CHAPTER 3. PHYSICAL CHARACTERISTICS

3.1 Runways

Number and orientation of runways

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

One important factor is the usability factor, as determined by the wind distribution, which is specified hereunder. Another important factor is the alignment of the runway to facilitate the provision of approaches conforming to the approach surface specifications of Chapter 4. **In Attachment A, Section I, information is given concerning these and other factors.**

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

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

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

3.1.2 Choice of maximum permissible cross wind components

In the application of 3.1.1 it shall be assumed that landing or take-off of aeroplanes is, in normal circumstances, precluded when the cross-wind component exceeds:

- 37 km/h (20 kt) in the case of aeroplanes whose reference field length is 1500 m or over, except that when poor runway braking action owing to an insufficient longitudinal coefficient of friction is experienced with some frequency, a cross-wind component not exceeding 24 km/h (13 kt) shall be assumed;

- 24 km/h (13 kt) in the case of aeroplanes whose reference field length is 1200 m or up to but not including 1500 m; and

- 19 km/h (10 kt) in the case of aeroplanes whose reference field length is less than 1200 m.

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

3.1.3 Data to be used

The selection of data to be used for the calculation of the usability factor shall be based on reliable wind distribution statistics that extend over as long a period as possible, preferably of not less than five years.

Note: - These winds are mean winds. Reference to the need for some allowance for gusty conditions is given in **ICAO, Annex-14**, Attachment A, Section 1.

Location of threshold

3.1.4 A threshold shall normally be located at the extremity of a runway unless operational considerations justify the choice of another location.

Guidance on the siting of threshold.

3.1.4.1 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 shall 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 ICAO Annex10, Volume I, Part I.)

3.1.4.2 In determining that no obstacle penetrate above the approach surface, account shall be taken of mobile objects (vehicles on roads, trains, etc.)at least within that portion of the approach area within1200m longitudinally from the threshold and of an over-all width of not less than 150 m.

Displaced threshold

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

Guidance on factors, which may be considered in determination of location of a displaced threshold.

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

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

3.1.5.3 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, shall 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.

3.1.5.4 notwithstanding the consideration of landing distance available, the selected position for the threshold shall not be such that the obstacle-free surface to the thresh-old 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.

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

Actual length of runways

3.1.6 Primary runway

Except as provided in 3.1.8, the actual runway length to be provided for a primary runway shall be adequate to meet the operational requirements of the aeroplanes for which the runway is intended and shall be not less than the longest length determined by applying the corrections for local conditions to the operations and performance characteristics of the relevant aeroplanes.

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

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

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

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

Secondary runway

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

Runways with stopways or clearways

3.1.8 **Recommendation: -** Where a runway is associated with a stopway or clearway, an actual runway length less than that resulting from application of 3.1.6 or 3.1.7, as appropriate, may be considered satisfactory, but in such a case any combination of runway, stopway and clearway provided should permit compliance with the operational requirements for take-off and landing of the aeroplanes the runway is intended to serve.

Guidance on use of Stopway and clearways.

3.1.8.1 The decision to provide a stopway and/or a clearway as an alternative to an increased length of runway will depend on the physical characteristics of the area beyond the runway end, and on the operating performance requirements of the prospective aeroplanes. The runway, stopway and clearway lengths to be provided are determined by the aeroplane take-off performance, but a check shall 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.

3.1.8.2 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.

3.1.8.3 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.

3.1.8.4 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.

3.1.8.5 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.

3.1.8.6 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 over-all length.

3.1.8.7 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) shall 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.

3.1.8.8 The minimum runway length and the maximum stop-way or clearway length to be provided may be determined as follows, from the data in the aeroplane flight manual for the aeroplane considered to be critical from the viewpoint of runway length requirements:

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

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

3.1.8.9 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.

3.1.8.10 The economy of a stopway can be entirely lost if, after each usage, it must be regarded and compacted. Therefore, it shall 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.

Width of runways

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

	Code letter					
Code number	**A**	**B**	**C**	**D**	**E**	**F**
1[a]	18 m	18 m	23 m	-	-	-
2[a]	23 m	23 m	30 m	-	-	-
3	30 m	30 m	30 m	45 m	-	-
4	-	-	45 m	45 m	45 m	60 m

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

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

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

Minimum distance between parallel runways

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

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

150 m where the higher code number is 2; and

120 m where the higher code number is 1.

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

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

- **1035 m** for independent parallel approaches;
- **915 m** for dependent parallel approaches;
- **760 m** for independent parallel departures;
- **760 m** for segregated parallel operations;

Except that:

a) For segregated parallel operations the specified minimum distance:

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

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

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

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

Slopes on runways

Longitudinal slopes

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

- **1 per cent** where the code number is 3 or 4; and
- **2 per cent** where the code number is 1 or 2.

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

- **1.25 per cent where the code number is 4**, except that for the first and last quarter of the length of the runway the longitudinal slope should not exceed 0.8 per cent;
- **1.5 per cent where the code number is 3**, except that for the first and last quarter of the length of a precision approach runway category II or III the longitudinal slope should not exceed 0.8 per cent; and
- **2 per** cent where the code number is 1 or 2.

Longitudinal slope changes

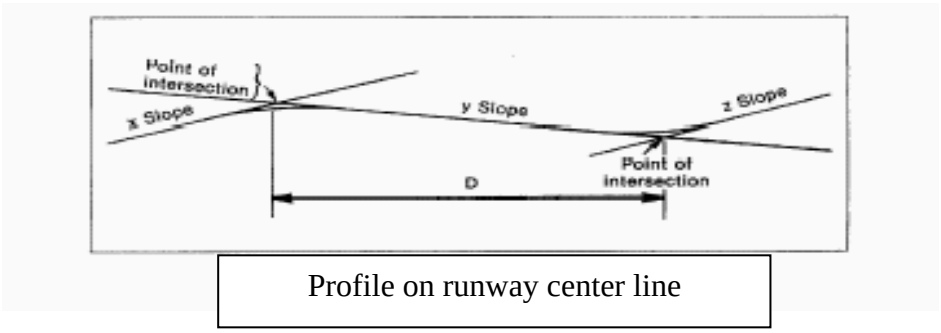
3.1.14 **Recommendation:** - Where slope changes cannot be avoided, a slope change between two consecutive slopes should not exceed:

- 1.5 per cent where the code number is 3 or 4; and
- 2 per cent where the code number is 1 or 2.

