ADVISORY CIRCULAR

SLCAA-AC-AGA043-Rev. 00

SIERRA LEONE CIVIL AVIATION AUTHORITY

EFFECTIVE DATE: 21st December 2022

Guidance Material Supplementary to the SLCAR Part 14A

Moses Tiffa Baio
Director General
Sierra Leone Civil Aviation Authority

TABLE OF CONTENT

1 GENERAL

Sierra Leone Civil Aviation Authority Advisory Circulars contains information about standards, practices and procedures that the Authority has found to be an Acceptable Means of Compliance (AMC) with the associated Regulations.

An AMC is not intended to be the only means of compliance with a Regulation, and consideration will be given to other methods of compliance that may be presented to the Authority. When new standards, practices or procedures are found to be acceptable, they will be added to the appropriate Advisory Circular.

Information considered directive in nature is described in this AC in terms such as “shall” and “must”, indicating the actions are mandatory. Guidance information is described in terms such as “should” and “may” indicating the actions are desirable or permissive, but not mandatory.

1.1 Purpose

This Advisory Circular provides methods, acceptable to the Authority, for showing compliance with the SLCAR Part 14A, as well as explanatory and interpretative material to assist in showing compliance.

1.2 Applicability

This AC is designed to give guidance to Aerodrome operators on compliance with the requirements established in the SLCAR Part 14A – Aerodrome Design and Operations Stanadards.

1.3 Description of Changes

This AC is the first to be issued on this subject

1.4 References

(a) SLCAR Part 14A – Aerodrome Design and Operations
(b) SLCAR Part 10A – Aeronautical Telecommunication
(c) ICAO Doc 9157 – Parts 1, 2, 3 & 4
(d) ICAO Doc 9137 – Parts 2 & 8
(e) ICAO Doc 9184 – Part 2
(f) ICAO Doc 9829
(g) ICAO Doc 9981
(h) ICAO Doc 9870
(i) ICAO Doc 10066

1.5 Cancelled Documents

Not Applicable

2 NUMBER, SITING AND ORIENTATION OF RUNWAYS

2.1 Siting and Orientation of Runways

a) Many factors should be taken into account in the determination of the siting and orientation of runways. Without attempting to provide neither an exhaustive list of these factors nor an analysis of their effects, it appears useful to indicate those which most frequently require study. These factors may be classified under four headings:
   (i) **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.
   (ii) **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:
      (1) Wind statistics used for the calculation of the usability factor are normally available in ranges of speed and direction, and the accuracy of the results obtained depends, to a large extent on the assumed distribution of observations within these ranges. In the absence of any sure information as to the true distribution, it is usual to assume a uniform distribution since in relation to the most favourable runway orientations; this generally results in a slightly conservative usability factor.
      (2) The maximum mean crosswind component given in Chapter 3, 3.1.3 of the SLCAR Part 14A, refers 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 crosswind components, among diverse types of aeroplanes (including future types) within each of the three groups given in 3.1.3 of the SLCAR Part 14A;
         (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 on the runway materially reduces the allowable crosswind component; and
         (g) the strength of the wind associated with the limiting cross wind component.
         (h) 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.
   (iii) **Topography of the aerodrome site, its approaches, and surroundings, particularly:**
      (1) compliance with the obstacle limitation surfaces;
      (2) current and future land use. The orientation and layout should be selected so as to protect as far as possible the particularly sensitive areas such as residential, school and hospital zones from the discomfort caused by aircraft noise. Detailed information on this topic is provided in the ICAO Airport Planning Manual (ICAO

Doc 9184), Part 2, and in the ICAO Guidance on the Balanced Approach to Aircraft Noise Management (ICAO Doc 9829);

(3) current and future runway lengths to be provided;

(4) construction costs; and

(5) possibility of installing suitable non-visual and visual aids for approach-to-land.

(iv) Air traffic in the vicinity of the aerodrome, particularly:

(1) proximity of other aerodromes or ATS routes;

(2) traffic density; and

(3) air traffic control and missed approach procedures.

2.2 Number of Runways in Each Direction

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

3 CLEARWAYS AND STOPWAYS

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

(b) 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.

(c) 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.

(d) 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.

(e) A variety of combinations of accelerate-stop distances 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.

(f) 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.

(g) 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.

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

   (i) 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;

   (ii) 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.

(i) 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.

(j) The economy of a stopway can be entirely lost if, after each usage, it must be re-graded 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.

4 SLOPES ON A RUNWAY

4.1 Distance between Slope Changes

The following example illustrates how the distance between slope changes is to be determined (see Figure 4-1):

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

15 000 (|x – y| + |y – z|) m

|x – y| being the absolute numerical value of x –y
|y – z| being the absolute numerical value of y –z

Assuming x = +0.01
y =–0.005
z =+0.005
then |x – y| = 0.015
|y – z| = 0.01

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

15 000 (0.015 + 0.01) m,
that is, 15 000 × 0.025 = 375 m

4.2 Consideration of Longitudinal and Transverse Slopes

When a runway is planned that will combine the extreme values for the slopes and changes in slope permitted under Chapter 3, 3.1.13 to 3.1.19 of the SLCAR Part 14A, a study shall be made to ensure that the resulting surface profile will not hamper the operation of aeroplanes.

