) is adopted or ± 2°, if Figure 6 (B) is adopted.

(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.

(6) When a crossbar in the system shown in Figure 6 (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 Installation Tolerances

27. (1) The ideal arrangement is to mount all the approach lights in the horizontal plane passing through the threshold (see Figure 7), and this should be the general aim as far as local conditions permit. However, buildings, trees, etc., should not obscure the lights from the view of a pilot who is assumed to be 1° below the electronic glide path in the vicinity of the outer marker.

(2) 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.

(3) 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.

(4) 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.

(5) ***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.

(6) ***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.

Clearance of Obstacles

28. (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.

(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.

(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.

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

(5) Where applicable, 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.

(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.

(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.

Consideration of the Effects of Reduced Lengths

29. (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.

(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.

(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 in deciding if any restrictions are necessary to any precision approach and these are detailed in ICAO Annex 6 and TTCAR No.2.

PRIORITY OF INSTALLATION OF VISUAL APPROACH SLOPE INDICATOR SYSTEMS

30. (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.

(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 the Manual of Aerodrome Standards, Chapter 5 may be used as a general guide. These may be summarized as:

(a) Inadequate visual guidance because of:

(i) Approaches over water or featureless terrain, or absence of sufficient extraneous light in the approach area by night;

(ii) Deceptive surrounding terrain;

(b) Serious hazard in approach;

(c) Serious hazard if aeroplanes undershoot or overrun; and

(d) Unusual turbulence.

(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.

(4) Priority should be given to runways used by turbojet aeroplanes.

LIGHTING OF UNSERVICEABLE AREAS

31. 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 omni-directional 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.

RAPID EXIT TAXIWAY INDICATOR LIGHTS

32. (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.

(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.

(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.

INTENSITY CONTROL OF APPROACH AND RUNWAY LIGHTS

33. (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.

(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.

(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, Part 4.

SIGNAL AREA

34. 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.

RESCUE AND FIRE FIGHTING SERVICES

Administration

35. (1) The rescue and fire fighting 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 fulfill its proper functions.

(2) In drawing up the detailed plan for the conduct of search and rescue operations in accordance with 4.2.1 of Annex 12, 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.

(3) Coordination between the rescue and fire fighting 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.

(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 fire fighting 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.

(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.

Training

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

(a) Airport familiarization;

(b) Aircraft familiarization;

(c) Rescue and fire fighting 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 the Manual of Aerodrome Standards, Chapter 9, 9.2;

(f) Application of the types of extinguishing agents required for compliance with the Manual of Aerodrome Standards, Chapter 9, 9.2;

(g) Emergency aircraft evacuation assistance;

(h) Fire fighting operations;

(i) Adaptation and use of structural rescue and fire fighting equipment for aircraft rescue and fire fighting;

(j) Dangerous goods;

(k) Familiarization with fire fighters' duties under the aerodrome emergency plan; and

(l) Protective clothing and respiratory protection.

Level Of Protection To Be Provided

37. (1) In accordance with the Manual of Aerodrome Standards, Chapter 9, 9.2 aerodromes should be categorized for rescue and fire fighting purposes and the level of protection provided should be appropriate to the aerodrome category.

(2) However, the Manual of Aerodrome Standards, 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.

Rescue Equipment for Difficult Environments

38. (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.

(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.

(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 fire fighting 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 fire fighting service (such as police, military services, harbour patrol or coast guard).

(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.

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

Facilities

39. (1) The provision of special telephone, two-way radio communication and general alarm systems for the rescue and fire fighting 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 fire fighting vehicles and personnel in the event of an aircraft accident or incident;

(b) Emergency signals to ensure the immediate summoning of designated personnel not on standby duty;

(c) As necessary, summoning essential related services on or off the aerodrome; and

(d) Maintaining communication by means of two-way radio with the rescue and fire fighting vehicles in attendance at an aircraft accident or incident.

(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.

OPERATORS OF VEHICLES

40. (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 fire fighting.

(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.

(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.

(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.

THE ACN-PCN METHOD OF REPORTING PAVEMENT STRENGTH

Overload operations

41. (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 over-loading 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.

(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.

(3) 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 the Manual of Aerodrome Standards, Chapter 2, 2.6.6 b) and the results tabulated in the *Aerodrome Design Manual*, Part 3.

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Director General of Civil Aviation

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APPENDIX

LIMITED INDEX OF SIGNIFICANT SUBJECTS INCLUDED IN THE MANUAL OF AERODROME STANDARDS, VOLUME 1

Those specifications which relate to the daily operation of an aerodrome as compared with those which relate to its design or facilities to be provided.

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***Those specifications which relate to the daily operation of an aerodrome as compared with those which relate to its design or facilities to be provided.*

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*****_Those specifications which relate to the daily operation of an aerodrome as compared with those which relate to its design or facilities to be provided._

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