Guidance on the slope changes before a runway

3.1.14.1 Distance between slope changes

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



Profile on runway center line

D for a runway where the code number is 3 shall 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 = B0.005
z = +0.005

then |x - y| = 0.015

|y - z| = 0.01

To comply with the specifications, D shall 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

3.1.14.2 When a runway is planned that will combine the extreme values for the slopes and changes in slope permitted under Chapter 3, 3.1.12 to 3.1.18, a study shall be made to ensure that the resulting surface profile will not hamper the operation of aeroplanes.

Radio altimeter operating area

3.1.14.3 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 shall 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 shall not exceed 2per cent per 30 m.

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

- 0.1 per cent per 30 m (minimum radius of curvature of 30 000 m) where the code number is 4;
- 0.2 per cent per 30 m {minimum radius of curvature of 15 000 m) where the code number is 3; and
- 0.4 per cent per 30 m {minimum radius of curvature of 7 500 m) where the code number is I or 2.

Sight distance

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

- Any point 3 m above a runway to all other points 3 m above the runway within a distance of at least half the length of the runway where the code letter is C, D, E or E

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

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

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

Distance between slope changes

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

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

- 30 000 m where the code number is 4;
- 15 000 m where the code number is 3; and
- 5000 m where the code number is I or 2; or

b) 45 m;

Whichever is greater.

Transverse slopes

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

- 1.5 per cent where the code letter is C, D, E or F; and
- 2 per cent where the code letter is A or B;

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

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

Note: - On wet runways with cross-wind conditions the problem of aquaplaning from poor drainage is apt to be accentuated. In Chapter **2, Para 2.11.** Information is given concerning this problem and other relevant factors.

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

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

Strength of runways

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

Surface of runways

3.1.21 The surface of a runway shall be constructed **without irregularities** that would result in loss in friction characteristics or otherwise adversely affect the take-off or landing of an aeroplane.

Note: - 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.

Guidance on surface evenness

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

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

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

3.1.21.3 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.

3.1.21.4 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.

Note: - Additional guidance is included in the Aerodrome Design Manual, Part 3.

3.1.22 The surface of a paved runway shall be so constructed as to provide good friction characteristics when the runway is wet.

3.1.23 Measurements of the friction characteristics of a new or resurfaced runway shall be made with a continuous friction-measuring device using self-wetting features in order to assure that the design objectives with respect to its friction characteristics have been achieved. **For guidance See Chapter 2, Para 2.11** and additional guidance is available in the Airport Services Manual, Part 2.

3.1.24 The average surface texture depth **of a new surface** shall be not less than 1.0 mm.

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

Note 2: - Guidance on methods used to measure surface texture is available in the Airport Services Manual, Part 2.

3.1.25 when the surface is grooved or scored, the grooves or scorings shall be either perpendicular to the runway centre line or parallel to non-perpendicular transverse joints, where applicable.

Note: - Guidance on methods for improving the runway surface texture is available in the Aerodrome Design Manual, Part 3.

3.2 Runway shoulders

General

Note: - Guidance on characteristics and treatment of runway shoulders is given in **ICAO, Annex-14 vol. 1**,Attachment A, Section 8, and in the Aerodrome Design Manual, Part 1.

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

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

Width of runway shoulders

3.2.3 **Recommendation: -** The runway shoulders should extend symmetrically on each side of the runway so that the overall width of the runway and its shoulders is not less than:

- **60 m** where the code letter is D or E; and
- **75 m** where the code letter is F.

Slopes on runway shoulders

3.2.4 **Recommendation**. -The surface of the shoulders that abuts the runway should be flush with the surface of the runway and its transverse slope should not exceed 2.5 percent.

Strength of runway shoulders

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

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

Guidance on characteristic and treatment of runway shoulders

3.2.5.1 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.

3.2.5.2 In some cases, the bearing strength of the natural ground in the strip may be sufficient, without special preparation, to meet the requirements for shoulders. Where special preparation is necessary, the method used will depend on local soil conditions and the mass of the aeroplanes the runway is intended to serve.

Soil tests will help in determining the best method of improvement (e.g. drainage, stabilization, surfacing, light paving).

3.2,5.3 Attention shall 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, Part 2, both as to the special measures, which may be necessary, and as to the distance over which such special measures, if required, shall be taken.

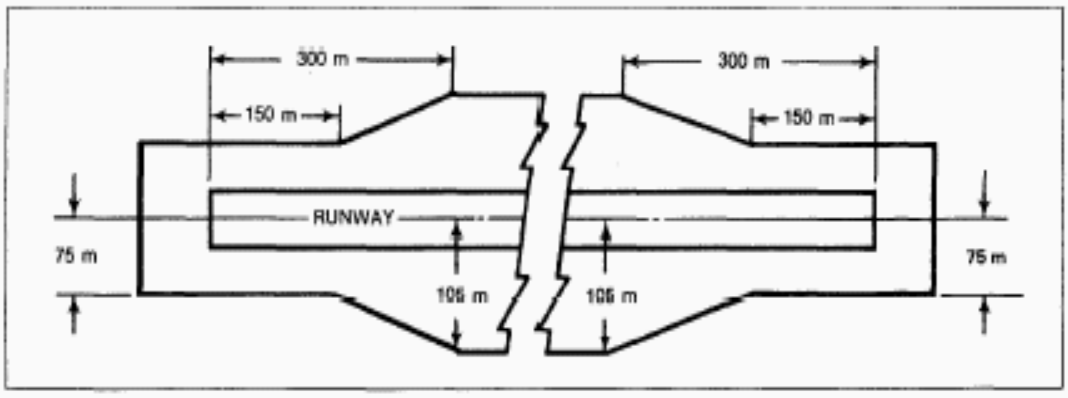
3.2.5.5 Where shoulders have been treated specially, either to provide the required bearing strength or to prevent the presence of stones or debris, difficulties may arise because of a lack of visual contrast between the runway surface and that of the adjacent strip. This difficulty can be overcome either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

3.2.5.6 Within the general area of the strip adjacent to the runway, measures shall 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, shall be buried to a depth of not less than 30 cm.