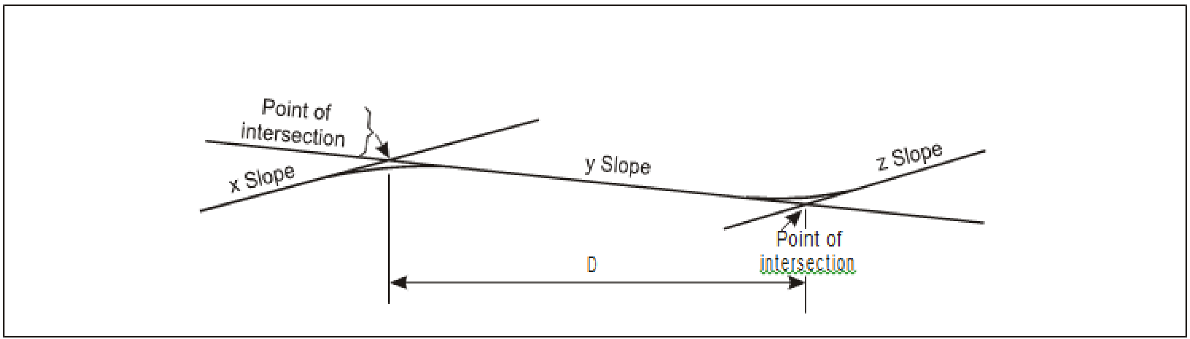


Figure 4-1: Profile on centre line of runway

4.3 Radio Altimeter Operating Area

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

5 RUNWAY SURFACE EVENNESS

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

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

(b) 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.

(c) The operations 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 2.5cm to 3cm over a 45m distance are acceptable, as shown in Figure 5-1. Although maximum acceptable deviations vary with the type and speed of an aircraft, the limits of acceptable surface irregularities can be estimated to a reasonable extent. The following table describes acceptable, tolerable and excessive limits:

(i) if the surface irregularities exceed the heights defined by the acceptable limit curve but are less than the heights defined by the tolerable limit curve, at the specified minimum acceptable length, herein noted by the tolerable region, then maintenance action should be planned. The runway may remain in service. This region is the start of possible passenger and pilot discomfort;

(ii) 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

(iii) 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.

Table 5-1: Pavement Surface Irregularity Limit

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: -

Surface irregularity - defined herein to mean isolated surface elevation deviations that do not lie along a uniform slope through any given section of a runway.

Section of a runway - 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.

(iv) 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.

(d) Figure 5-1 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 ICAO Aerodrome Design Manual, Part 3 - Pavements (ICAO Doc 9157).

(e) Deformation of the runway with time may also increase the possibility of the formation of water pools. Pools as shallow as approximately 3mm 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.

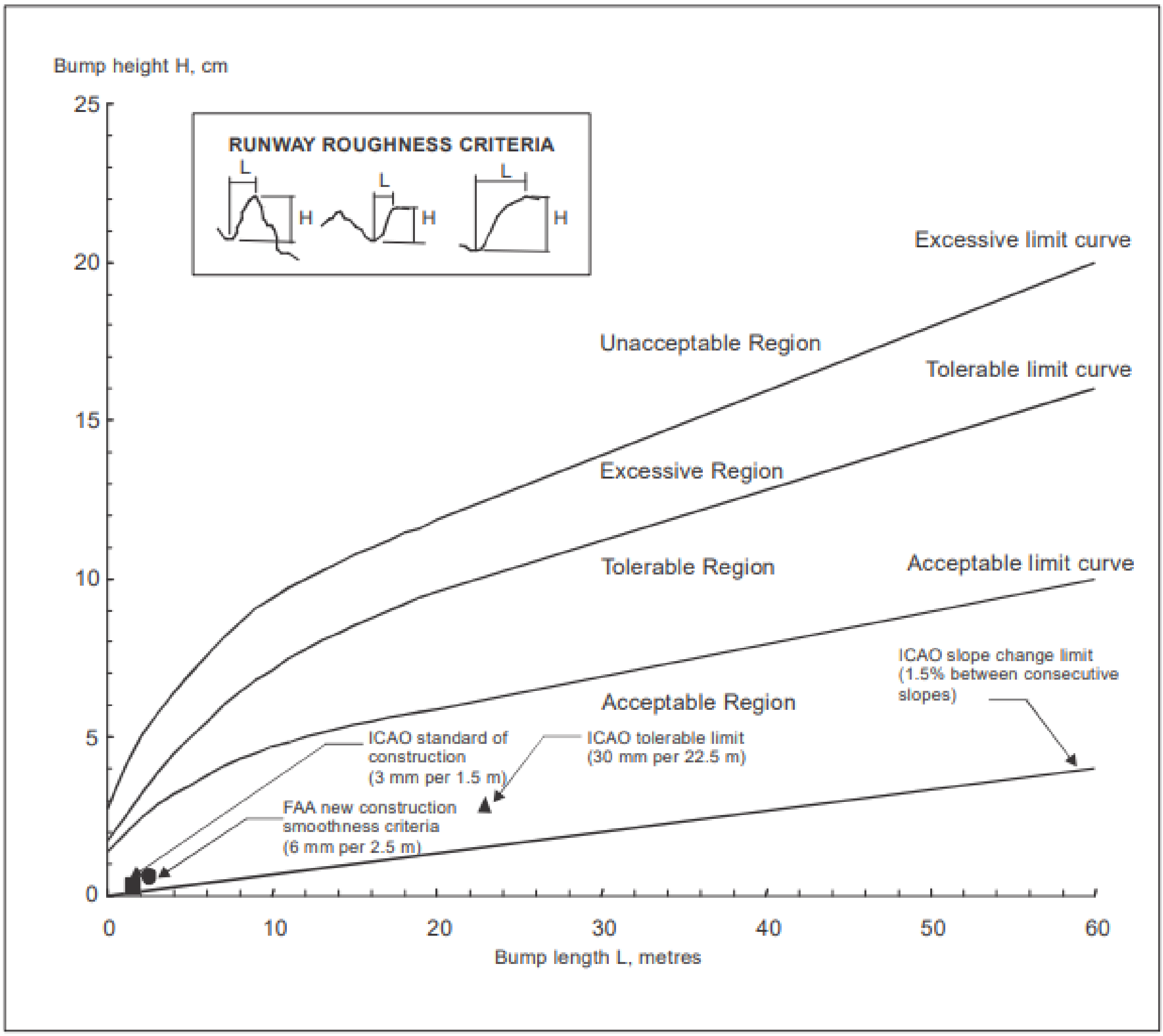


Figure 5-1: Comparison of roughness criteria

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 CONDITIONS.

(a) 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 shall be structured in such a way that can be adjusted to the climatic conditions applicable to Sierra Leone.

(b) The concept of the RCR is premised on:

(i) an agreed set of criteria used in a consistent manner for runway surface condition assessment, aeroplane (performance) certification and operational performance calculation;

(ii) 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;

(iii) reporting of contaminant type and depth that is relevant to take-off performance;

(iv) a standardized common terminology and phraseology for the description of runway surface conditions that can be used by the aerodrome operator's inspection personnel, air traffic controllers, aircraft operators and flight crew; and

(v) 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.

(c) 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.

(d) Procedures which relate to the use of the RCAM are provided in the ICAO PANS-Aerodromes (ICAO Doc9981).

(e) It is recognized that information provided by the aerodrome operators 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).

(f) 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.

(g) 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. Aerodrome personnel should be trained in the relevant fields of competence and their competence verified in a manner required by the Authority, to ensure confidence in their assessments.

(h) The training syllabus may include initial and periodic recurrent training in the following areas:

(i) aerodrome familiarization, including aerodrome markings, signs and lighting;
(ii) aerodrome procedures as described in the aerodrome manual;
(iii) aerodrome emergency plan;
(iv) Notice to Airmen (NOTAM) initiation procedures;
(v) completion of/initiation procedures for RCR;
(vi) aerodrome driving rules;
(vii) air traffic control procedures on the movement area;
(viii) radiotelephone operating procedures;
(ix) phraseology used in aerodrome control, including the ICAO spelling alphabet;
(x) aerodrome inspection procedures and techniques;
(xi) type of runway contaminants and reporting;
(xii) assessment and reporting of runway surface friction characteristics;
(xiii) use of runway friction measurement device;
(xiv) calibration and maintenance of runway friction measurement device;
(xv) awareness of uncertainties related to l) and m);and
(xvi) low visibility procedures.

7 DRAINAGE CHARACTERISTICS OF THE MOVEMENT AREA AND ADJACENT AREAS

7.1 General

(a) 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:
   (i) 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
   (ii) dynamic drainage of the surface water trapped under a moving tire until it reaches outside the tire-to-ground contact area.

(b) Both processes can be controlled through:
   (i) design;
   (ii) construction; and
   (iii) maintenance of the pavements in order to prevent accumulation of water on the pavement surface.

7.2 Design of Pavement

(a) 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.

(b) 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

(a) Through construction, the drainage characteristics of the surface are built into the pavement. These surface characteristics are:
   (i) slopes;
   (ii) texture:
      (1) microtexture;
      (2) macrotexture;

(b) Slopes for the various parts of the movement area and adjacent parts are described in Chapter 3 of the SLCAR Part 14A, and figures are given as per cent. Further guidance is given in the ICAO Aerodrome Design Manual (ICAO Doc 9157), Part 1, Chapter5.

(c) Texture in the literature is described as microtexture or macrotexture.

(d) **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.

(e) Microtexture is a built-in quality of the pavement surface. By specifying crushed material that will withstand polishing microtexture, drainage of thin water films 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.

(f) 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.

(g) **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.

(h) 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.

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

Runway classification based on texture information from ESDU 71026:

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

(j) Using this classification, the threshold value between microtexture and macrotexture is 0.1mm 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 (0.25mm). 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 Authority. Presently credit is given to grooved or porous friction course runways following design, construction and maintenance criteria acceptable to the Authority. The harmonized certification standards of some States refer to texture giving drainage and friction qualities midway between classification D and E (1.0mm).

(k) For construction, design and maintenance, the ISO 13473-1 (should be used): 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 0.5mm. The volumetric method has a validity range from 0.25 to 5mm MTD. The profilometry method has a validity range from 0 to 5mm 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.

(l) The Engineering Science Data Unit (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 OFPAVEMENT.

(a) Macrotexture does not change within a short time span 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 ICAO Airport Services Manual (ICAO Doc 9137), Part 2. Guidance on methods for improving surface texture can be found in the ICAO Aerodrome Design Manual (ICAO Doc 9157), Part3.

(b) When grooving is 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 ICAO Airport Services Manual (ICAO Doc 9137), Part 2 - Pavement Surface Conditions and Part 9 - Airport Maintenance Practices and the ICAO Aerodrome Design Manual (ICAO Doc 9157), Part2.

(c) The pavement may be shot blasted in order to enhance the pavement macrotexture.

8 STRIPS

8.1 Shoulders

(a) The shoulder of a runway or stopway shall 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.

(b) 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).

(c) 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 ICAO Aerodrome Design Manual (ICAO 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.

(d) 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 30cm 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 30cm.

8.3 Grading of a Strip for Precision Approach Runways

Chapter 3, 3.4.8 of the SLCAR Part 14A, recommends that the portion of a strip of an instrument runway within at least 75 m from the centre line shall 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 8-1 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 105m from the centre line, except that the distance is gradually reduced to 75m from the centre line at both ends of the strip, for a length of 150m from the runway end.