Grading of a strip for precision approach runways

3.2.5.7 Chapter 3, 3.3.8 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 Below** 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.



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

3.3 Runway turn pads

General

3.3.1 where the end of a runway is note served by a taxiway or a taxiway turn around, and where the code letter is D, E or F, a runway turn pad shall be provided to facilitate a 180-degree turn of aeroplanes. (See Figure 3-1)

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

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

Note 2: - Guidance on the design of the runway turn pads is available in the Aerodrome Design Manual, Part-1, Guidance on taxiway turn around as an alternate facility is available in the Aerodrome Design Manual, Part-2.

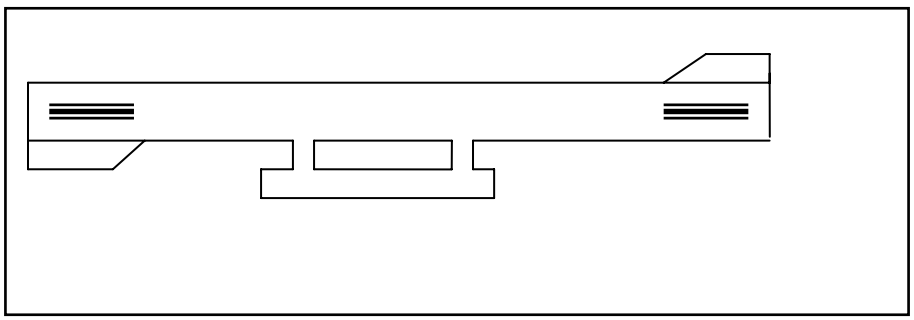


Figure 3-1. Typical turn pad layout

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

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

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

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

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

Code Letter	Clearance
A	1.5 m
B	2.25 m
C	3 m if the turn pad is intended to be used by aeroplanes with a wheel base less than 18 m. 4.5m if the turn pad is intended to be used by aeroplanes with a wheel base equal to or greater than 18 m
D	4.5 m
E	4.5 m
F	4.5 m

Note 1: - Wheelbase means the distance from the nose gear to the geometric center of the main gear.

3.3.7 where severe weather conditions and resultant lowering of the surface friction characteristics prevail, a larger wheel-to-edge clearance of **6 m** shall be provided where the **codes letter is E or F**

Slopes on runway turn pads

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

Strength of runway turn pads

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

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

Surface of runway turn pads

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

3.3.11 The surface of a runway turn pad shall be so constructed as to provide good friction characteristics for aeroplanes using the facility when the surface is wet.

Shoulders for runway turn pads

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

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

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

3.4 Runway strips

General

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

Length of runway strips

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

- **60 m** where the code number is 2, 3 or 4;
- **60 m** where the code number is 1 and the runway is an instrument one; and
- **30 m** where the code number is 1 and the runway is a non-instrument one.

Width of runway strips

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

- **150 m** where the code number is 3 or 4; and
- **75 m** where the code number is 1 or 2;

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

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

- **1.50 m** where the code number is 3 or 4; and
- **75 m** where the code number is I or 2;

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

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

- **75 m** where the code number is 3 or 4;
- **40 m** where the code number is 2; and
- **30 m** where the code number is 1.

Objects on runway strips

Note: - See **9.9** for information regarding siting and construction of equipment and installations on runway strips.

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

3.4.7 **No fixed** object, other than visual aids required for air navigation purposes and satisfying the relevant frangibility requirement in Chapter 5, shall be permitted on a runway strip:

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

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

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

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

Grading of runway strips

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

- **75 m** where the code number is 3 or 4; and
- **40 m** where the code number is I or 2;

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

Note: - Guidance on grading of a greater area of a strip including a precision approach runway where the code number is 3 or 4 is given in **Para 3.2.5.1.**

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

- **75 m** where the code number is 3 or 4;
- **40 m** where the code number is 2; and Strength of runway strips
- **30 m** where the code number is 1;

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

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

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

Slopes on runway strips

Longitudinal slopes

3.4.12 **Recommendation.** -A longitudinal slope along that portion of a strip to be graded should not exceed:

- 1.5 per cent where the code number is 4;
- 1.75 per cent where the code number is 3; and
- 2 per cent where the code number is 1 or 2.

Longitudinal slope changes

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

Transverse slopes

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

- **2.5** per cent where the code number is 3 or 4; and
- **3** per cent where the code number is I or 2;

Except that to facilitate drainage the slope for the first 3 m outward from the runway, shoulder or stopway edge should be negative as measured in the direction away from the runway and may be as great as 5 per cent.

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

Strength of runway strips

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

- **75** m where the code number is 3 or 4; and
- **40** m where the code number is 1 or 2;

from the centre line of the runway and its extended centre line **shall be so prepared or constructed as to minimize hazards** arising from differences in load bearing capacity to aeroplanes which the runway is intended to serve in the event of an aeroplane running off the runway.

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

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

- **75** m where the code number is 3 or 4; and
- **40** m where the code number is 2; and
- **30** m where the code number is I;

from the centre line of the runway and its extended centre line **shall be so prepared or constructed as to minimize hazards** arising from differences in load bearing capacity to aeroplanes which the runway is intended to serve in the event of an aeroplane running off the runway.

3.5 Runway end safety areas

3.5.1 General

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

- The code number is **3 or 4**; and

- The code number is **1 or 2** and the runway is an instrument one.

Note. - Guidance on runway end safety areas is given in Para 3.5.12.

Dimensions of runway end safety areas

3.5.2 A runway end safety area shall extend from the end of a runway strip to a distance of **at least 90 m.**

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

- 240 m where the code number is 3 or 4; and
- 120 m where the code number is 1 or 2.

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

3.5.5 The width of a runway end safety area shall, wherever practicable, be equal to that of the graded portion of the associated runway strip.

Objects on runway end safety areas

Note: - **See 9.9** for information regarding siting and construction of equipment and installations on runway end safety areas.

3.5.6 An object situated on a runway end safety area which may endanger aeroplanes **shall be regarded as an obstacle** and shall, as far as practicable, be removed.

Clearing and grading of runway end safety areas

3.5.7 A runway end safety area shall provide a cleared and graded area for aeroplanes which the runway is intended to serve in the event of an aeroplane undershooting or overrunning the runway.