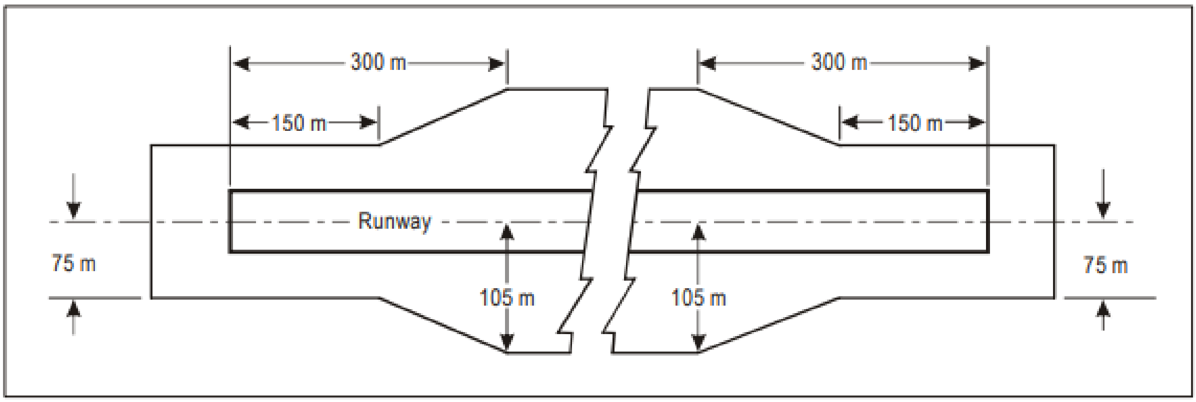


Figure 8-1: Graded portion of a strip including a precision approach runway where the code number is 3 or 4.

9 RUNWAY END SAFETYAREAS

(a) Where a runway end safety area is provided in accordance with Chapter 3 of the SLCAR Part 14A, 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 or other constructed or natural feature. The provision of a runway end safety area shall take such obstacles into consideration.

(b) 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.

(c) 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.

(d) 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.

(e) 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.

(f) 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.

(g) Additional information is contained in the ICAO Aerodrome Design Manual(ICAO Doc 9157), Part1

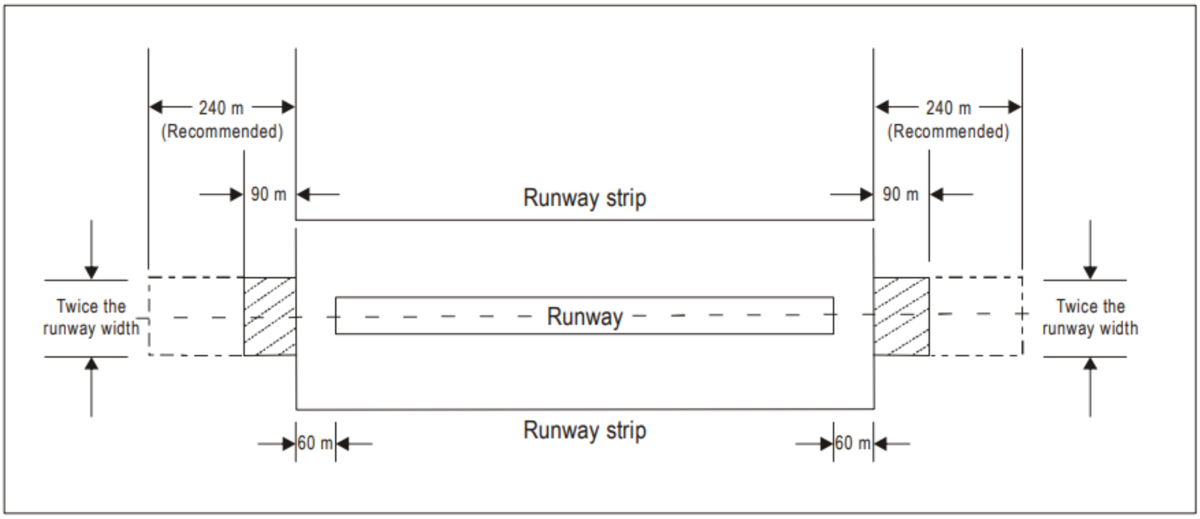


Figure 9-1: Runway end safety area for a runway where the code number is 3 or 4

10 LOCATION OF THRESHOLD

10.1 General

(a) 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 SLCAR Part 10A).

(b) 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 1,200m longitudinally from the threshold and of an overall width of not less than 150m.

10.2 Displaced Threshold

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

(b) To meet the obstacle limitation objectives of Chapter 4 of the SLCAR Part 14A, the threshold should ideally be displaced down the runway for the distance necessary to provide that the approach surface is cleared of obstacles.

(c) 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.

(d) 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.

(e) 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 of the SLCAR Part 14A should continue to be met in relation to the displaced threshold.

(f) 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 aerodrome operator.

(g) Provisions in SLCAR Part 14A, 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

(a) The specifications in the SLCAR Part 14A 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 12-2 and 12-3. A diagram of the inner 300m of the precision approach category II and III lighting system is shown in Figure 5-14 of the SLCAR Part 14A.

(b) 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 of the SLCAR Part 14A, and the photo metric requirements specified in IS 10.5.1, Figure A2-1 or A2-2.

(c) Flight path envelopes to be used in designing the lighting are shown in Figure 12-1.

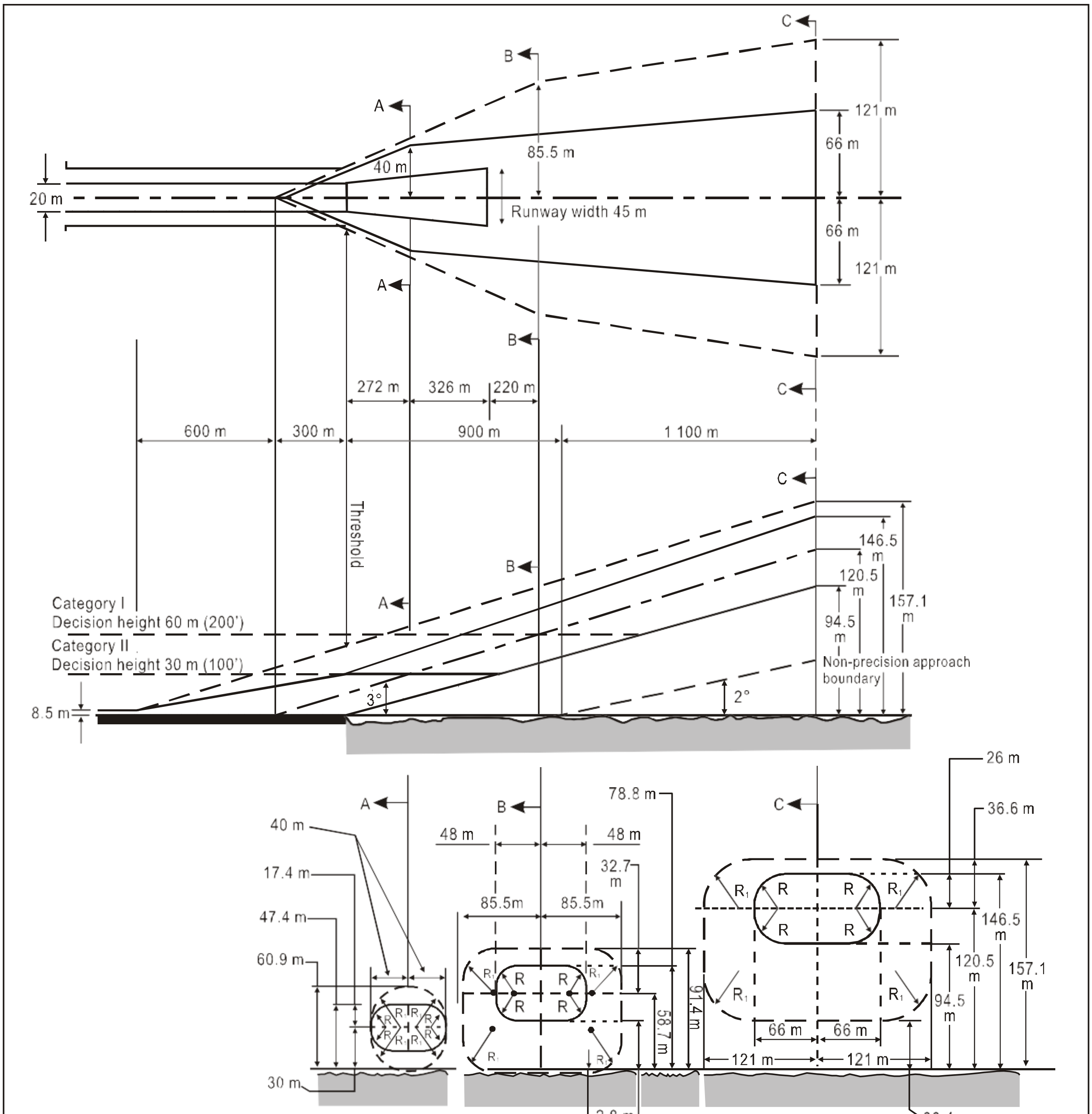


Figure 111-1: Flight path envelopes to be used for lighting design for category I, II and III operations.