Note: - The surface of the ground in the runway end safety area does not need to be prepared to the same quality as the runway strip. See, however, 3.5.11.

Slopes on runway end safety areas

General

3.5.8 **Recommendation:-** The slopes of a runway end safety area should be such that no part of the runway end safety area penetrates the approach or take-off climb surface.

Longitudinal slopes

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

Transverse slopes

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

Strength of runway end safety areas

3.5.11 A runway end safety area shall be so prepared or constructed as to reduce the risk of damage to an aeroplane undershooting or overrunning the runway, enhance aeroplane deceleration and facilitate the movement of rescue and fire fighting vehicles as required in 9.2.26 to 9.2.28.

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

Guidance on runway end safety area.

3.5.12 where a runway end safety area is provided in accordance with Chapter 3, consideration shall 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 shall 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 shall extend as far as the obstacle.

3.5.13 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.

3.6 Clearways

Note: -The inclusion of detailed clearways in this section is not intended to imply that a clearway has to be provided. Guidance on the use of **clearway is given in Para 3.1.8.1.**

Location of clearways

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

Length of clearways

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

Width of clearways

3.6.3 A clearway shall extend laterally to a distance of at least 75 m on each side of the extended centre line of the runway.

Slopes on clearways

3.6.4 The ground in a clearway shall not project above a plane having an upward slope of 1.25 per cent, the lower limit of this plane being a horizontal line which:

a) is perpendicular to the vertical plane containing the runway centre line: and
b) passes through a point located on the runway centre line at the end of the take-off run available.

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

3.6.5 Abrupt upward changes in slope shall be avoided when the slope on the ground in a clearway is relatively small or when the mean slope is upward. In such situations, in that portion of the

clearway within a distance of 22.5 m or half the runway width whichever is greater on each side of the extended centre line, the slopes slope changes and the transition from runway to clearway shall generally conform with those of the runway with which the cleat-way is associated.

Objects on clearways

Note: - See **9.9** for information regarding siting and construction of equipment and installations on clearways.

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

3.7 Stopways

Note: - The inclusion of detailed specifications for stopways in this section is not intended to imply that a stopway has to be provided. Guidance on the use of stopway **is given in Para 3.1.8.1.**

Width of stopways

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

Slopes on stopways

3.7.2 **Recommendation:** -Slopes and changes in slope on a stopway, and the transition from a runway to a stopway, should comply with the specifications of 3.1.12 to 3.1.18 for the runway with which the stopway is associated except that:

a) The limitation in 3.1.13 of a 0.8 per cent slope for the first and last quarter of the length of a runway need not be applied to the stopway; and

b) At the junction of the stopway and runway and along the stopway the maximum rate of slope change may be 0.3 per cent per 30 m (minimum radius of curvature of 10 000 m) for a runway where the code number is 3 or 4.

Strength of stopways

3.7.3 A stopway shall be prepared or constructed so as to be capable, in the event of an abandoned take-off; of supporting the

aeroplane which the stopway is intended to serve without inducing structural damage to the aeroplane.

Note: - Para 3.1.8.1 presents guidance relative to the support capability of a stopway.

Surface of stopways

3.7.4 The surface of a paved stopway shall be so constructed as to provide a good coefficient of friction to be compatible with that of the associated runway when the stopway is wet.

3.7.5 The friction characteristics of an unpaved stopway shall not be substantially less than that of the runway with which the stopway is associated.

3.8 Radio altimeter operating area

General

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

Length of the area

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

Width of the area

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

Longitudinal slope changes

3.8.4 **Recommendation: -** *On a radio altimeter operating area, slope changes should be avoided or kept to a minimum. Where slope changes cannot be avoided, the slope changes should be as gradual as practicable and abrupt changes or*

sudden reversals of slopes avoided. The rate of change between two consecutive slopes should not exceed 2 per cent per 30 m.

Note: - Guidance on radio altimeter operating area is given in **Para 3.1.14.3.**and in the Manual of All-Weather Operations, (Dot 9365), Section 5.2. Guidance on the use of radio altimeter is given in the PANS-OPS, Volume II, Part III, Chapter 21.

3.9 Taxiways

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

General

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

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

Note: - Where the end of a runway is not served by a taxiway, it may be necessary to provide additional pavement at the end of the runway for the turning of aeroplanes. Such areas may also be useful along the runway to reduce taxiing time and distance for some aeroplanes.

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

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

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

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

Width of taxiways

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

Code letter	Taxiway Width
A	7.5 m
B	10.5 m
C	**15 m** if the taxiway is intended to be used by aeroplanes with a wheel base less than **18 m**; **18 m** if the taxiway is intended to be used by aeroplanes with a wheel base equal to or greater than **18 m**;
D	**18 m** if the taxiway is intended to be used by aeroplanes with an outer main gear wheel span of less than **9 m**; **23 m** if the taxiway is intended to be used by aeroplanes with an outer main gear wheel span equal to or greater than **9 m**.
E	23 m
F	25 m

Note: - Guidance on width of taxiways is given in the ICAO Aerodrome Design Manual, Part 2

Taxiway curves

3.9.5 Changes in direction of taxiways shall be as few and small as possible. The radii of the curves shall be compatible with the manoeuvring capability and normal taxiing speeds of the aeroplanes for which the taxiway is intended. The design of the curve shall be such that, when the cockpit of the aeroplane remains over the taxiway centre line markings, the clearance distance between the outer main wheels of the aeroplane and the edge of the taxiway shall not be less than those specified in 3.9.3.

Note 1: - An example of widening taxiways to achieve the wheel clearance specified is illustrated in **Figure 3-2**. Guidance on the values of suitable dimensions is given in the Aerodrome Design Manual, Part 2.

Note 2: - The location of taxiway centre line markings and lights is specified in 5.2.8.4 and 5.3.16.11.