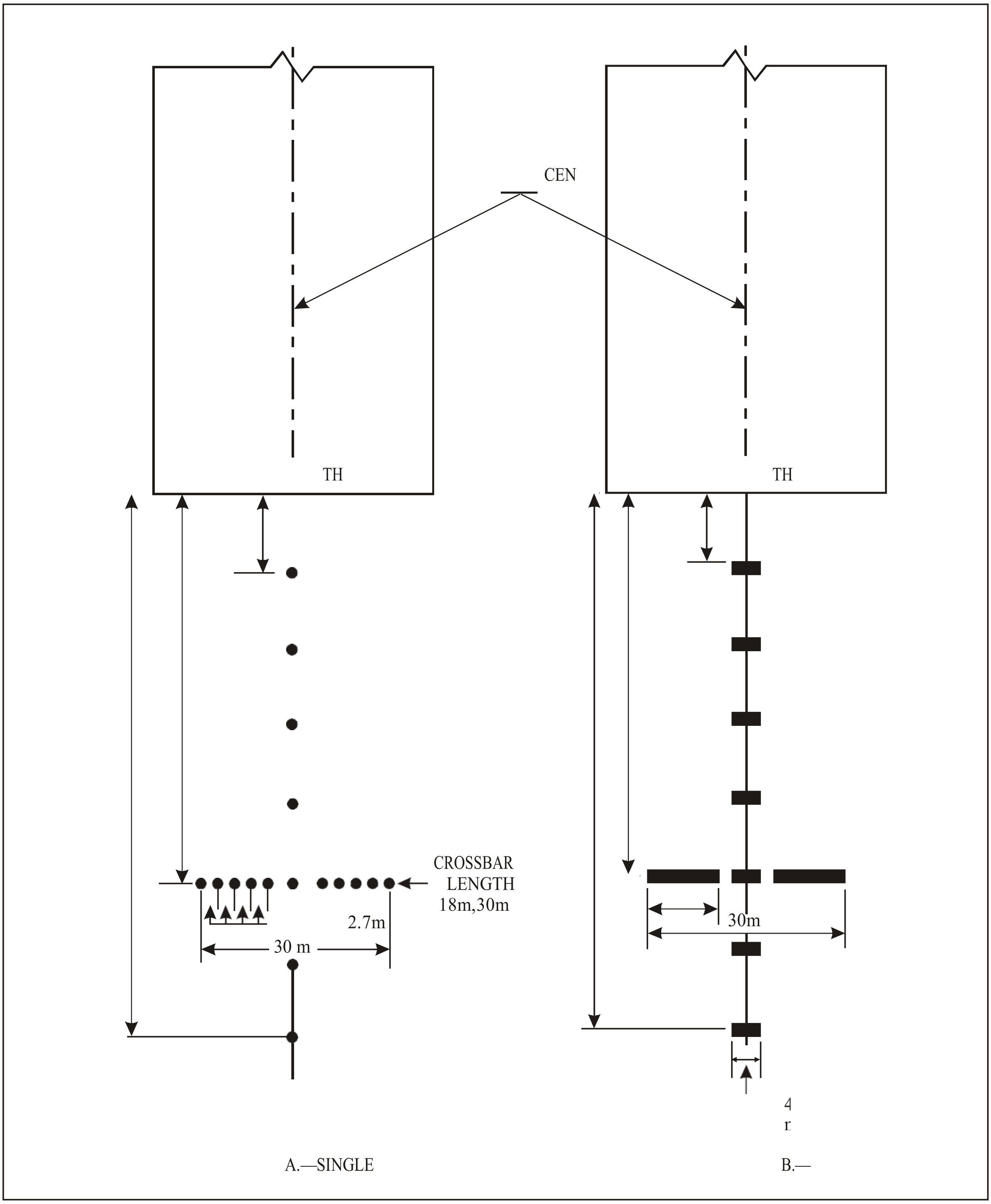

CEN
TH
TH
CROSSBAR
LENGTH
18m,30m
2.7m
30 m
30m
4
r
A.—SINGLE
B.—

Figure 11-2: Simple approach lighting systems

11.2 Installation Tolerances

(a) The dimensional tolerances are shown in Figure 12-3.

(b) 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′.

(c) 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.

(d) 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 12-3(A) is adopted or ±2°, if Figure 12-3B) is adopted.

(e) 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 cross bar spacing.

(f) When a crossbar in the system shown in Figure 12-3(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 2.7m spacing between the crossbar lights, but the crossbars should be kept symmetrical about the centre line of the approach lighting.

VERTICAL

(g) The ideal arrangement is to mount all the approach lights in the horizontal plane passing through the threshold (see Figure 12-4), 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.

(h) Within a stopway or clearway, and within 150m 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.

(i) It is desirable that the lights be mounted so that, as far as possible, no object within a distance of 60m on each side of the centre line protrudes through the plane of the approach lighting system. Where a tall object exists within 60m of the centre line and within 1,350 m from the threshold for a precision approach lighting system, or 900m 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.

(j) 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 300m out, and below a gradient of 1 in 40 beyond the 300m point. For a precision approach category II and III lighting system, more stringent criteria may be necessary, e.g. negative slopes not permitted within 450m of the threshold.

(k) **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 1in60. 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.

(l) **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 across-fall.

11.3 Clearance of Obstacles

(a) 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 centreline. It starts at the threshold and extends 60m beyond the approach end of the system and is 120m wide.

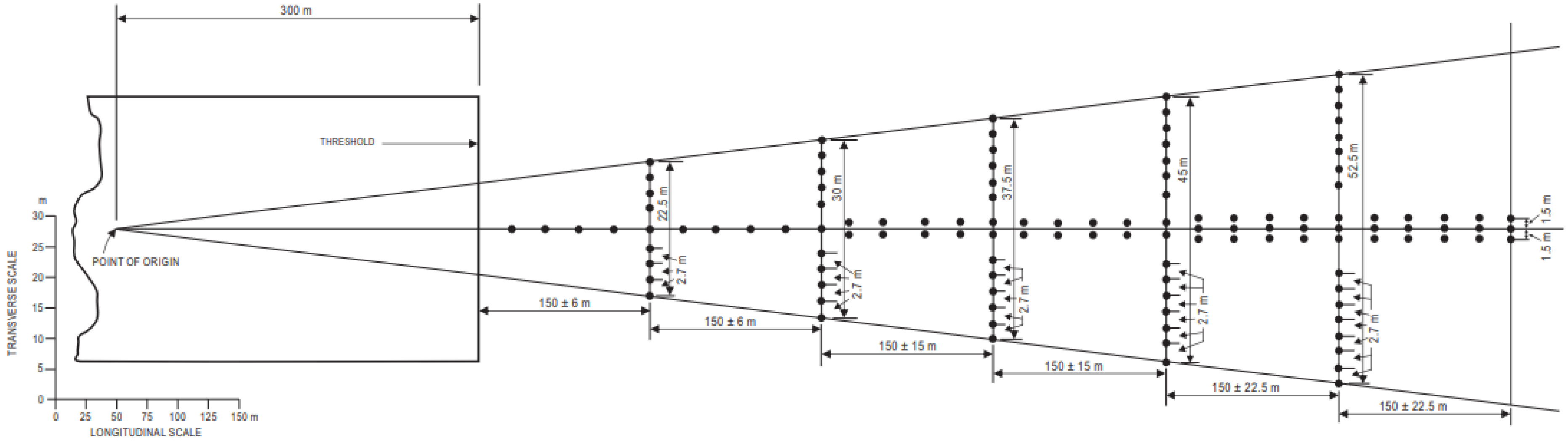
(b) No objects are permitted to exist within the boundaries of the light plane which are higher than the light plane except as designated herein. All roads and highways are considered as obstacles extending 4.8m above the crown of the road, except aerodrome service roads where all vehicular traffic is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

(c) 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.

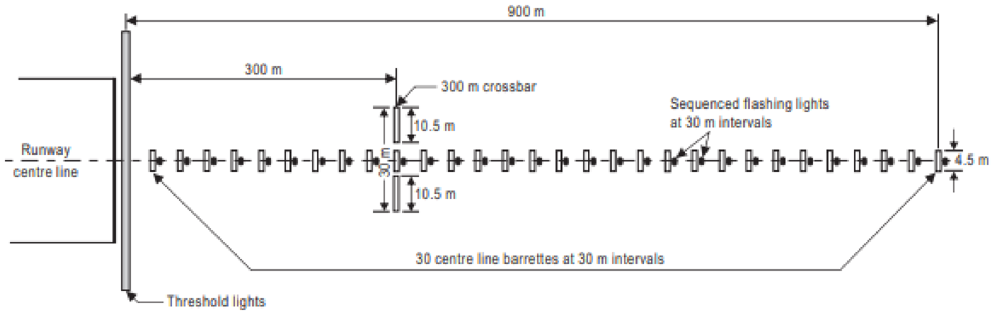
(d) Where an ILS localizer is installed within the light plane boundaries, it is recognized that the localizer, or screen if used, must extend above the light plane. In such cases the height of these structures should be held to a minimum and they should be located as far from the threshold as possible.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

(e) In locating an MLS azimuth antenna the guidance contained in SLCAR Part 10A should be followed - further guidance can be found in ICAO Annex 10, Volume I, attachment G. 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 0.3m 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 0.15m 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 300m and the preferred location is 25m beyond the 300m crossbar (this would place the antenna 5m behind the light position 330m from the runway end). Where an MLS azimuth antenna is so located, a central part of the 300m 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.

(f) 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.



A — DISTANCE CODED CENTRE LINE



B — BARRETTE CENTRE LINE

Figure 11-3: Precision approach CAT 1 Lighting System

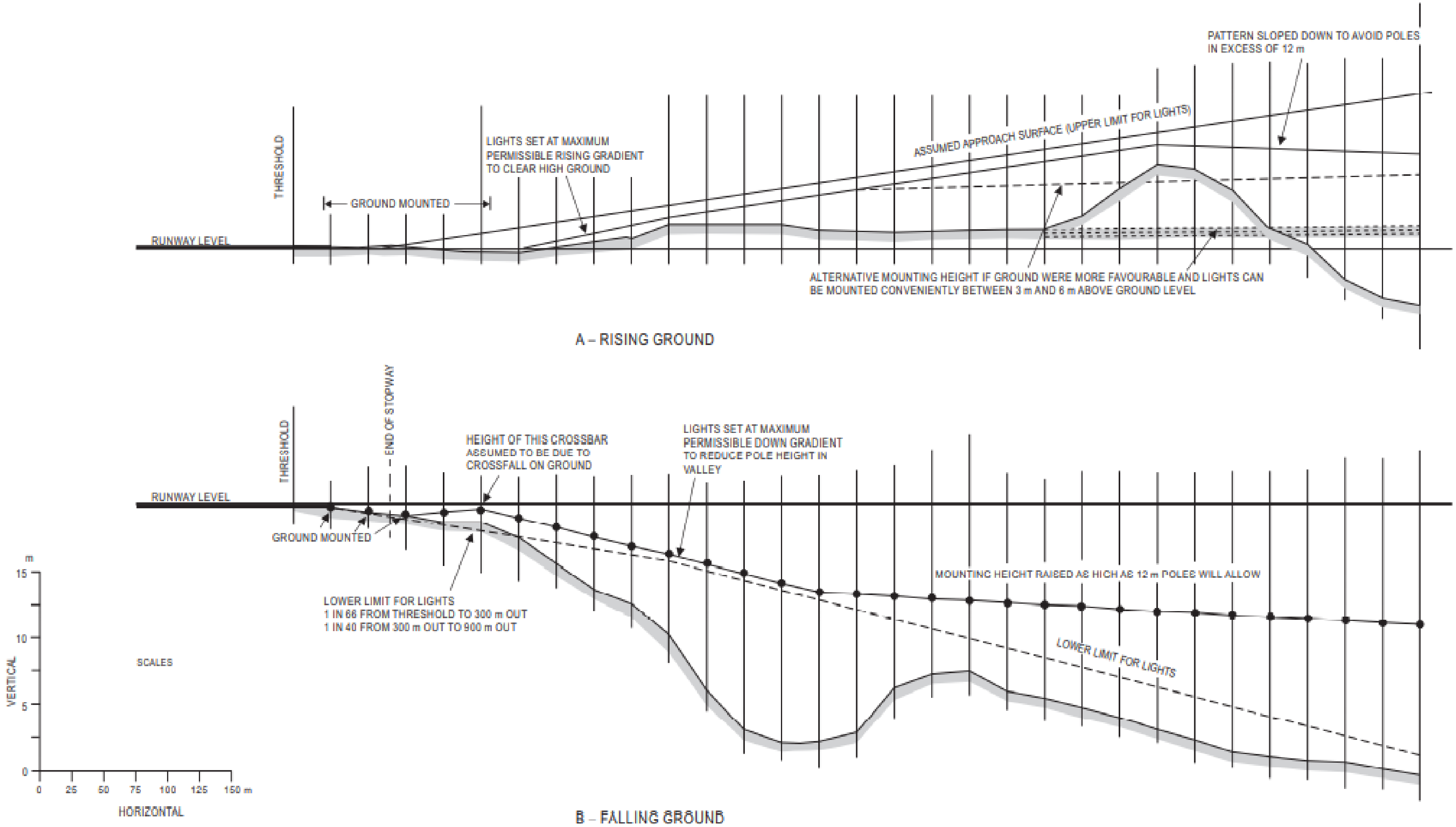


Figure 11-4: Vertical Installation tolerance

(g) 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

(a) 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 900m, and this shall always be provided whenever possible.

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

(c) In such cases, every effort should be made to provide as much approach lighting system as possible. The 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 Authority in deciding if any restrictions are necessary to any precision approach and these are detailed in the SLCAR Part 6.

12 PRIORITY OF INSTALLATION OF VISUAL APPROACH SLOPE INDICATOR SYSTEMS

(a) 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:

(i) frequency of use;

(ii) seriousness of the hazard;

(iii) presence of other visual and non-visual aids;

(iv) type of aeroplanes using the runway; and

(v) frequency and type of adverse weather conditions under which the runway will be used.