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

Table 3-1 – Taxiway minimum separation distances

Code letter	Distance between taxiway centre line and runway centre line (**metres**)								Taxiway centre line to taxiway centre line (**metres**)	Taxiway, other than aircraft stand taxilane, centre line to object (**metres**)	Aircraft stand taxilane centre line to object (**metres**)
	Instrument runways Code number				Non-instrument runways Code number						
	1	2	3	4	1	2	3	4			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
A	82.5	82.5	-	-	37.5	47.5	-	-	23.75	16.25	12
B	87	87	-	-	42	52	-	-	33.5	21.5	16.5
C	-	-	168	-	-	-	93	-	44	26	24.5
D	-	-	176	176	-	-	101	101	66.5	40.5	36
E	-	-	-	182.5	-	-	-	107.5	80	47.5	42.5
F	-	-	-	190	-	-	-	115	97.5	57.5	50.5
Note 1: – The separation distances shown in columns (2) to (9) represent ordinary combinations of runways and taxiways. The basis for development of these distances is given in the ICAO Aerodrome Design Manual, Part 2.											
Note 2: – The distances in columns (2) to (9) do not guarantee sufficient clearance behind a holding aeroplane to permit the passing of another aeroplane on a parallel taxiway. See ICAO Aerodrome Design Manual, Part 2.											

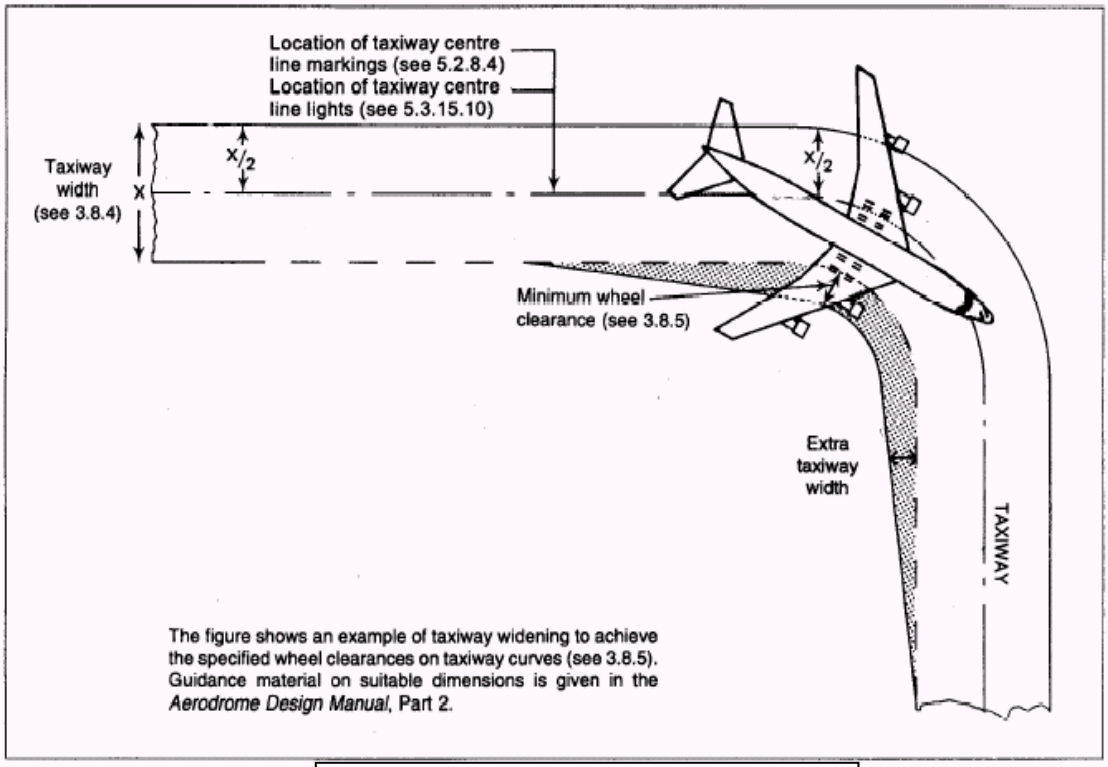


Figure 3-2 Taxiway curve

Junctions and intersections

3.9.6 To facilitate the movement of aeroplanes, fillets shall be provided at junctions and intersections of taxiways with runways, aprons and other taxiways. The design of the fillets shall ensure that the minimum wheel clearances specified in **3.9.3** are maintained when aeroplanes are manoeuvring through the junctions or intersections.

Note: - Consideration will have to be given to the aeroplane datum length when designing fillets. Guidance on the design of fillets and the definition of the term aeroplane datum length are given in the Aerodrome Design Manual, Part 2.

Taxiway minimum separation distances

3.9.7 **Recommendation: -** The separation distance between the centre line of a taxiway and the centre line of a runway, the centre line of a parallel taxiway or an object should not be less than the appropriate dimension specified in Table 3-1, except that it may

be permissible to operate with lower separation distances at an existing aerodrome if an aeronautical study indicates that such lower separation distances would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.

Note 1: - Guidance on factors which may be considered in the aeronautical study is given in the Aerodrome Design Manual, Part 2.

Note 2: - ILS and MLS installations may also influence the location of taxiways due to interferences to ILS and MLS signals by a taxiing or stopped aircraft. Information on critical and sensitive areas surrounding KS and MLS installations is contained in Annex IO, Volume I, Attachments C and G (respectively) to Part I.

Note 3: - The separation distances of Table 3-1, column IO, do not necessarily provide the capability of making a normal turn from one taxiway to another parallel taxiway. Guidance for this condition is given in the Aerodrome Design Manual, Part **2.**

Note 4: - The separation distance between the centre line of an aircraft stand taxilane and an object shown in Table 3-1, column 12, may need to be increased when jet exhaust wake velocity may cause hazardous conditions for ground servicing.

Slopes on taxiways

3.9.8 **Longitudinal slopes**

The longitudinal slope of a taxiway shall not exceed:

- **1.5** per cent where the code letter is C, D, E or F; and
- **3** per cent where the code letter is A or B.

3.9.9 **Longitudinal slope changes**

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

- 1 per cent per 30 m (minimum radius of curvature of 3 000 m) where the Code letter is C, D, E or F; and

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

Sight distance

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

- 3 m above the taxiway, it will be possible to see the whole surface of the taxiway for a distance of at least 300 m from that point, where the code letter is C, D, E or F;

- 2 m above the taxiway, it will be possible to see the whole surface of the taxiway for a distance of at least 200 m from that point, where the code letter is B; and

- 1.5 m above the taxiway, it will be possible to see the whole surface of the taxiway for a distance of at least 150 m from that point, where the code letter is A.

Transverse slopes

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

- 1.5 per cent where the code letter is C, D, E or F; and
- 2 per cent where the code letter is A or B.

Note: - See 3.12.4 regarding transverse slopes on an aircraft stand taxilane.

Strength of taxiways

3.9.12 The strength of a taxiway shall be **at least equal to that of the runway it serves**, due consideration being given to the fact that a taxiway will be subjected to a greater density of traffic and, as a result of slow moving and stationary aeroplanes, to higher stresses than the runway it serves.

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

Surface of taxiways

3.9.13 The sulfate of a taxiway shall not have irregularities that cause damage to aeroplane structures.

3.9.14 The surface of a paved taxiway shall be so constructed as to provide good friction characteristics when the taxiway is wet.

Rapid exit taxiways

Note: - The following specifications detail requirements particular to rapid exit taxiways. **See Figure 3-3.** Genera requirements for taxiways also apply to this type of taxiway. Guidance on the provision, location and design of rapid exit taxiways is included in the Aerodrome Design Manual, Part 2.

3.9.15 **Recommendation: -**A rapid exit taxiway should be designed with a radius of turn-off curve of at least:

- 550 m where the code number is 3 or 4; and
- 275 m where the code number is 1 or 2;

To enable exit speeds under wet conditions of

- 93 km/h where the code number is 3 or 4; and
- 65 km/h where the code number is 1 or 2.

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

3.9.16 **Recommendation: -**The radius of the fillet on the inside of the curve at a rapid exit taxiway should be sufficient to provide a widened taxiway throat in order to facilitate early recognition of the entrance and turn-off onto the taxiway.

3.9.17 **Recommendation: -** A rapid exit taxiway should include a straight distance after the turn-off curve sufficient for an exiting aircraft to come to a full stop clear of any intersecting taxiway.

3.9.18 **Recommendation: -** The intersection angle of a rapid exit taxiway with the runway should not be greater than 45″ nor less than 25″ and preferably shall be 30″.

Taxiways on bridges

3.9.19 The width of that portion of a taxiway bridge capable of supporting aeroplanes, as measured perpendicularly to the taxiway centre line, shall not be less than the width of the graded area of the strip provided for that taxiway, unless a proven method of lateral restraint is provided which shall not be hazardous for aeroplanes for which the taxiway is intended.

3.9.20 Access shall be provided to allow rescue and fire fighting vehicles to intervene in both directions within the specified response time to the largest aeroplane for which the taxiway bridge is intended.

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

3.9.21 A bridge shall be constructed on a straight section of the taxiway with a straight section on both ends of the bridge to facilitate the alignment of aeroplanes approaching the bridge.

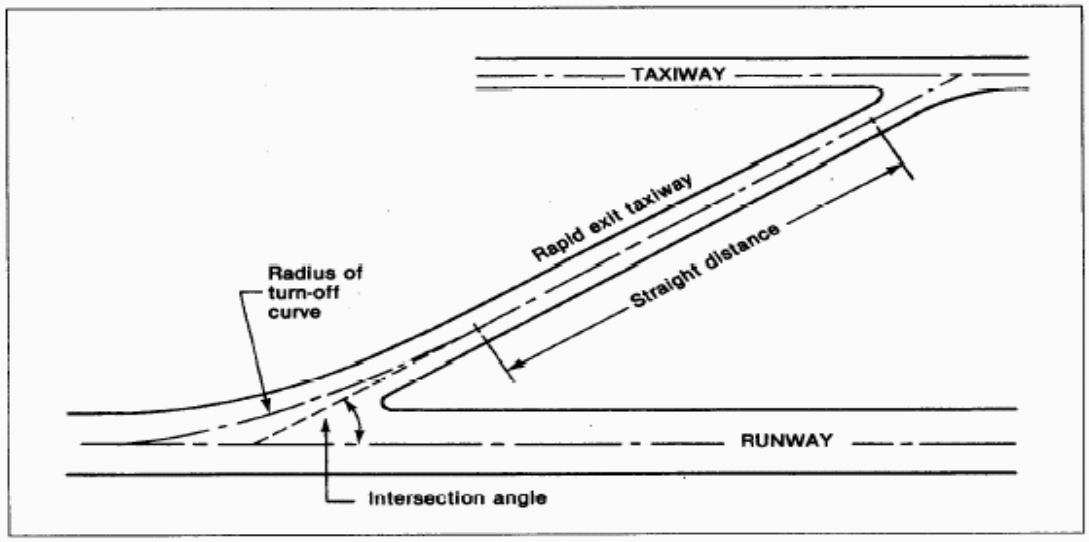


Figure 3-3 Rapid exit taxiway

3.10 Taxiway shoulders

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

3.10.1 Straight portions of a taxiway where the code letter is C, D, E or F shall be provided with shoulders which extend symmetrically on each side of the taxiway so that the overall width of the taxiway and its shoulders on straight portions is not less than:

- **60** m where the code letter is **F**;
- **44** m where the code letter is **E**;
- 38 m where the code letter is D; and
- 25 m where the code letter is C.

On taxiway curves and on junctions or intersections where increased pavement is provided, the shoulder width shall be not less than that on the adjacent straight portions of the taxiway.

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

3.11 Taxiway strips

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

General

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

Width of taxiway strips

3.11.2 A taxiway strip shall extend symmetrically on each side of the centre line of the taxiway throughout the length of the taxiway to at least the distance from the centre line given in Table 3-1, column II.

Objects on taxiway strips

Note: - See 9.9 for information regarding siting and construction of equipment and installations on taxiway strips.

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

Note: - Consideration will have to be given to the location and design of drains on a taxiway strip to prevent damage to an aeroplane accidentally running off a taxiway. Suitably designed drain covers may be required.

Grading of taxiway strips

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

- 11 m where the code letter is A;
- 12.5 m where the code letter is B or C;
- 19 m where the code letter is D;
- **22** m where the code letter is **E**; and
- **30** m where the code letter is **F**

Slopes on taxiway strips

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

- 2.5 per cent for strips where the code letter is C, D, E or F; and
- 3 per cent for strips of taxiways where the code letter is A or B;

the upward slope being measured with reference to the transverse slope of the adjacent taxiway surface and not the horizontal. The downward transverse slope shall not exceed 5 per cent measured with reference to the horizontal.