(b) With respect to the seriousness of the hazard, the order given in the application specifications for a visual approach slope indicator system, 5.3.5.1b) to e) of Chapter 5 of the SLCAR Part 14A, may be used as a general guide. These may be summarized as:

(i) 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;

(ii) serious hazard in approach;

(iii) serious hazard if aeroplanes undershoot or overrun; and

(iv) unusual turbulence.

(c) 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.

(d) Priority should be given to runways used by turbo jet 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 7.5m 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

(a) 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 100m 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.

(b) In low visibility conditions, RETILs provide useful situational awareness cues while allowing the pilot to concentrate on keeping the aircraft on the runway centreline.

(c) 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 60knots until the first RETIL (three-light barrette) is reached is seen as the optimum.

15 INTENSITY CONTROL OF APPROACH AND RUNWAY LIGHTS

(a) 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 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, 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.

(b) 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 2000 or 3000 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.

(c) 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 ICAO Aerodrome Design Manual (ICAO Doc 9157), Part4.

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 OPERATORS OF VEHICLES

(a) 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:

(i) the geography of the aerodrome;
(ii) aerodrome signs, markings and lights;
(iii) radiotelephone operating procedures;
(iv) terms and phrases used in aerodrome control including the ICAO spelling alphabet;

(v) rules of air traffic services as they relate to ground operations;
(vi) airport rules and procedures; and
(vii) Specialist functions as required, for example, in rescue and firefighting.

(b) The operator should be able to demonstrate competency, as appropriate, in:
(i) the operation or use of vehicle transmit/receive equipment;
(ii) understanding and complying with air traffic control and local procedures;
(iii) vehicle navigation on the aerodrome; and
(iv) special skills required for the particular function.

(c) In addition, as required for any specialist function, the operator should be the holder of a National driving licence, valid airside driver's licence issued by the aerodrome operator, a radio operator's licence issued by the appropriate ANSP at that aerodrome, or other licences as deemed necessary by the aerodrome operator.

(d) 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.

(e) 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.

18 THE ACN -PCN METHOD OF REPORTING PAVEMENT STRENGTH (*applicable until 27th November, 2024*)

18.1 Overload Operations

(a) 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:
(i) for flexible pavements, occasional movements by aircraft with ACN not exceeding 10 per cent above the reported PCN should not adversely affect the pavement;
(ii) 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;
(iii) if the pavement structure is unknown, the 5 per cent limitation should apply; and
(iv) the annual number of overload movements should not exceed approximately 5 per cent of the total annual aircraft movements.

(b) 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 aerodrome operator should review the relevant pavement condition regularly, and should also review the criteria for overload operations periodically since excessive repetition of overloads can cause severe shortening of pavement life or require major rehabilitation of pavement.

18.2 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) of the SLCAR Part 14A, and the results tabulated in the ICAO Aerodrome Design Manual (ICAO Doc 9157), Part 3.

19 THE ACR -PCR METHOD OF REPORTING PAVEMENT STRENGTH *(applicable as of 27th November, 2024)*

(a) 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:

  (i) For flexible and rigid pavements, occasional movements by aircraft with ACR not exceeding 10 per cent above the reported PCR should not adversely affect the pavement; and

  (ii) The annual number of overload movements should not exceed approximately 5 per cent of the total annual movements excluding light aircraft.

(b) Such overload movements should not normally be permitted on pavements exhibiting signs or failure. Furthermore, overloading should be avoided 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 the pavement.

19.1 ACRs for several aircraft types

For convenience, a dedicated software is available on the ICAO website, for computing any aircraft ACRs at any mass on rigid and flexible pavements for the four standard subgrade categories detailed in chapter 2, 2.6.6 (b) of the SLCAR Part14A.

20 AUTONOMOUS RUNWAY INCURSION WARNING SYSTEM (ARIWS)

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

20.1 General Description

(a) 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.

(b) 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.

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

(d) 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

(a) 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.

(b) 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.

(c) 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.

(d) 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 (c).

20.3 Aerodromes

(a) 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.

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

(i) 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;

(ii) the system must operate independently from ATS communications;

(iii) the system must provide a globally accepted visual signal that is consistent and instantly understood by crews; and

(iv) 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

(a) 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.

(b) In the case where a clearance has been issued and crew reports 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 (c) and 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.

(c) 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.

(d) 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

(a) Information on the characteristics and status of an ARIWS at an aerodrome are promulgated in the AIP section AD 2.9 in the ICAO PANS-AIM (ICAO Doc 10066), and its status updated as necessary through NOTAM or ATIS in compliance with 2.9.1 of the SLCAR Part 14A.

(b) Aircraft operators are to ensure that flight crews' documentation include procedures regarding ARIWS and appropriate guidance information, in compliance with the SLCAR Part 6A.

(c) 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

(a) 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.

(b) 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.

(c) For taxiways intersecting with runways, avoid designing taxiways wider than recommended in the SLCAR Part 14A. This design principle offers improved recognition of the location of the runway holding position and the accompanying sign, marking and lighting visual cues.

(d) Existing taxiways wider than recommended in the SLCAR Part 14A, 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.

(e) 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.

(f) 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.

(g) 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.

(h) 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.

(i) 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.

(j) 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.

(k) A perimeter taxiway would be designed according to the following criteria:

   (i) 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.

   (ii) 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.

   (iii) 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.

(iv) 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 of the SLCAR Part 14A, relates 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 the Authority 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

(a) 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:

(i) on-board positioning and route awareness including moving maps with own aircraft position, surface guidance and navigation;

(ii) traffic awareness including surveillance and runway incursion detection and alerting (such as, respectively, in A-SMGCS levels 1 and2);

(iii) 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 and4);

(iv) facilitation of aerodrome-related aeronautical information, including NOTAMs;

(v) resource and aerodrome facility management; and

(vi) aeronautical chart production.

(b) 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:

(a) safety risks at the aerodrome;

(b) visibility conditions;

(c) aerodrome layout; and

(d) traffic density.

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