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

3.12 Holding bays, runway-holding positions, intermediate holding positions and road-holding positions.

General

3.12.1 Holding bay(s) shall be provided when the traffic density is medium or heavy.

3.12.2 A runway-holding position or positions shall be established:

a) on the taxiway, at the intersection of a taxiway and a runway; and
b) at an intersection of a runway with another runway when the former runway is part of a standard taxi-route.

3.12.3 A runway-holding position shall be established on a taxiway if the location or alignment of the taxiway is such that a taxiing aircraft or vehicle can infringe an obstacle limitation surface or interfere with the operation of radio navigation aids.

3.12.4 An intermediate holding position shall be established on a taxiway at any point other than a runway-holding position where it is desirable to define a specific holding limit.

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

Location

3.12.6 The distance between a holding bay, runway-holding position established at a taxiway/runway intersection or road-holding position and the centre line of a runway shall be in accordance with **Table 3-2** and, in the case of a precision approach runway,

such that a holding aircraft or vehicle will not interfere with the operation of radio navigation aids.

3.12.7 At elevations greater than 700 m (2300 ft) the distance of 90 m specified in Table 3-2 for a precision approach runway code number 4 shall be increased as follows:

a) Up to an elevation of 2,000 m (6,600 ft); 1m for every 100 m (330 ft) in excess of 700 m (2 300 ft);

b) Elevation in excess of 2 000 m (6 600 ft) and up to 4 000 m (13 320 ft); 13 m plus 1.5 m for every 100 m (3303) in excess of 2 000 m (6 6003); and

c) Elevation in excess of 4 000 m (13 320 ft) and up to 5 000 m (16 650 ft); 43 m plus 2 m for every 100 m (330 ft) in excess of 4 000 m (13 3209).

3.12.8 If a holding bay, runway holding position or road holding position for a precision approach runway code number 4 is at a greater elevation compared to the threshold, the distance of 90 m or 107.5 m, as appropriate, specified in Table 3-2 shall be further increased 5 m for every meter the bay or position is higher than the threshold.

3.12.9 The location of a runway-holding position established in accordance with 3.11.3 shall be such that a holding aircraft or vehicle will not infringe the obstacle free zone, approach surface, take-off climb surface or ILS/MLS critical/sensitive area or interfere with the operation of radio navigation aids.

3.13 Aprons

General

3.13.1 Aprons shall be provided where necessary to permit the on and off-loading of passengers, cargo or mail as well as the servicing of aircraft without interfering with the aerodrome traffic.

Size of aprons

3.13.2 The total apron area shall be adequate to permit expeditious handling of the aerodrome traffic at its maximum anticipated density.

Strength of aprons

3.13.3 Each part of an apron shall be capable of withstanding the traffic of the aircraft it is intended to serve, due consideration being

given to the fact that some portions of the apron will be subjected to a higher density of traffic and, as a result of slow moving or stationary aircraft, to higher stresses than a runway.

Slopes on aprons

3.13.4 Slopes on an apron, including those on an aircraft stand taxilane, shall be sufficient to prevent accumulation of water on the surface of the apron but shall be kept as level as drainage requirements permit.

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

Table 3-2 – Minimum distance from the runway centre line to a hold bay, Runway-holding position or road-holding position

	Code number			
Type of runway	1	2	3	4
Non-instrument	30 m	40 m	75 m	75 m
Non-precision	40 m	40 m	75 m	75 m
Precision approach category I	60 m [b]	60 m [b]	90 m [a b]	90 m [a,b,c]
Precision approach categories II and III	-	-	90 m [a,b]	90 m [a,b,c]
Take-off runway	30 m	40 m	75 m	75 m

a. If a holding bay, runway-holding position or road-holding position is at a lower elevation compared to the threshold, the distance may be decreased 5 m for every meter the bay or holding position is lower than the threshold, contingent upon not infringing the inner transitional surface.

b. This distance may need to be increased to avoid interference with radio navigation aids, particularly the glide path and localizer facilities. Information on critical and sensitive areas of ILS and MLS is contained in ICAO Annex 10, Volume I, Attachments C and G to Part I, respectively (See also paragraph 3.12.6 of this Manual).

Note 1 — The distance of **90 m** for code number 3 or 4 is based on an aircraft with a tail height of **20 m**, a distance from the nose to the highest part of the tail of 52.7 m and a nose height of 10 m holding at an angle of 450 or more with respect to the runway centre line, being clear of the obstacle free zone and not accountable for the calculation of OCA/H.

Note 2 — The distance of 60 m for code number 2 is based on an aircraft with a tail height of 8 m, a distance from the nose to the highest part of the tail of **24.6 m** and a nose height of **5.2 m** holding at an angle of 45° or more with respect to the runway centre line, being clear of the obstacle free zone.

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

Note — The distance of **107.5 m** for code number 4 where the code letter is F is based on an aircraft with a tail height of 24 m, a distance from the nose to the highest part of the tail of **62.2 m** and a nose height of 10 m holding at an angle of 45° or more with respect to the runway centre line, being clear of the obstacle free zone.

Clearance distances on aircraft stands

3.13.6 An aircraft stand shall provide the following minimum clearances between an aircraft using the stand and any adjacent building, aircraft on another stand and other objects:

Code letter	Clearance
A	3 m
B	3m
C	4.5m
D	7.5m
E	7.5m
F	7.5m

When special circumstances so warrant, these clearances may be reduced at a nose-in aircraft stand, where the code letter is **D, E or F:**

a) Between the terminal, including any fixed passenger bridge, and the nose of an aircraft; and
b) Over any portion of the stand provided with azimuth guidance by a visual docking guidance system.

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

3.14 Isolated aircraft parking position

3.14.1 An isolated aircraft parking position shall be designated or the aerodrome control tower shall be advised of Annex I4 – Aerodromes an area or areas suitable for the parking of an aircraft which is known or believed to be the subject of unlawful interference, or which for other reasons needs isolation from normal aerodrome activities.

3.14.2 **Recommendation: -** The isolated aircraft parking position should be located at the **maximum distance practicable** and in any case **never less than 100 m** from other parking positions, buildings or public areas, etc. Care should be taken to ensure that the position is not located over underground utilities such as gas and aviation fuel and to the extent feasible, electrical or communication cables.

3.15 De/anti-icing facilities

Note: - Safe and efficient aeroplane operations are of primary importance in the development of an aeroplane de/anti-icing facility. For further guidance, see the Manual on Aircraft Ground De/Anti-icing Operations (Dot 9640).

General

3.15.1 **Recommendation. -** Aeroplane de/anti-icing facilities should be provided at an aerodrome where icing conditions are expected to occur.

Location

3.15.2 **Recommendation. -** De/anti-icing facilities should be provided either at aircraft stands or at specified remote areas along the taxiway leading to the runway meant for take-off provided that adequate drainage arrangements for the collection and safe disposal of excess de/anti-icing fluids are available to prevent ground water contamination. The effect of volume of traffic and departure flow rates should also be considered.

Note 1: - One of the primary factors influencing the location of a de/anti-icing facility is to ensure that the holdover time of the anti-icing treatment is still in effect at the end of taxiing and when take-off clearance of the treated aeroplane is given.

Note 2: - Remote facilities compensate for changing weather conditions when icing conditions or blowing snow are expected to occur along the taxi route taken by the aeroplane to the runway meant for take-off.

3.15.3 **Recommendation. -** The remote de/anti-icing facility should be located to be clear of the obstacle limitation surfaces specified in Chapter 4, not cause interference to the radio navigation aids and be clearly visible from the air traffic control tower for clearing the treated aeroplane.

3.15.4 **Recommendation. -** The remote de/anti-icing facility should be so located as to provide for an expeditious traffic flow, perhaps with a bypass configuration, and not require unusual taxiing manoeuvre into and out of the pads.

Note. - The jet blast effects caused by a moving aeroplane on other aeroplanes receiving the anti-icing treatment or taxiing behind will have to be taken into account to prevent degradation of the treatment.

Size and number of de/anti-icing pads

Note: - An aeroplane de/anti-icing pad consists of a) an inner area for parking of an aeroplane to be treated, and b) an outer area for movement of two or more mobile de/anti-icing equipment.

3.15.5 **Recommendation.** - The size of a de/anti-icing pad should be equal to the parking area required by the most demanding aeroplane in a given category with at least 3.8 m clear paved area all round the aeroplane for the movement of the de/anti-icing vehicles.

Note: - Where more than one de/anti-icing pad is provided, consideration will have to be given to providing de/anti-icing vehicle movement areas of adjacent pads that do not overlap, but are exclusive for each pad. Consideration will also need to be given to bypassing of the area by other aeroplanes with the clearances specified **in 3.15.9 and 3.15.10**.

3.15.6 **Recommendation. -** The number of de/anti-icing pads required should be determined based on the meteorological conditions, the type of aeroplanes to be treated, the method of application of de/anti-icing fluid, the type and capacity of the dispensing equipment used, and the departure flow rates.

Note: - See the Aerodrome Design Manual, Part 2.

Slopes on de/anti-icing pads

3.15.7 **Recommendation. -** The de/anti-icing pads should be provided with suitable slopes to ensure satisfactory drainage of the area and to permit collection of all excess de/anti-icing fluid running off an aeroplane. The maximum longitudinal slope should be as little as practicable and the transverse slope should not exceed 1 per cent.

Strength of de/anti-icing pads

3.15.8 **Recommendation. -** The de/anti-icing pad should be capable of withstanding the traffic of the aircraft it is intended to serve, due consideration being given to the fact that the de/anti-icing

pad (like an apron) will be subjected to a higher density of traffic and, as a result of slow-moving or stationary aircraft, to higher stresses than a runway.

Clearance distances on a de/anti-icing pad

3.15.9 **Recommendation. -** A de/anti-icing pad should provide the minimum clearances specified in 3.13.6 for aircraft stands. If the pad layout is such as to include bypass configuration, the minimum separation distances specified in Table 3-1, column 12, should be provided.

3.15.10 **Recommendation. -** Where the de/anti-icing facility is located adjoining a regular taxiway, the taxiway minimum separation distance specified in Table 3-1, column 11, should be provided. (See Figure 3-4.)

Environmental considerations

Note: - The excess de/anti-icing fluid running off an aeroplane poses the risk of contamination of ground water in addition to affecting the pavement surface friction characteristics.

3.15.11 **Recommendation: -** Where de/anti-icing activities are carried out, the surface drainage should be planned to collect the run-off separately, preventing its miring with the normal sulfate run-off so that it does not pollute the ground water.

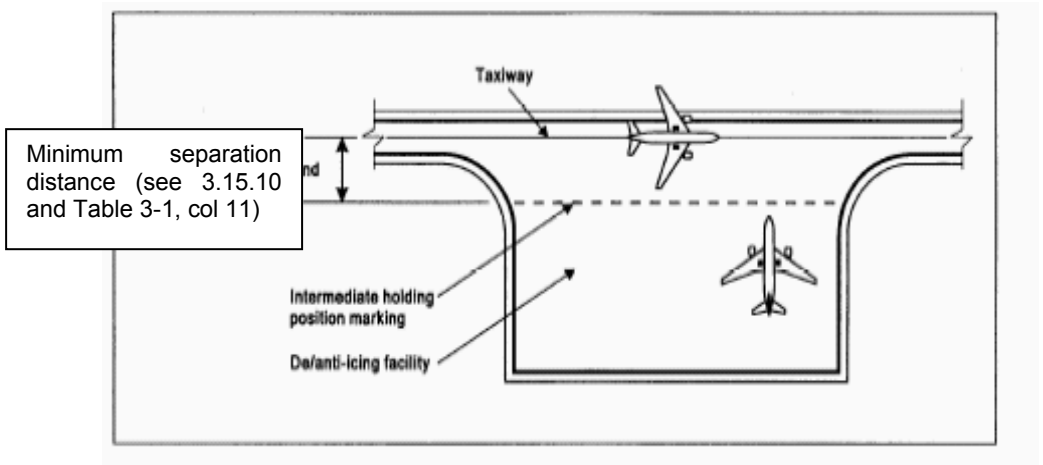


Figure 3-4 minimum separation distances on a de-icing/anti-icing facility

END OF CHAPTER 3